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Investigation of the Regional Innovation Paradox in the EU's "Lagging" Regions

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DEDICATION

To Jane, Eábha and Owen

DECLARATION

The author hereby declares that, except where duly acknowledged and referenced, this research is entirely his own work and has not been submitted for any degree or other qualification in Waterford Institute of Technology or any other third-level institution in Ireland or internationally.

Signed: Niall Crosbie

NIALL CROSBIE

Date: July 2021

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ABSTRACT

Investigation of the Regional Innovation Paradox in the EU's "Lagging" Regions

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This research has been inspired by what has been termed the "regional innovation paradox" (Oughton, Landabaso and Morgan, 2002), which suggests that the more that innovation is needed in order to improve competitiveness in "lagging" regions (or less developed regions), the more difficult it is to invest effectively in research and development (R&D) in such regions, and the more likely it is that they will be seen to under-invest in R&D and innovation. Furthermore, it has also been inspired by the Oughton et al (2002) assertion that the main cause of this paradox lay in the fragmented nature of "regional innovation systems" in these regions, and the institutional characteristics of regions, rather than availability of public funds.

The purpose of this research, therefore, has been to investigate how public policy towards and public investment in regional innovation systems has contributed to R&D and innovation performance in lagging regions. To do this, it adopted a mixed methods approach, combining use of quantitative and qualitative methods. Quantitative methods involved use of descriptive quantitative analysis of R&D and innovation inputs and outputs across a sample of lagging regions in the European Union (EU). Qualitative methods, meanwhile, involved the use of case study research of Galicia (Spain) and Puglia (Italy), using both secondary data (datasets, policy and strategy documents, funding programme documents, other reports and articles) and primary data (interviews with knowledgeable and experienced key informants).

Research findings suggest that public authorities in lagging regions have increasingly turned their attention towards developing policies to promote R&D and innovation and foster regional innovation systems, and that such policies in turn have most likely contributed to an increase in investment in R&D and innovation in such regions and an increase in outputs arising from R&D and innovation activity. At the same time, however, perceived weaknesses within lagging regions' innovation systems still appear to be evident, despite progress made and the associated growth in R&D and innovation investment and outputs, while the progress of R&D and innovation policy and performance in regions has also been affected by their interaction with other spatial levels (including interaction between policy makers at different spatial levels) and by the structural nature of the change being effected.

The research presents a number of important contributions to both theory and practice. Firstly, it contributes to bridging an ongoing knowledge gap on the development of regional innovation systems in lower performing regions. Secondly, it provides a more mixed methods approach to investigation of issues surrounding the regional innovation paradox. Thirdly, it contributes to knowledge and understanding of how inter-dependencies between different spatial levels (including inter-dependencies in policy making) influence R&D and innovation activity in lagging regions, while cautioning against a "one size fits all", best practice application of the regional innovation systems concept in lagging regions. And finally, it contributes to practice by highlighting policy implications for lagging regions, which include: stronger regional input or focus at all spatial levels of policy making; better collaboration and allocation of responsibility between different spatial levels of government; better integration of regional innovation policy with related policy areas; the need for long-term policy commitment in fostering innovation in lagging regions; the need for increased emphasis on non-R&D innovation initiatives; the need to improve understanding of the culture of both firms and supply-side institutions in lagging regions; better measures to promote collaboration between research institutions and firms, and among firms themselves; and targeted incentives to encourage research institutions and larger firms to increase R&D and innovation that aligns with regional needs.

Keywords: regional innovation paradox; regional innovation systems; lagging regions; regional innovation policy.

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PART A – PURPOSE, CONTEXT AND METHOD

CHAPTER 1 – INTRODUCTION

1.1 Introduction

The purpose of this chapter is to provide an introduction to the research. In this regard, Section 1.2 describes the background to the research topic. Section 1.3 outlines the research question and objectives, while Section 1.4 briefly introduces the conceptual framework underpinning the research. Thereafter, Section 1.5 provides an outline summary of the research process, while Section 1.6 describes the structure of the thesis.

1.2 Background

1.2.1 Regional Innovation Paradox

The focus of interest for this research lies in what has been termed the *regional innovation paradox*. This perceived paradox, which was first referred to in the early 2000s by Oughton, Landabaso and Morgan (2002), describes:

> *"… the apparent contradiction between the comparatively greater need to spend on innovation in lagging regions (i.e. less developed regions)*[1] *and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities, compared to more advanced regions" (Oughton et al, 2002, p. 98).*

That is, the more that innovation is needed in lagging regions in order to improve competitiveness, the more difficult it is to invest effectively in research and development (R&D) in such regions, and the more likely it is that such regions will be seen to under-invest in R&D and innovation (Oughton et al, 2002).

To illustrate this paradox, Oughton et al (2002) presented an empirical analysis of 178 regions across 12 member states of the European Union (EU). This analysis, according to the authors, suggested that regions that were lagging in economic output, in this case as measured by gross domestic product (GDP) per capita, devoted less resources to

[1] For a definition and description of lagging regions, as applied for the purposes of this research, see Chapter 3.

R&D and innovation activity, even when looked at in relative terms (e.g. as a percentage of GDP)[2]. However, the authors at the same time suggested that there was a strong positive correlation between investment in R&D, innovation activity and economic wealth, again as measured by GDP per capita, while also suggesting that this positive correlation between technological innovation and growth implied a need to close innovation/technology gaps as a pre-requisite to closing income gaps across regions[3].

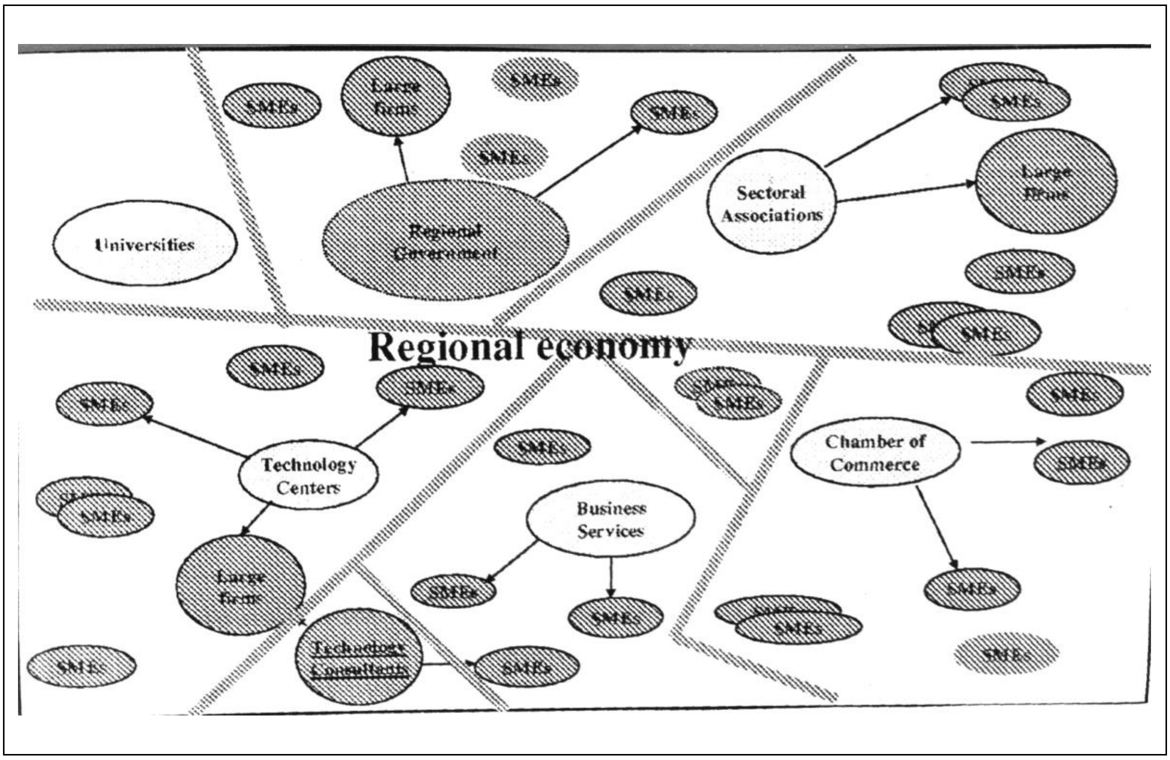
Moreover, Oughton et al (2002) noted that publicly funded expenditure on R&D in Europe (i.e. spending by the government sector, together with publicly funded spending on R&D in the education sector) was concentrated more on leading rather than lagging regions, both in absolute and relative terms. In terms of the paradox, therefore, the authors contended that industrial policy (e.g. investment implemented through the EU "Structural Funds"[4]) aimed to promote the convergence of lagging regions, by targeting public funds at poorer regions, but that technology policy reinforced regional imbalances, because public support was absorbed to a greater extent by leading regions. The nature of the paradox was thus described as showing complementary trends in business, education and government spending on R&D, but with technology and innovation policy, on the one hand, and industrial policy in regions, on the other, working in opposite directions (Oughton et al, 2002).

In response to these findings, Oughton et al (2002) stated that the main cause of the regional innovation paradox lay in the fragmented nature of *regional innovation systems* in lagging regions, and the institutional characteristics of such regions, rather than the availability of public funds (see Figure 1.1). It was argued, for example, that firms in lagging regions often articulate little demand for R&D and other innovation inputs, and tend to lack a tradition of co-operation and trust amongst both themselves or with

[2] In this regard, research by Rodríguez-Pose (2001), in an analysis of European regions between 1986 and 1996, also found that investment in R&D was more commonly concentrated in leading regions, and lagging regions tended to have the lowest R&D investment in relative terms.
[3] In this regard, Rodríguez-Pose (2001) also noted that several less developed countries (e.g. Ireland, Greece, Spain, Portugal) saw levels of R&D expenditure increase in relative terms over the 1986-96 period, while research by Bilbao-Osorio and Rodríguez-Pose (2004), which looked at regions across nine of the (then) 15 member states in the EU during the 1990-98 period, made similar findings.
[4] The EU's European Structural and Investment Funds (more commonly known as the Structural Funds) are the main investment funds that the EU uses to support economic development across its member states. For further context on the role of the Structural Funds as an EU policy vehicle, see Chapter 2.

regional innovation actors (e.g. universities), while regional research and technological infrastructure (e.g. universities) tends not to be embedded in the regional economy, with suppliers of innovation services unable to identify the innovation needs and capabilities of firms in the regional economy. Such regions were hence described as lacking the necessary interfaces and co-operation mechanisms to match supply of innovation inputs to firms' demand, or the appropriate conditions to exploit synergies and co-operation among regional innovation actors, which could eventually fill gaps and avoid duplications in service provision (Oughton et al, 2002)[5].

Figure 1.1: Fragmented Nature of Regional Innovation Systems



Source: Oughton et al (2002)

Oughton et al (2002), therefore, contended that any remedy to address the regional innovation paradox required public policies that would improve the wider systemic capacity of a region to absorb investment for innovation activities, with suggested action to resolve the paradox involving policies that:

[5] Similarly, Grillo and Landabaso (2011) have also asserted that the paradox occurs because of the nature of the regional innovation system and the institutional capacity in lagging regions, and that such regions need stronger planning capacity, appropriate intermediaries to implement policy and effective co-operation mechanisms between the private sector and/or knowledge institutions in order to overcome this.

- *"... increase the innovation capacity of regions by working on both the demand and the supply side of the system to increase both private and public sector investment in innovation activity";*
- *"... integrate technology policy and industrial policy by encouraging expenditure on innovation activity within mainstream industrial policy [e.g. EU Structural Fund] programmes" (Oughton et al, 2002, p. 108).*

Conceptually, the suggested remedies to the paradox thus subscribed to a *systems of innovation* approach. Such an approach, which is described in more detail in the literature review in Chapter 4, is now also briefly discussed in Section 1.2.2.

1.2.2 Systems of Innovation

The systems of innovation approach is a conceptual approach to understanding R&D and innovation, which became popular in the 1990s through the work of authors such as Lundvall (2010, first published in 1992), Nelson and Rosenberg (1993) and Nelson (1993).

The Lundvall description of such systems of innovation defined the system as being "… constituted by a number of elements and by the relationships between these elements" (Lundvall, 2010, p. 2), or as being "… constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge" (Lundvall, 2010, p. 2). In their contribution, Nelson and Rosenberg (1993), in Nelson (1993), interpreted the concept of an innovation system as being a group of institutions or actors that interact with each other, and which thereby are a direct determinant of the innovative performance of firms, while Autio (1998) described such systems as being "essentially social systems, composed of interacting sub-systems … (and) the interactions within and between organisations and sub-systems generate the knowledge flows that drive the evolution of the innovation systems" (Autio, 1998).

The elements that interact within such systems, meanwhile, have been summarised by Lundvall (2010) as including: the internal organisation of firms and the relationships between firms; the role of the public sector; the institutional set-up of the financial sector; the education and training system; and the level of intensity and organisation of R&D within the system. Nelson (1993), in a similar vein, also strongly emphasised the competitive competence of firms, education and training systems and the role of government as being common elements in stimulating effective innovation performance in such systems. Individual actors within such systems, therefore, might include individual firms, sectoral or value chain clusters or networks, business service providers, technology centres, R&D centres, university departments, technology transfer centres and government departments or development agencies.

However, and especially in Lundvall's conception, it was the learning generated and knowledge created from the interaction of these elements that was considered to be critical in stimulating innovation within a system, while learning within such systems was also assumed to be principally an interactive process. Thus, innovative capacity (and the learning ability associated with it) was considered to be directly related to the density and quality of networking within innovation systems, with inter-firm and public-private co-operation (and the institutional framework within which these relationships take place) being key sources of innovation, which required active rather than passive involvement of the elements or actors within the system.

According to Oughton et al (2002), therefore, this type of approach improves our understanding of the various channels, mechanisms and conditions through which innovation improves economic performance, while at the same time they acknowledge the potential complexity of the myriad of relationships in such a system and, indeed, the need for further research in the area.

Yet, the work of Lundvall, Nelson and others tended to focus on the national level as the main locus for innovation systems, whereas Oughton et al (2002) argued that the role of innovation systems needs to be acknowledged not only at a national level but also at a regional level (based on an argument that many of the factors that influence innovation capability at a national level also have regional dimensions). In doing this, the authors were thus drawing on an emerging body of research into the concept of regional innovation systems.

Further discussion of the concept of systems of innovation is provided in the literature review in Chapter 4, while the concept of regional innovation systems is now briefly discussed in Section 1.2.3.

1.2.3 Regional Innovation Systems

The focus of Oughton et al (2002) on regional innovation systems has drawn on the work of academics such as Cooke (1998) and Howells (1999), who had helped to popularise such regional systems as a stand-alone concept in the latter half of the 1990s.

The literature on regional innovation systems, in particular, suggests that the concept clearly draws on the systems of innovation approach and other spatial models of innovation (see Chapter 4), and shares many parallels with these concepts, while at the same time highlighting more conventionally familiar elements of what might be found in a "system", alongside regional or local factors. For example, regional innovation systems would seem to involve public and private interests, formal institutions and other organisations, operating through organisational and institutional arrangements and relationships (Doloreux and Parto, 2005). The importance of specific regional resources, characteristics or intangible assets is often highlighted, as is interaction and learning processes between multiple actors, localised capabilities, the importance of proximity (physical, social, cultural), tacit knowledge and some degree of "embeddedness" (Doloreux and Parto, 2005, p. 144). The more systemic nature of the concept, meanwhile, is largely seen to derive from more enhanced governance arrangements and institutional infrastructures.

As noted in Section 1.2.2, however, Oughton et al (2002) considered the regional dimension of innovation systems to be important because of perceived factors or external economies that can be exploited differently or even uniquely at that level. In particular, they argued that the factors that drive national systems of innovation can vary across regions, and that regional systems can therefore differ from national systems because of differences in these factors. For example, they argued that regional innovation systems may be distinguished from national innovation systems by differences in industrial structure, R&D and technology provision, policy initiatives, business service provision, governance structures and the institutional framework, including the nature and extent of inter-relationships between key players. They suggested that knowledge transfer, learning and external economies are factors that can operate differently, and in some cases exclusively, at regional level, while they also contended that the regional dimension is important in the formation of networks of firms, because communication and trust are facilitated by proximity and repeated interaction, which is easier and cheaper in a local context. Moreover, in the context of governance and institutional frameworks, Oughton et al (2002) have asserted that regional governments, and their development agencies, can be a catalyst in articulating and dynamising a regional innovation system by articulating ways to link regional actors (e.g. universities, firms, research centres), and by matching firms' innovation needs with knowledge supply, in search of synergies and complementarities among different actors, policies and sub-systems[6].

Yet, despite its growing prominence, not only in an academic context but also in a normative, EU policy context (see Chapter 4), the regional innovation systems concept has been subject to much critique and debate, which has highlighted possible conceptual issues or weaknesses, such as:

- lack of a commonly agreed definition of what constitutes a regional innovation system, and perceived difficulties in the literature regarding the link between its concept and its reality (e.g. see Cooke, 2001, Evangelista, Iammarino, Mastrostefano and Silvani, 2002, Heraud, 2003, Doloreux and Parto, 2005);
- little consensus about how the concept deals with different types and/or scales of regional innovation system, or with regions at different levels or stages of development (e.g. see Cooke, 1998, Asheim and Isaksen, 2002, Pugh, 2016, Trippl, Asheim and Miörner, 2016, Njøs and Jakobsen, 2018, Tödtling and Trippl, 2018);
- lack of clarity about what defines regional scale/function, a cause of ambiguity given various definitions and understandings that combine the geographical, functional, economic, institutional and cultural (e.g. see Uyarra, 2007);
- over-reliance on an assumption that the local or regional level is a strategic, internally cohesive unit, without taking sufficient account of links to or the

[6] In a similar vein, an analysis by Muscio, Reid and Rivera Leon (2015) of paradox issues in Eastern European countries (i.e. those countries that acceded to the EU in 2004) asserted that low quality of governance was a key issue underlying the existence of a paradox in these countries, and that resolving the paradox would require ongoing investment in the machinery of governance in regions so as to strengthen strategic management capacity and foster partnerships within regional innovation systems.

influence of the inter-regional, national or global levels, including extra-regional networks and institutions, which may influence policy, governance or resources at the regional level (e.g. see Asheim and Isaksen, 2002, De Bruijn and Lagendijk, 2005, Doloreux and Parto, 2005, Uyarra, 2007, Pugh, 2016, Leydesdorff and Cucco, 2019);

- criticism that the diversity, path dependency and varying patterns of development of regions can be overlooked under the regional innovation systems concept, that such diversity can render best practice or "one size fits all" guidelines (Asheim, Boschma and Cooke, 2011b) for regional systems to be of little benefit, or that transferring models to other regions can be difficult if not impossible (e.g. see Iammarino, 2005, Uyarra, 2007, Asheim et al, 2011b).

Further discussion of the concept of regional innovation systems, and its critique, is provided in the literature review in Chapter 4.

1.3 Research Question and Objectives

It is against this background, therefore, that the current research seeks to address the following research question:

> *How has public policy towards and public investment in regional innovation systems contributed to R&D and innovation performance in lagging regional economies?*

In addition, there are a number of research objectives that are underlying the research question, which are to:

- *examine how investment in R&D and innovation in lagging regions, and outputs attributed to R&D and innovation in such regions, have changed over time;*
- *explore public policy and public investment interventions that have been used to promote the development of regional innovation systems in lagging regions;*

- *understand the elements that constitute regional innovation systems in lagging regions, and the extent to which such systems have developed over time;*
- *examine how lagging regions address their region-specific characteristics when developing policies to promote regional innovation systems;*
- *examine how interaction with other spatial levels (e.g. national, EU) influences the development of policies to promote regional innovation systems in lagging regions.*

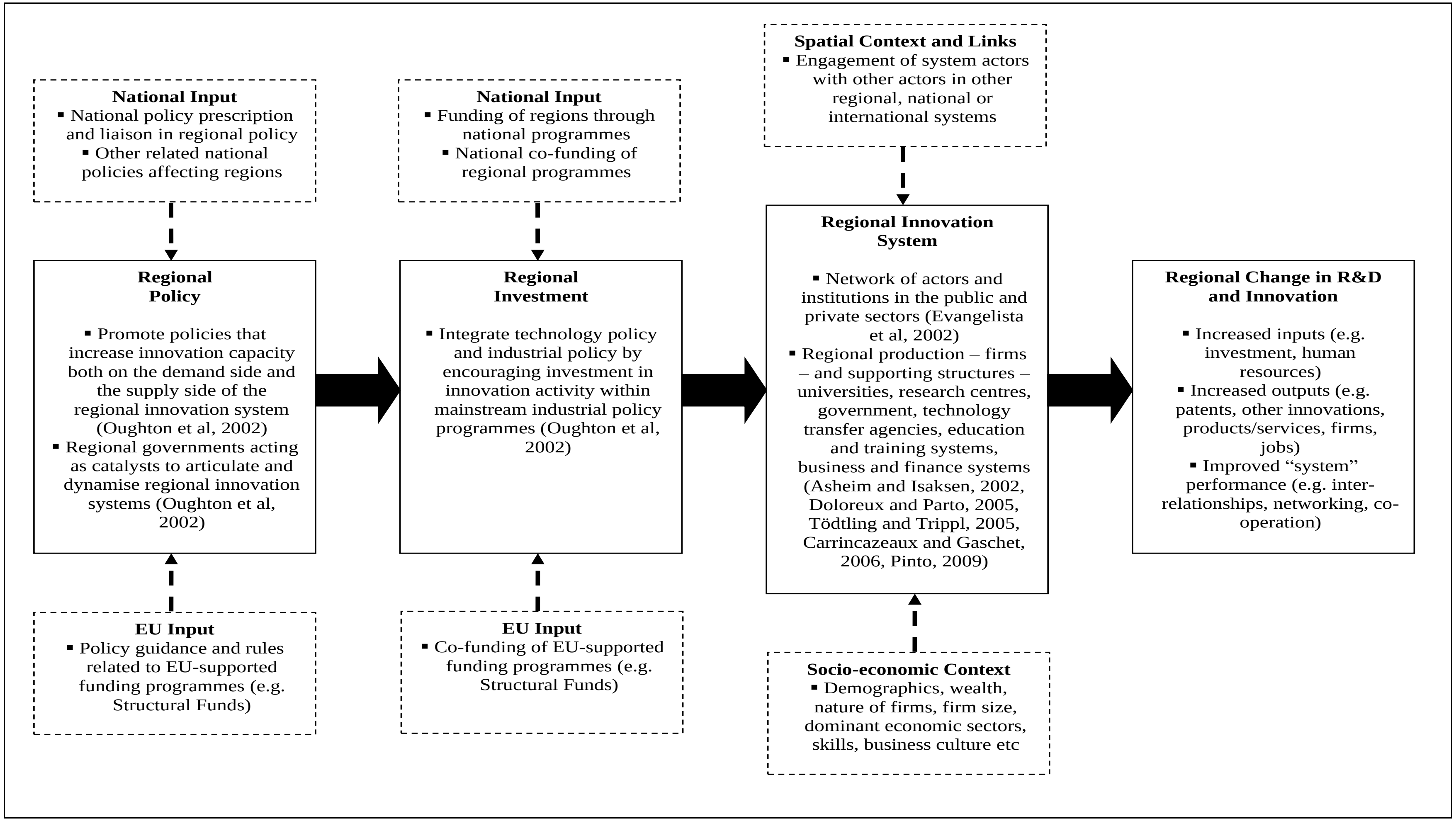
To address the research question and objectives, the research has used a mixed methods approach, based on a pragmatist research philosophical perspective, with a particular focus on R&D investment and the development of regional innovation systems in lagging regions during the 2000-13 period. Further explanation of the research question and objectives, and the research time horizon, is provided in Chapter 5.

1.4 Conceptual Framework

For the purposes of this research, the researcher has developed a conceptual framework for use as a "working hypothesis", based on a largely exploratory research purpose, a pragmatist research paradigm or philosophy and a mixed methods approach. A working hypothesis, in this context, should be understood as a provisional hypothesis or statement of expectation that is tested in action, which allows for the gathering of both quantitative and qualitative evidence (Shields and Rangarajan, 2013, Shields, Rangajaran and Casula, 2019), and which is subject to change, with a real possibility that contradictory evidence will be found (Shields et al, 2019).

The conceptual framework/working hypothesis for this research therefore is that "public policy promotion of and public investment in regional innovation systems contributes to improved R&D and innovation performance in lagging regional economies". The graphical illustration of this framework, as outlined in Figure 1.2, thus incorporates this "hypothesis", which is inferred from the description of the regional innovation paradox in the research literature (and its emphasis on the need to develop regional innovation systems), but while also embracing critique of the concept of regional innovation systems, again as per the research literature.

Figure 1.2: Conceptual Framework



Source: Author

The arrows connecting the boxes in Figure 1.2 thus denote the working assumption that pro-innovation policy in a region drives increased public investment in the regional innovation system, which in turn leads to improved R&D and innovation performance. However, the framework also alludes to potential influences on the boxes, as inferred from the research literature, which must be taken into account when considering how this underlying assumption might work in practice.

Further explanation of the conceptual framework, and its underlying thinking and rationale, is provided in Chapter 5.

1.5 Research Process

As noted in Section 1.3 above, the research process has adopted a pragmatist research philosophical perspective and a mixed methods approach, which has primarily consisted of two main elements, which were:

- quantitative analysis, through use of descriptive statistics;
- case study research, incorporating both desk research and interviews.

The core purpose of the quantitative analysis was to use descriptive data to help to identify lagging regions whose recent innovation activity and performance (in terms of growth or change in activity and performance) might provide candidates for deeper, more qualitative case study research. This analysis drew on commonly used indicators for R&D and innovation (e.g. R&D investment, R&D human resources, patent applications, employment in relevant sectors etc), which were mainly sourced from Eurostat (the statistical office of the EU), plus other European Commission data on the absorption of EU Structural Funds for investment in R&D and innovation (see European Commission, 2012b, 2014b) in order to:

a) look at growth in R&D and innovation activity across lagging regions over the 2000-13 period;

b) categorise lagging regions into different performance groups, based on both absorption of EU Structural Funds for investment in R&D and innovation (as per European Commission data) and growth in R&D and innovation activity over the period (as per the commonly used indicators).

Data availability issues, in turn, meant that the core analysis was performed on a sample of 22 lagging regions, situated mainly from Spain, Italy and Portugal, from which two (2) regions (Galicia in Spain and Puglia in Italy) were selected to be included in the case study research.

More detailed explanation of the methodology underlying the quantitative analysis and the sample of regions used is provided in Chapter 5, Chapter 6 and Chapter 7.

The case study research, meanwhile, has been central to addressing the research objectives. In this regard, the core purpose of the research has been to perform a more in-depth analysis of the development of regional innovation systems in the selected regions, given that the nature of such systems and the institutional characteristics of lagging regions was asserted by Oughton et al (2002) to be the main cause of the regional innovation paradox, and to see what changes have occurred over time and to what extent weaknesses in the system have been addressed. The case studies have thus explored each region's wider socio-economic setting, their perceived R&D and innovation performance (based on commonly used indicators of R&D and innovation), the nature of their regional innovation systems and the key actors within those systems, the progression of R&D and innovation investment and policy over time, and the governance arrangements that influence R&D and innovation policy. To do this, the case study research has also drawn on evidence from:

a) secondary data, such as R&D/innovation and wider socio-economic datasets, national and regional policy and strategy documents, national and regional funding programme documents or sources, or other published reports and articles on development of R&D and innovation in the regions;

b) research interviews carried out with a sample of key stakeholders in each region (e.g. policy makers, policy implementers, research institutions, industry representative bodies).

The evidence from the secondary data, in particular, has helped to inform the research about the inputs, outputs and outcomes associated with the development of R&D and innovation in the case study regions. However, the research interviews have been crucial in aiding the interpretation of this secondary data by providing the insights, perceptions and opinions of experienced, knowledgeable informants on such matters as the development of regional innovation systems and the role of key actors, the development of policy for R&D and innovation over time, the importance of governance arrangements within the regions, and the importance of the EU to the development of R&D and innovation in the regions.

More detailed explanation of the methodology underlying the case study research is provided in Chapter 5 and in Chapters 8-11.

1.6 Thesis Structure

The structure of the research thesis can be divided into four parts, as outlined in Table 1.1 and Table 1.2. Part A, which includes Chapters 1-5, describes the research purpose, context and method. Part B, which includes Chapters 6-7, covers the quantitative analysis. Part C, which includes Chapters 8-11, covers the case study research, while Part D, which includes Chapters 12-13, presents the discussion of the research findings and its conclusions.

Chapter 1, as has been described here, opens Part A by providing an introduction to the research, including the background to the research topic and a brief outline of the research question/objectives, its conceptual framework, its research process and the thesis structure. Chapter 2, in turn, describes the policy context, and its relevance and importance, with a particular focus on its place within the wider importance of (a) economic and social cohesion and (b) research and innovation as policy priorities within the EU.

Chapter 3, meanwhile, provides an overview of regions that have been classified as "lagging regions" in an EU context, i.e. the main focus of interest from the perspective of the regional innovation paradox, including the definition of lagging regions that has been used, some of the key characteristics that typify such regions, and recent socio-economic trends. Chapter 4 places the regional innovation paradox in the context of the literature on regional innovation generally, including systems of innovation, spatial perspectives on innovation and regional innovation systems, while Chapter 5 provides a more detailed explanation of the research methodology, again including the research question and objectives, the conceptual framework and the research design (i.e. research philosophy, research approach, research strategy, research time horizon and data collection and analysis techniques).

Chapter 6, which opens Part B, presents the findings of this research's descriptive quantitative analysis of innovation performance in lagging regions over the 2000-13 period, including both the EU's 2000-06 and 2007-13 Structural Fund programming periods, based on the commonly used indicators for R&D and innovation (R&D investment, R&D human resources, patent applications, employment in relevant sectors etc).

To conclude Part B, Chapter 7 then presents a categorisation of innovation performance in lagging regions over the 2000-06 and 2007-13 Structural Fund programming periods, which is based on the findings of the quantitative analysis described in Chapter 6, and which also informed the selection of case study regions. In addition, Chapter 7 introduces the selected case study regions, and outlines the reasons underlying the choice of Galicia and Puglia as case study regions.

Table 1.1: Structure of the Research Thesis – Parts A-B

Chapter	Title	Description
PART A	PURPOSE, CONTEXT, METHOD	
Chapter 1	Introduction	▪ The purpose of this chapter is to provide an introduction to the research, including its background, its research question/objectives, its conceptual framework and research process, and its structure
Chapter 2	Policy Context and Importance	▪ The purpose of this chapter is to describe the policy context, and the relevance and importance of the research within the context, in particular, of EU objectives for economic/social cohesion and research/innovation
Chapter 3	Overview of Lagging Regions	▪ The purpose of this chapter is to provide an overview of "lagging regions", including the definition used for the purposes of this research, and an overview of socio-economic trends in such regions
Chapter 4	Literature Review	▪ The purpose of this chapter is to place the research in the context of the literature on regional innovation, including systems of innovation, spatial perspectives on innovation and regional innovation systems
Chapter 5	Methodology	▪ The purpose of this chapter is to outline in detail the research problem, objectives and questions, its conceptual and analytical frameworks, and the research design (philosophy, approach, strategy, time horizon, and data collection and analysis techniques)
PART B	QUANTITATIVE ANALYSIS	
Chapter 6	Innovation Performance in Lagging Regions	▪ The purpose of this chapter is to present the findings of the descriptive quantitative analysis of innovation performance in lagging regions over the EU's 2000-06 and 2007-13 Structural Fund programming periods
Chapter 7	Categorisation of Lagging Regions	▪ The purpose of this chapter is to present the categorisation of innovation performance in lagging regions over the 2000-06 and 2007-13 Structural Fund programming periods, as an aid to inform the selection of case study regions

Source: Author

Part C begins with a brief introduction to the case study research, which is provided in Chapter 8. This chapter, in particular, outlines the purpose of the case studies and the analytical framework used to research the case studies. Chapter 9 then describes secondary data findings on (a) the socio-economic context in the case study regions, as an input to understanding the regional socio-economic setting in each region, and (b) their innovation performance, based on the earlier quantitative analysis, while Chapter 10 describes secondary data findings on the regional innovation systems in the regions and the policies put in place to support R&D and innovation over the course of the study period.

However, as alluded to earlier in Section 1.5, both Chapter 9 and Chapter 10 can only tell us something about context, inputs, outputs and outcomes associated with the development of R&D and innovation in Galicia and Puglia over the 2000-13 period, while telling us less about the processes and connections underlying the development of R&D and innovation in the two regions (e.g. both within the regional innovation systems, or between regional systems and other systems that exist at different spatial levels). The purpose of Chapter 11, therefore, is to aid the interpretation of the evidence provided in Chapter 9 and Chapter 10 by discussing the findings arising from the series of research interviews that were carried out in the case study regions.

Finally, Part D concludes the thesis with a discussion of how the findings arising from the earlier chapters contribute to answering the research question and objectives, presented in Chapter 12, while Chapter 13 provides conclusions and addresses the research contributions of the thesis, the limitations of the research and recommendations for future research.

Table 1.2: Structure of the Research Thesis – Parts C-D

Chapter	Title	Description
PART C	CASE STUDIES	
Chapter 8	Introduction	▪ This chapter provides a brief introduction to the case study research, including its purpose, the framework used to analyse the case studies, and the structure of the analysis
Chapter 9	Socio-economic Context and Innovation Performance	▪ The purpose of this chapter is to describe secondary data findings on (a) the socio-economic context and (b) the innovation performance in the case study regions, based on commonly used indicators for socio-economic and R&D/innovation activity in regions
Chapter 10	Regional Innovation Systems and Policy Developments	▪ The purpose of this chapter is to describe secondary data findings on the regional innovation systems in the case study regions, and the policies that have been in place to support R&D and innovation over the course of the study period
Chapter 11	Interview Perspectives and Interpretation	▪ The purpose of this chapter is to aid the interpretation of the evidence provided in Chapter 9 and Chapter 10 by discussing the findings arising from the series of research interviews that were carried out in the case study regions
PART D	DISCUSSION AND CONCLUSION	
Chapter 12	Discussion	▪ This chapter presents discussion of how the findings arising from the earlier chapters contribute to answering the research question and objectives
Chapter 13	Conclusion, Contribution, Limitations and Recommendations	▪ This chapter concludes the thesis and addresses its research contributions, the limitations of the research and recommendations for future research

Source: Author

CHAPTER 2 – POLICY CONTEXT AND IMPORTANCE

2.1 Introduction

Context for this research lies at the confluence of two major policy objectives within the EU, i.e. the objective to promote economic and social cohesion, on the one hand, and the objective to promote research and innovation, on the other, and how the two have become increasingly intertwined in an EU policy context over time.

The purpose of this chapter, therefore, is to briefly describe this context, and to highlight the relevance and importance of the current research within its context. In this regard, Section 2.2 describes the emergence of economic and social cohesion as a policy priority within the EU, while Section 2.3 similarly describes the emergence of research and innovation as a policy priority. Thereafter, Section 2.4 highlights both (a) the emergence of the regional innovation systems concept as an approach or policy tool to address research and innovation policy objectives within the EU and (b) the importance of the current research in this policy context. Section 2.5, meanwhile, provides a synthesis of the main messages.

2.2 EU Objectives – Economic and Social Cohesion

The objective to promote economic and social cohesion within the EU first emerged in the late 1960s and early 1970s, due to increased concerns about levels of economic and social disparity between member states and regions (Barca, 2009), including less developed or less favoured regions (i.e. “lagging” regions). This, in turn, led to the first concrete moves towards the development of a Community “regional policy”, whereby EU leaders attending the Paris European Summit (in 1972) formally agreed to prioritise the need to correct structural and regional imbalances, and establish a “Regional Development Fund” to give effect to this.

Over time, moreover, the enactment of the Single European Act (in 1986) and the Maastricht Treaty (in 1992) would further enshrine economic and social cohesion as an important policy goal within the EU’s founding treaties (Barca, 2009), while the share of the EU budget that was allocated to address economic and social cohesion – through what became known as the Structural Funds – would grow from just 5% in the early 1970s up to 32% by the mid-1990s, a level that has been maintained up to the present day[7].

Also, the means by which EU regional policy has been formulated and implemented has changed over time. In the early 1970s, for example, supports for economic and social cohesion were allocated by means of national quotas, whereby funds were directly transferred to and disbursed by member states, based on their own national strategies or decisions, with no clear-cut EU input (Barca, 2009). From the 1980s onwards, however, the formulation and implementation of regional policy evolved towards a more partnership-based approach, whereby the EU seeks to identify and agree common Community priorities, member states submit regional development programmes to be approved by the EU (so as to integrate national and EU priorities), and regional and local authorities are encouraged to become more involved in programme formulation and implementation.

2.3 EU Objectives – Research and Innovation

The ambition to promote research and innovation, on the other hand, first emerged through early research programmes in energy, the environment and biotechnology, which were established after the Treaty of Rome (1957). Thereafter, the EU's first "Framework Programme" (FP) for funding research and innovation was launched in 1984, while research became a formal Community policy through its incorporation into the Single European Act (European Commission, 2014c). Since the late 1990s and early 2000s, however, the EU has noticeably increased its policy emphasis on promoting research and innovation within the EU, with De Bruijn and Lagendijk (2005) suggesting that innovation had, by the early 2000s, come to be regarded as the most important driving factor for sustainable economic development across Europe. In this regard, key policy initiatives that have been introduced in the EU include:

[7] Under the EU's multi-annual budgetary framework for the 2014-20 period, for example, commitments to address economic, social and territorial cohesion accounted for 34% of the EU budget for the period (see Official Journal of the European Union, 2013).

- the Lisbon Strategy (2000), which established a Community goal "to become the most competitive and dynamic knowledge-based economy in the world" over the following decade, to be achieved through policies to promote the information society and R&D[8];
- the establishment of the European Research Area (ERA) under the Lisbon Strategy, a unified research area in the internal market in which researchers, scientific knowledge and technology could circulate freely (European Commission, 2014c);
- the establishment of the European Research Council (ERC) in 2007 to support "frontier" research and scientific excellence in research across the EU (European Commission, 2014c);
- the Europe 2020 Strategy, which was adopted in 2010, and which highlighted "smart growth" (developing an economy based on knowledge and innovation) as one of three growth priorities in the EU in the following 10 years (European Commission, 2010);
- the "Innovation Union", launched as part of the Europe 2020 Strategy, which sought to improve conditions and access to finance for research and innovation in Europe through measures in areas such as patent protection, venture capital, public procurement and regulation (European Parliament, 2019).

Funding for research and innovation within the EU, meanwhile, has also expanded substantially over time. For example, the first Framework Programme (FP1), which covered the 1984-87 period, had a budget of about €4 bn, while the eighth Framework Programme 2014-20 (FP8, known as Horizon 2020) had a budget of closer to €80 bn and the ninth Framework Programme 2021-27 (FP9, known as Horizon Europe) has a budget of over €95 mn[9]. The main goal of funding under these programmes, as was alluded to by Oughton et al (2002), has been to promote research excellence rather than economic and social cohesion (Morgan, 1997, European Commission, 2014c), however research and innovation funding to address economic and social cohesion, via the Structural Funds, has also become a growing priority, with:

[8] See https://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/00100-r1.en0.htm.
[9] See https://horizoneurope.ie/.

- nearly €20 bn in expenditure committed to research and innovation during the 2000-06 programming period, or 11% of all Structural Fund expenditure for the period (European Commission, 2012b);
- nearly €43 bn in expenditure committed to research and innovation during the 2007-13 programming period, or 16% of all Structural Fund expenditure for the period (European Commission, 2014b);
- nearly €62 bn in funding allocated to research and innovation during the 2014-20 period, or 22% of total Structural Fund allocation for the period[10].

2.4 Regional Innovation Policy and Performance

In promoting innovation at the regional level, the EU has also to a large degree championed the adoption of a regional innovation systems approach, as suggested by Oughton et al (2002). Both Asheim, Lawton Smith and Oughton (2011a) and Pugh (2016), for example, asserted that the regional innovation systems concept has had a very significant influence on innovation policy development in the EU, with this influence being first evident in the late-1990s through programmes such as the Regional Technology Plan (RTP), the follow-up Regional Innovation Strategy (RIS) Programme and the Regional Innovation and Technology Transfer Strategy (RITTS) (Oughton et al, 2002). Furthermore, the influence of regional innovation systems thinking has continued to permeate regional innovation policy at an EU level over the course of both the Lisbon Strategy and Europe 2020 Strategy periods. In particular, Pugh (2016) has contended that the core ideas and elements of regional innovation systems thinking have been subsumed and reconfigured into contemporary regional innovation policy discourse on "smart specialisation", while the development of national and regional research and innovation strategies for smart specialisation was made a pre-requisite for the approval of national and regional Structural Fund programmes during the 2014-20 period (European Commission, 2012a)[11].

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[10] See https://cohesiondata.ec.europa.eu/overview#.

[11] According to the European Commission (2014d), smart specialisation is a strategic approach to economic development through targeted support to research and innovation, whereby each region (whether it be strong or weak, high-tech or low-tech) goes through a transformative process that involves: developing a vision for growth; identifying its competitive advantage; setting strategic priorities; and making use of smart policies and actions. Building competitive advantage under smart specialisation is intended to involve the development and matching of research and innovation strengths to business needs in order to address emerging opportunities and market developments.

Moreover, less developed regions, and not just advanced regions, have similarly been encouraged to adopt the regional innovation systems approach as a means to address the perceived issues underlying the regional innovation paradox. However, despite improvements in research and innovation performance, available evidence continues to suggest that these less developed regions lag more advanced regions, based on commonly used indicators of research and innovation performance. In this regard, for example, the results of the EU's Regional Innovation Scoreboard (European Commission 2012b, 2014b, 2016, 2017b, 2019) generally classify such regions as being either low-performing "Modest Innovators" or "Moderate Innovators", rather than more high-performing "Strong Innovators" or "Innovation Leaders", with little movement between these regional performance groupings over time.

At the same time, such evidence is based largely on data for inputs, outputs and outcomes arising from research and innovation (e.g. R&D expenditure, patent applications), while telling us less about the peculiarities of different regions, the processes underlying research and innovation performance in these regions (including policy making and policy implementation), and how these processes impact on performance, especially in less developed regions. In this regard, in particular, such evidence does little to convey the complexities that can be inherent in regional innovation systems, which are highlighted in the research literature (see Chapter 4), and how such complexities impact on performance.

The current research is relevant and important, therefore, because it seeks to add to the knowledge of regional innovation systems in lagging regions by developing an increased understanding of how public policy towards and public investment in regional innovation systems has contributed to R&D and innovation performance in lagging regional economies. By doing this, through research into the experience of regions in which government has promoted R&D and innovation policy and investment in recent times, it is in turn hoped that the research can help to better inform policy making for R&D and innovation in such regions into the future.

2.5 Chapter Summary

- Chapter 2 has presented the broader context to this research by describing how both economic/social cohesion and research/innovation have, over time, become high priority policy goals or objectives within the EU.
- Moreover, the perceived need to foster research and innovation as a means to promote economic and social cohesion is also now widely promoted in EU policy circles, both through (a) a clear increase in focus on R&D and innovation investment within Structural Fund programmes and (b) the promotion of concepts like regional innovation systems as a means to address policy objectives in this area, both in advanced regions and less developed regions.
- Nonetheless, despite improvements in research and innovation performance, available evidence continues to suggest that less developed regions lag more advanced regions, based on commonly used indicators of “inputs” and “outputs” of performance. Furthermore, such evidence does not take account of the complexities that can be inherent in regional innovation systems, and how such complexities impact on performance, especially in lagging regions.
- The current research is relevant and important, therefore, because it seeks to add to the development of an increased understanding of how the nature and complexities of regional innovation systems impact on lagging regions, while also addressing wider research gaps on (a) the development of regional innovation systems in lower performing regions more generally and (b) research into more dynamic rather than static perspectives on the development of regional innovation systems.
- Through research into the experience of regions in which government has promoted R&D and innovation policy and investment in recent times, it is in turn hoped that the research can help to better inform policy making for R&D and innovation in such regions into the future.

CHAPTER 3 – OVERVIEW OF LAGGING REGIONS

3.1 Introduction

The purpose of this chapter is to provide an overview of regions that have been classified in an EU context as "lagging regions", which are a focus of interest from the perspective of the regional innovation paradox. Section 3.2 outlines the definition of lagging regions that has been used for the purposes of this research, and some of the key characteristics that typify such regions. Section 3.3 then provides an overview of the sample of lagging regions that have been examined, and recent socio-economic trends in these regions, based on commonly used indicators for description of lagging regions. A summary of the findings of the chapter is provided in Section 3.4, while a more detailed review of socio-economic trends in such regions is provided in Appendix A.

3.2 Definition of a "Lagging" Region

For this research, and in line with its time horizon (see Chapter 1 and Chapter 5), the definition of lagging regions used includes regions that were eligible for priority Structural Fund support from the EU during the 2000-06 Structural Fund programming period and also, in some cases, the 2007-13 Structural Fund programming period, i.e.:

- regions that were designated as "Objective 1" regions in the 2000-06 period, whereby GDP per capita, expressed in purchasing power standard (PPS)[12] terms, was at less than 75% of the EU-15 average[13];
- regions that were designated as "Convergence" regions in the 2007-13 period, whereby GDP per capita in PPS terms was at less than 75% of the EU-25 average[14];

[12] "PPS" is an abbreviation for purchasing power standard. PPS is an artificial currency unit. Theoretically, one PPS can buy the same amount of goods and services in each country. However, price differences across borders mean that different amounts of national currency units are needed for the same goods and services depending on the country. PPS is derived by dividing any economic aggregate of a country in national currency by its respective purchasing power parities (PPPs). PPS is therefore the technical term used by Eurostat for the common currency in which national accounts aggregates are expressed when adjusted for price level differences using PPPs. Thus, PPPs can be interpreted as the exchange rate of the PPS against the euro.
[13] In this regard, GDP per capita, and its level relative to the EU-15 average, was calculated on the basis of figures for 1994, 1995 and 1996.
[14] In this regard, GDP per capita, and its level relative to the EU-25 average, was calculated on the basis of figures for 2000, 2001 and 2002.

- regions that were designated as “Convergence” regions on a transitional basis in the 2007-13 period, whereby GDP per capita in PPS terms was higher than 75% of the EU-25 average, but less than 75% of the EU-15 average.

In this regard, Table 3.1a and Table 3.1b show that there were 53 regions with Objective 1 status in the EU-15 during the 2000-06 Structural Fund programming period, while 34 of these regions also had Convergence status during the 2007-13 Structural Fund programming period.

Table 3.1a: Lagging Regions (EU-15) Eligible for EU Structural Fund Assistance 2000-13

Region	**Country**	**Objective 1 Region (2000-06)**	**Convergence Region (2007-13)**
Burgenland	Austria	✓	✓
Hainault	Belgium	✓	✓
Central Finland	Finland	✓	
Pohjois- ja Itä-Suomi	Finland	✓	
Corsica	France	✓	
Départements d'Outre-Mer	France	✓	✓
Brandenburg	Germany	✓	✓
Mecklenburg-Vorpommern	Germany	✓	✓
Sachsen	Germany	✓	✓
Sachsen-Anhalt	Germany	✓	✓
Thüringen	Germany	✓	✓
Attiki	Greece	✓	✓
Kentriki Ellada	Greece	✓	✓
Nisia Aigaiou, Kriti	Greece	✓	✓
Voreia Ellada	Greece	✓	✓
Border, Midland and Western	Ireland	✓	
Southern and Eastern	Ireland	✓	
Basilicata	Italy	✓	✓
Calabria	Italy	✓	✓
Campania	Italy	✓	✓
Molise	Italy	✓	
Puglia	Italy	✓	✓
Sardegna	Italy	✓	
Sicilia	Italy	✓	✓
Flevoland	Netherlands	✓	
Alentejo	Portugal	✓	✓
Algarve	Portugal	✓	✓
Norte	Portugal	✓	✓
Centro	Portugal	✓	✓
Lisboa	Portugal	✓	
Região Autónoma dos Açores	Portugal	✓	✓
Região Autónoma da Madeira	Portugal	✓	

Source: Derived from European Commission (1999, 2006)

Table 3.1b: Lagging Regions (EU-15) Eligible for EU Structural Fund Assistance 2000-13

Region	Country	Objective 1 Region (2000-06)	Convergence Region (2007-13)
Andalucía	Spain	✓	✓
Canarias	Spain	✓	✓
Cantabria	Spain	✓	
Castilla-la Mancha	Spain	✓	✓
Castilla y León	Spain	✓	
Ciudad Autónoma de Ceuta	Spain	✓	✓
Ciudad Autónoma de Melilla	Spain	✓	✓
Comunidad Valenciana	Spain	✓	
Extremadura	Spain	✓	✓
Galicia	Spain	✓	✓
Principado de Asturias	Spain	✓	✓
Región de Murcia	Spain	✓	✓
Mellersta Norrland	Sweden	✓	
Norra Mellansverige	Sweden	✓	
Övre Norrland	Sweden	✓	
Cornwall and Isles of Scilly	United Kingdom	✓	✓
Highlands and Islands	United Kingdom	✓	✓
Merseyside	United Kingdom	✓	
Northern Ireland	United Kingdom	✓	
South Yorkshire	United Kingdom	✓	
West Wales and the Valleys	United Kingdom	✓	✓

Source: Derived from European Commission (1999, 2006)

Moreover, a European Commission report (European Commission, 2017a), which focused on competitiveness in lagging regions, referred to such regions as being either:

a) "low-growth regions", i.e. less developed and transition regions that did not converge to the EU average for GDP per capita between the years 2000 and 2013. This refers, in particular, to almost all lagging regions in Greece, Spain, Italy and Portugal;
b) "low-income regions", i.e. regions with a GDP per capita in PPS terms that is below 50% of the EU average in 2013. This group, in particular, generally covers lagging regions in newer EU member states like Bulgaria, Hungary, Poland and Romania.

However, lagging regions in newer EU member states, which joined the EU from 2004 onwards, were not included in this research because they did not become eligible for Structural Fund assistance until the middle of the 2000-06 Structural Fund programming period, and thus had less access to EU support for R&D and innovation in that period. Therefore, the regions examined in this research, which are drawn from the pre-accession EU-15 member states, would generally be classified as low-growth regions rather than low-income regions in this regard.

Such regions, according to the European Commission (2017a), typically have lower levels of productivity, educational attainment and employment rates compared to more developed regions, with labour market rigidities and poor business environments regarded as having a higher impact in these regions, while population performance also varies, with some regions growing population and some regions losing population, including out-migration of the younger and more educated population. In addition, the same report argues that under-developed regional innovation systems, skills gaps and poor institutional quality undermine the growth potential of such regions, with a lack of efficient interactions between higher education institutions and the productive sector, and a lack of suitable human capital.

As noted in Chapter 1, however, and as outlined in more detail in Chapter 5, investigation of the nature of regional innovation systems in lagging regions lies at the core of this research, and it is discussed extensively in Chapters 6-11. The rest of this chapter, therefore, provides further context by outlining recent wider socio-economic trends in lagging regions, so as to illustrate the nature of such regions in more detail.

3.3 Profile of Lagging Regions

3.3.1 Introduction

This section provides an overview of key aspects of the socio-economic profile of the lagging regions that have been examined as part of the quantitative analysis for this research (see Chapters 6-7).

The sample of regions examined in this research, in particular, focuses on 22 regions, which are listed in Table 3.2. These regions are drawn from the 53 regions in the EU-15 which had Objective 1 status for Structural Fund support during the 2000-06 Structural Fund programming period (see Table 3.1a and Table 3.1b), but with these regions being included over other regions based on the availability of data regarding innovation performance (see Chapter 5 and Chapter 6). While all 22 regions had Objective 1 status for Structural Fund support during the 2000-06 Structural Fund programming period, 15 regions also had Convergence status for Structural Fund support during the 2007-13 Structural Fund programming period.

Table 3.2: Lagging Regions Eligible for EU Structural Fund Assistance 2000-13 – Study Sample

Region	Country	Objective 1 Region (2000-06)	Convergence Region (2007-13)
Corsica	France	✓	
Basilicata	Italy	✓	✓
Calabria	Italy	✓	✓
Campania	Italy	✓	✓
Molise	Italy	✓	
Puglia	Italy	✓	✓
Sardegna	Italy	✓	
Sicilia	Italy	✓	✓
Algarve	Portugal	✓	✓
Norte	Portugal	✓	✓
Região Autónoma dos Açores	Portugal	✓	✓
Região Autónoma da Madeira	Portugal	✓	
Andalucía	Spain	✓	✓
Canarias	Spain	✓	✓
Cantabria	Spain	✓	
Castilla-la Mancha	Spain	✓	✓
Castilla y León	Spain	✓	
Comunidad Valenciana	Spain	✓	
Extremadura	Spain	✓	✓
Galicia	Spain	✓	✓
Principado de Asturias	Spain	✓	✓
Región de Murcia	Spain	✓	✓

Source: Derived from European Commission (1999, 2006)

The purpose of the section, moreover, is to highlight broad similarities or differences between the regions as well as some recent trends in commonly used socio-economic indicators, based on the types of indicators that are typically used when describing regions that are classified as being “lagging”. In particular, and in line with the description of such regions as per the European Commission (2017a), this includes: population and population density; GDP; labour market participation, employment and unemployment rates; education levels (level of tertiary education attainment); and sectoral breakdown of economic activity (i.e. broad sectoral shares attributable to agriculture, industry and construction, and services). The data examined looks at trends between 2000 and 2013 (to correspond with the period of analysis for innovation performance in this research – see Chapter 6), while taking note of trends between 2013 and 2018 (or most recent year available), and regional trends are compared with EU-15 averages, where available, in line with the chosen sample of regions and study period.

In addition, as noted earlier, a more detailed review of socio-economic trends in the sample of 22 regions, including supporting charts and tables, is provided in Appendix A.

3.3.2 Population

As noted in Section 3.2, the European Commission (2017a) has pointed to varying population performance in lagging regions, with some regions growing population and some regions losing population, including out-migration of younger and more educated people. This, in turn, is borne out when looking at trends in population growth in the regions between 2000 and 2013, and between 2013 and 2018.

In this regard, for example, data on population levels in the 22 lagging regions under review (based on 2018 data, sourced from Eurostat) shows that population in these regions varies considerably, ranging from a low of 240,000 (Açores in Portugal) up to a high of 8.4 mn (Andalucía in Spain). Moreover, between 2000 and 2013, population change in the regions ranged from a low of -4% (Basilicata in Italy) up to a high of about 27% (Canarias in Spain), with only three regions experiencing a decline in population, and with the EU-15 average for population growth in the period being 6%. In contrast to this, however, population change between 2013 and 2018 ranged from negative growth of -4% (Castilla y León in Spain) up to positive growth of 5% (Corsica in France), with 15 regions experiencing a decline in population, and with only three regions experiencing population growth (of 1% or more), compared to average EU-15 population growth of 2% (a trend most likely influenced by the aftermath of the global financial and economic crisis of 2008-09, and its impact on regional economies).

In addition, population density in the regions varies considerably although, perhaps unsurprisingly, the population density in most regions has seen little change over time. Eurostat data, for example, shows that the most densely populated regions include Campania, Puglia and Sicily (Italy) as well as Madeira (Portugal), Canarias and Comunidad Valenciana (Spain), while the most sparsely populated regions are found in

Corsica (France), Castilla y León, Extremadura and Castilla-la Mancha (Spain). A majority of regions have population densities that are below the EU-15 average, however.

Finally, reflecting population densities, urban-rural typologies for the 22 regions would suggest a mix of either "predominantly rural" regions (whereby the rural population accounts for more than 50% of the total population) or "intermediate" regions (whereby the rural population accounts for between 20% and 50% of the total population)[15].

3.3.3 GDP

The analysis of the European Commission (2017a), as noted earlier in Section 3.2, has also pointed to lower levels of economic output in lagging regions, when compared to more advanced regions. In terms of GDP per capita in the 22 sample regions, for example, Eurostat data suggests that economic output ranged from a low of €16,300 (Calabria in Italy) up to a high of €23,800 (Corsica in France) in 2013, with a median GDP per capita of €19,500. For all regions, therefore, GDP per capita was well below the EU-15 average of €29,300, i.e. much the same situation as was evident in 2000. By 2017, meanwhile, levels of GDP per capita in the regions had improved somewhat, ranging from a low of €17,400 (Calabria in Italy) up to a high of €25,800 (Castilla y León in Spain), though GDP per capita in the regions still remained well below the EU-15 average of €32,400.

Nonetheless, Eurostat data also shows that economic output in these regions generally grew between 2000 and 2013, though the rate of growth varied, with growth in many Spanish and Portuguese regions that was at a rate above the EU-15 average for the period (27%). However, growth in other Spanish regions and all Italian regions was below the EU-15 average, and in many cases it was well below average. Moreover, it is also notable during this period that growth in many regions was particularly strong during the 2000-07 period, while several regions then experienced a decline in GDP per capita over the 2007-13 period, following the global financial and economic crisis that occurred in 2008 and 2009. For example:

[15] See, for example, http://ec.europa.eu/eurostat/statistics-explained/index.php/Urban-rural_typology#.

- between 2000 and 2007, growth in the regions ranged from a low of 15% (Puglia in Italy) up to a high of 56% (Galicia in Spain) with growth in most Spanish regions being well above the EU-15 average of 27%, while growth in the Italian regions was mainly below this;
- between 2007 and 2013, on the other hand, all but three of the lagging regions examined in this research (Corsica in France, and Norte and Açores in Portugal) experienced a decline in GDP per capita;
- thereafter, there was some recovery in GDP per capita between 2013 and 2017, with 13 of the 22 regions (mainly in Spain and Portugal) experiencing growth that was higher than the EU-15 average of 11% for that period.

Lagging regions thus made some progress in converging GDP per capita towards the EU-15 average between 2000 and 2007, before experiencing a reversal of this trend in many cases between 2007 and 2013, followed by some recovery in growth between 2013 and 2017. However, Eurostat data shows that only two of the regions examined (Corsica in France and Castilla y León in Spain) had a GDP per capita that was 75% or more of the EU-15 average in 2013, increasing to seven regions (Castilla y León, Cantabria, Galicia, Principado de Asturias and Comunidad Valenciana in Spain, Algarve in Portugal and Corsica in France) by 2017. Also, several Italian regions, including Puglia, Sicily, Campania and Calabria, still had a GDP per capita at less than 60% of the EU-15 average in both 2013 and 2017.

3.3.4 Labour Market

Another perceived issue or weakness in lagging regions, as alluded to by the European Commission (2017a), relates to the labour market situation in such regions, and rates of employment/unemployment.

In this regard, for example, Eurostat data shows that relatively few of the 22 regions had a labour force participation rate (i.e. the economically active population within the total working age population aged 15-64) that was at or above the EU-15 average in 2013 (73%), with these regions being mainly Spanish regions (Comunidad Valenciana, Canarias, Castilla-la Mancha). By 2018, meanwhile, only Algarve in Portugal had labour force participation that was at or above the EU-15 average in that year (74%), with the Spanish regions falling very slightly behind average, while labour force participation in most of the Italian regions was below 60% in both 2013 and 2018.

Eurostat data also suggests that rates of employment for all regions (as a share of the total working age population aged 15-64) were below the EU-15 average of 65% in 2013, with the rate of employment being below 50% in regions such as Canarias, Extremadura and Andalucía (Spain), and in Sardinia, Molise, Basilicata and Puglia (Italy), while it was below 40% in regions such as Campania, Sicily and Calabria (Italy). In 2018, meanwhile, employment rates in Algarve (Portugal) and Corsica (France) were higher than the EU-15 average of 69%, most Spanish regions had employment rates of between 55% and 65%, while some Italian regions (Basilicata, Puglia, Calabria, Campania, Sicily) still had employment rates below 50%.

Similarly, given the trends evident in labour force participation and employment levels, Eurostat data shows that unemployment rates were above the EU-15 average (11%) in all 22 lagging regions in 2013. However, unemployment rates were particularly high in Spanish lagging regions, ranging from about 20% (Cantabria) up to 36% (Andalucía), while the unemployment rate for regions in Italy and Portugal in 2013 was generally between 15% and 20%. By 2018, however, the Portuguese regions of Algarve and Norte had unemployment levels that were slightly below the EU-15 average (7%). Spanish regions had also experienced a notable reduction in unemployment, ranging from 11% (Cantabria) up to 24% (Extremadura), while unemployment in Italian regions ranged from about 12% (Basilicata) up to about 22% (Calabria). Nonetheless, unemployment rates in most of these regions still remained high relative to the EU-15 average.

3.3.5 Education

The analysis of the European Commission (2017a), as noted earlier in Section 3.2, has also pointed to lower levels of educational attainment in lagging regions, and thus lower levels of advanced skills, when compared to more advanced regions. In this regard, for example, Eurostat data shows that the share of the population aged 25-64 that had completed tertiary education, in each of the 22 lagging regions, was below the EU-15 average of 30% in 17 of the regions in 2013, with the level of tertiary education in Italian regions and Portuguese regions being below 20%. A number of Spanish regions, however, had tertiary education levels that were above the EU-15 average in 2013, while tertiary education levels were at 25% or more in other Spanish regions in the same year. By 2018, moreover, the share of the population aged 25-64 with completed tertiary education remained lower in Italian and Portuguese regions, while several Spanish regions still had tertiary education levels that were above the EU-15 average of 34% (with the level in other Spanish regions ranging from 25% to 31%).

Similarly, Eurostat data for the narrower 30-34 age group[16] shows that tertiary education levels were below the EU-15 (38%) in 16 of the regions examined in 2013. Among the Italian regions, for example, the level of tertiary education among 30-34 year olds ranged from 16% (Campania) up to 24% (Molise), while among Portuguese regions it ranged from 27% (Algarve and Madeira) up to 31% (Norte). Among the Spanish regions, on the other hand, the share of population with completed tertiary education in this age group in 2013 ranged from 29% (Región de Murcia) up to 50% (Principado de Asturias), with Principado de Asturias, Cantabria, Castilla y León, Galicia and Comunidad Valenciana all being above the EU-15 average. By 2018, meanwhile, the share of the population aged 30-34 that had completed tertiary education remained lower in Italian and Portuguese regions, though its share in all regions had grown to more than 20%, while the Spanish regions of Principado de Asturias, Cantabria, Castilla y León, Galicia and Comunidad Valenciana had tertiary education levels for the age group that were above the EU-15 average (41%), with the level in other Spanish regions ranging from 33% to 38%.

3.3.6 Sectors

Finally, it is also informative to look at the sectoral breakdown of economic activity in lagging regions (i.e. the broad sectoral shares attributable to agriculture, industry and construction, and services) and how it compares to EU-15 averages. In this regard, for example, Eurostat data shows that the share of employment in agriculture in these regions, with the exception of Corsica in France, was higher than the EU-15 average of nearly 3% in 2013, with the relative importance of agriculture in these regions ranging from the EU-15 average level of 3% up to more than 13%. Share of employment in

[16] The focus on the narrower 30-34 age group has previously been highlighted in other European Commission studies, such as its Regional Innovation Scoreboard (European Commission, 2014b, 2016, 2017b, 2019), in order to better reflect the potential impact of changes in educational policies that are intended to lead to more tertiary graduates in countries/regions.

agriculture was above 7% in 15 of the regions, while it was above 10% in six regions. By 2018, meanwhile, just two regions (Corsica in France and Canarias in Spain) had a share of employment in agriculture that was lower than the EU-15 average (3%), while its share of employment in other regions again ranged from about 3% up to more than 13%. Nine regions had a share of employment in agriculture that was above 7% in 2018, while five regions had a share of employment above 10%.

In terms of employment attributable to industry and construction in the regions, Eurostat data shows that a majority of regions (14) had a share of employment in these sectors that was below the EU-15 average of 23% in 2013, though some regions also had a relatively high level of activity in these sectors. In this regard, share of activity therefore ranged from as low as 10%-12% up to as high as 33%. Moreover, there was relatively little change in the share of employment in industry and construction in the regions between 2013 and 2018, with 14 regions having a share of employment in these sectors that was below the EU-15 average in 2018 (22%), while sectoral share ranged from as low as 10%-12% up to as high as 34%.

Lastly, Eurostat data for the share of employment that was attributable to services across the 22 regions suggests that a majority of the regions (15) had a share of employment in services that was below the EU-15 average of 75% in 2013, though with some regions also having a relatively high level of activity in the sector, and with share of services activity ranging from less than 60% of employment up to more than 80% of employment. There was also relatively little change in the share of employment in services in these regions between 2013 and 2018, with 15 regions having a share of employment in services that was below the EU-15 average in 2018 (75%), while sectoral share again ranged from 60% up to more than 80%.

3.4 Chapter Summary

- This chapter has defined and described "lagging" regions, which are the main focus of interest from the perspective of the regional innovation paradox.
- In this regard, the "definition" of such regions for the purposes of this research is thus drawn from EU prescriptions of "lagging" regions. Lagging regions, in this EU context, are regions with below average levels of output/productivity (GDP per capita), which have in turn been prioritised, over time, for receipt of the highest levels of support from the EU's Structural Funds during the 2000-06 and 2007-13 periods.
- The EU has prioritised Structural Fund support for such regions because they are perceived to "lag" more advanced regions in terms of lower levels of productivity, educational attainment and employment rates, for example, while population performance also varies. Moreover, despite evidence of growth over the 2000-13 period and in more recent years (and thus some "convergence" towards EU averages), most lagging regions examined in this chapter nonetheless continue to lag more advanced regions in terms of their economic output, labour market participation, employment and unemployment, and educational attainment.
- At the same time, it is notable that there are clear differences between the regions, e.g. in terms of population density, sectoral composition etc. Also, there have been clear differences in socio-economic performance across regions since 2000, with Spanish lagging regions in particular showing more evidence of convergence towards EU averages than Italian lagging regions, in terms of economic output, labour market and educational attainment. In the context of innovation, for example, the suggested differences in knowledge and learning between Spanish and Italian regions, in terms of educational attainment, might appear especially stark.
- However, the socio-economic experience since 2000 also suggests how such regions might be vulnerable to wider external forces, with the effect of the global financial and economic crisis in 2008-09 clearly impacting on both GDP and employment growth in the regions.

CHAPTER 4 – LITERATURE REVIEW

4.1 Introduction

The purpose of this chapter is to place the regional innovation paradox (as described in Chapter 1) in the context of the literature on regional innovation generally, and how it has evolved. In summary, this is achieved through a review of the following key themes in the literature:

- economic perspectives on the importance of innovation for growth and competitiveness (Section 4.2);
- systems of innovation approaches (Section 4.3);
- spatial perspectives on innovation, and their emphasis on the role of place in stimulating innovation (Section 4.4);
- the emergence of regional innovation systems, both as a conceptual and policy tool (Section 4.5).

A summary of the findings of the chapter is also provided in Section 4.6.

4.2 Economic Perspectives on Innovation

4.2.1 The Nature of Innovation from an Economic Perspective

Innovation has become a very popular theme of study within the academic community over recent decades, and many definitions of innovation have been put forward in the academic literature in this time. However, the concept of innovation is very wide-ranging and complex in nature, it is a concept that straddles many disciplines, and it therefore cannot solely be defined from a narrow perspective of business or economics. Therefore, rather than seeking to identify an all-embracing definition of innovation, this section will instead seek to highlight key aspects of the nature of innovation, which are pertinent to an economic perspective and relevant to the current research.

A good starting point in this regard, from an economic perspective, lies in the views of the renowned Austrian economist, Joseph Schumpeter, who laid the foundations for much of the future study of innovation (see Section 4.2.2 below). Sweezy (1943), for example, notes Schumpeter's description of innovation as "doing things differently in the realm of economic life" (Schumpeter, 1939, p. 84). Furthermore, Schumpeter's later discussions of innovation (see Schumpeter, 1976) then go on to list several types of doing things differently, which are: developing new consumer goods; developing new methods of production and transportation; developing new sources of supply; developing new markets; and developing new forms of industrial organisation.

Schumpeter's view of innovation, therefore, includes making new products (and, extending this to the modern context, new services), developing new ways to make these products, coming up with new inputs to the production process, finding new markets for products, finding better ways to distribute products, and making improvements to the internal workings of innovation organisations or industry structures. Innovation is about much more than just product, or even process, and Fagerberg (2003) points out that any emphasis on these types of innovation should not detract from the importance of other types of innovation (such as organisational innovation).

It would also appear important to distinguish innovation from ideas or inventions, as each of these are distinct stages or outputs in an innovation process. Fagerberg (2003), for example, refers to invention as "... the first occurrence of an idea for a new product or process", while innovation is "... the first commercialization of the idea" (Fagerberg, 2003, p. 3). He notes that invention and innovation can be hard to differentiate in some cases, but in other cases there is a significant time lag between the stages. Thomson (2011), meanwhile, views innovation as beginning with an idea, which could be the possibility of either a new or improved product or a new or improved process, and this then becomes an invention. Turning the idea into an invention needs the use of resources to make it happen, which he terms R&D. The outcome of successful R&D, in turn, is the ability to either produce a new product or an existing product with a different process, which he calls technology or innovation.

Another important factor, noted by Fagerberg (2003), is that the innovation process is a continuous process, whereby initial innovations undergo continual improvements, often through integration with and absorption of other inventions and innovations. He cites the example of the car, which has changed radically since its original commercial introduction. Moreover, Fagerberg notes the views of Kline and Rosenberg (1986) in this regard, who point out that important innovations can go through significant transformations, which in turn can greatly enhance their economic significance relative to their original form.

Lundvall (2010), meanwhile, also discusses how innovation can often be of a gradual and cumulative nature, and he especially points out how innovation can be found through the use of existing knowledge, but with that knowledge used in different ways. In this regard, he points to the various choice of terms used by Schumpeter, whereby "innovation" as a term was often interchangeable with "new combinations" (of knowledge), highlighting the importance of pre-existing knowledge in generating innovation.

Fagerberg (2003) points out that such gradual, cumulative innovations are often referred to as incremental innovations. However, both Fagerberg (2003) and Lundvall (2010) nonetheless also highlight how innovation and its use of existing knowledge can be radical in form. In this regard, Lundvall points to Schumpeter's description of "creative destruction" in the innovation process (see Section 4.2.2 below), which makes elements of existing knowledge obsolete.

Finally, Morgan (1997) notes that the importance of innovation has come to be understood in a very broad sense. This includes not only product, process and organisational innovation at the level of the firm, but also social and institutional innovation at an industry, regional or national level. This importance of social and institutional inputs within the innovation sphere will become evident from the discussion in later sections of this literature review.

4.2.2 The Schumpterian View of Innovation

At this stage, there is widespread consensus and acknowledgment, particularly within the academic literature in the areas of innovation and economic development, regarding the leading role that Joseph Schumpeter played in identifying the importance of innovation in fostering economic change. Most of Schumpeter's seminal works on the topic were produced during the first half of the 20th Century, and at that time, contemporaries such as Sweezy (1943) had already begun to acknowledge his important contributions to understanding the process of economic change and his conception of innovation as a key component of that change. Many years on, however, leading academics continue to recognise the pivotal role of Schumpeter in the study of innovation. Cooke and Leydesdorff (2006), for example, credit Schumpeter as being the first pioneer to acknowledge the role of knowledge in the economy, while Cooke, Uranga and Etxebarria (1997) have hailed Schumpeter as “the founding father of innovation studies” (Cooke et al, 1997, p. 476).

Schumpeter’s theories on innovation are found in key works such as: “The Theory of Economic Development” (Schumpeter, 2008), which was first published in 1912; “Business Cycles” (Schumpeter, 1939); and “Capitalism, Socialism and Democracy” (Schumpeter, 1976), which was first published in 1942. A key focus of his theories of innovation, as described in these works, is the emphasis on the role of the entrepreneur in the capitalist economy and the process of “creative destruction”.

Sweezy (1943) describes Schumpeter’s starting point for his theories as an economy without entrepreneurs or innovation. This type of economy is in what Schumpeter describes as a “circular flow”. The circular flow, as described by Schumpeter, refers to mainstream economic theory at that time (Frank, 1998). It is an abstract view of an economic system that operates continuously through the same channels, with very few economic forces at play, and it is therefore an economy in which change (but not growth) is assumed to be absent (Sweezy, 1943).

Into this system, Schumpeter then introduces innovation, in the form of entrepreneurs. In Schumpeter’s view, entrepreneurs do things in new ways, such as developing new products or new methods of production, introducing new inputs to the production process or accessing new markets (Frank, 1998). It is this “creative response” of entrepreneurs, and entrepreneurial innovation, which in turn generates dynamic change that disrupts the static (circular) flow of the economy and generates economic growth (Frank, 1998). The creative response of entrepreneurs, meanwhile, leads to Schumpeter’s process of “creative destruction”. In this process, Thomson (2011) notes that an innovating entrepreneur destroys an incumbent’s market position, e.g. because innovations that improve existing products are “quality improving” and therefore destroy demand for that product. In such a case, competition for monopoly rents incentivises efforts to innovate (Thomson, 2011).

According to Sweezy (1943), Schumpeter's analysis is therefore intended to demonstrate that the absence of entrepreneurs in an economic system results in a stationary, static economy. Also, Frank (1998) highlights Schumpeter's view that capitalism, in order to be successful, depends on the presence of ongoing economic evolution and change, and that capitalism would stagnate in the absence of entrepreneurs and innovation, because there would be no economic change.

Underlying these theories, of course, is Schumpeter's vision or understanding of who or what constitutes the entrepreneur. Frank (1998) notes that Schumpeter's earlier work focused on small firms and individuals as the entrepreneurs driving economic change, whereas his later work gave more acknowledgement to larger, more established firms or other organisations (e.g. government agencies) as drivers of change. In this regard, he asserts that the earlier Schumpeter view described entrepreneurs as very motivated and driven individuals, and as leaders who overcome considerable social resistance and opposition to change in order to achieve success, whereas in the later Schumpeter view the entrepreneur is seen in more bureaucratic, less "romantic" forms.

This evolution in Schumpeter's view of the entrepreneur has similarly been recognised by other authors such as Lundvall (2010) and Morgan (1997). Morgan (1997), for example, cites a shift from a more "heroic" individual entrepreneur to a more "routinized" form of innovation through R&D departments. Lundvall (2010), meanwhile, cites a theoretical move from a more "individual" view of the entrepreneur in Schumpeter's earlier works to a more "collective" view (e.g. such as through R&D laboratories) in later works. Indeed, in this context, Lundvall suggests that the "systems of innovation" approach which he advocates (see Section 4.3 below) is reflective of this shift from an individual to a collective view of entrepreneurship.

Frank (1998) acknowledges that many authors regard this shift in the Schumpeterian view of the entrepreneur as being dichotomous or divergent. However, he does not believe that this creates any contradiction in Schumpeter's theories on innovation. Rather, he argues that Schumpeter's theory was not intended to explicitly identify who or what type an entrepreneur would be, as this was more a matter for study in economic history rather than economic theory. Instead, he suggests that Schumpeter's earlier views on the entrepreneur were more representative of the type of innovator found in the 19th Century, while his later views on the entrepreneur reflect the evidence available (at the time) for the 20th Century.

4.2.3 Modelling of Innovation and Economic Growth

As a result of the pioneering work of Schumpeter, the importance of innovation as a driver of economic growth and competitiveness has now become widely acknowledged, and it continues to be highlighted regularly in the more recent academic literature. Morgan (1997) and Frank (1998), for example, both note that technology and innovation developed an increasing prominence in the theories and literature on economic growth and economic development during the 1980s and 1990s, while Oughton et al (2002) contend that there is now widespread consensus for a positive link between knowledge, technological innovation and competitiveness.

In this context, accounting for the impact of technology and innovation has also become an important input to the study of long-run models of economic growth. Pinto (2009), for example, notes the work on "growth accounting", "new growth theory" (also known as "endogenous growth theory") or "technological gap" models, which have posited that innovation and technological change is crucial to economic development. Key contributors to the development of such models include Solow (1956, 1957), Romer (1986, 1990), Fagerberg and Verspagen (1996) and Fagerberg, Verspagen and Caniels (1997).

Growth Accounting: Solow (1956, 1957) was one of the first and most influential pioneers in modelling the long-run impact of innovation and technological change on economic growth. His work on models of long-run economic growth attempted to show the importance of "technical change" to economic output per capita, relative to changes in the availability of capital per head of population, using a long-run growth accounting model based on the evidence of economic growth in the United States (US) in the 1909-49 period. In this context, Solow's use of the term "technical change" referred to any kind of change in the production function, which could include slowdowns, accelerations, or changes in the education level of the labour force. His findings suggested that economic output per man hour in the US over a 40-year period, for example, increased by just over 100%. Furthermore, his analysis suggested that about one-eighth of this increase was attributable to growth in capital per man hour, with the other seven-eighths being attributable to technical change.

Solow's model, however, was based on an exogenous view of innovation and technological change. Such a view, for example, asserts that the development of ideas cannot be modelled, and that ideas appear independently of the efforts of innovators (Thomson, 2011). Allied to this exogenous view is the concept of technology as a "public good", which Thomson (2011) describes as meaning that it is non-rival (i.e. the use of a technology by one agent does not prevent its use by another agent at the same time) and non-excludable (i.e. it is difficult or impossible for one agent to prevent other agents from using a technology). Knowledge spillovers, in turn, arise where innovators cannot capture the effect that their research has on the productivity of future research.

Endogenous Growth Theory: The opposite of the exogenous view, on the other hand, is an endogenous view, which asserts that ideas and inventions can result from the innovative efforts of innovators (Thomson, 2011). Lundvall (2010) suggests that the earlier, exogenous view of innovation, where it emerges as what he terms "extraordinary events" (Lundvall, 2010, p. 8), has been superseded by a more modern endogenous view of innovation, where innovation is fundamental to the competitiveness of the firm.

An endogenous model, or "new growth theory" of long-run growth, and the impact of innovation and technological growth on change, was developed by Romer (1986, 1990). In Romer's model, technological change is generated endogenously through the conscious decisions and actions of actors (e.g. to invest in R&D), who react to market incentives with the intention of creating profit from their actions. Knowledge is assumed to be a capital good with an increasing marginal product, meaning that its marginal product would never become so low as to act as a disincentive for carrying out further R&D. However, the development of new knowledge in one firm is also assumed to have a positive effect on the production potential of other firms because knowledge cannot be kept perfectly secret.

In the model, technology is treated neither as a normal good nor a public good. Rather, it is what Romer describes as a "non-rival, partially excludable good" (Romer, 1990, p. 71). Use of a non-rival good by one firm cannot restrict its use by another firm, while a good is excludable if its owner can prevent others from using it. Technology is described as being only partially excludable, however, because of the potential for knowledge spillovers.

Romer defines technological change in this context as "improvement in the instructions for mixing together raw materials" (Romer, 1990, p. 72). In his model, technological change incentivises the accumulation of capital (investment) and both capital accumulation and technological change then generate the majority of increases in economic output. A key conclusion of his research was that the rate of economic growth is significantly determined by the availability of human capital, which in turn is crucial to the development of research and innovation.

Technological Gap: Finally, and of particular interest in a European context, a technological gap model of the impact of innovation and technological change on economic growth was developed in the work of Fagerberg and Verspagen (1996) and Fagerberg et al (1997). The stimulus for this model was provided by an analysis by Fagerberg and Verspagen (1996), which looked at overall GDP per capita and growth in GDP per capita in 70 regions spread across six (then) EU member states – Belgium, France, Germany, Italy, the Netherlands and the UK. The analysis showed a moderate but consistent trend towards convergence in GDP per head for much of the post-Second World War period, up to and including the 1970s, but a decline in this trend in the 1980s, when there was no catch-up evident (Fagerberg and Verspagen, 1996). Moreover, Fagerberg and Verspagen (1996) noted that the shift in trend did not mean that full convergence between regions had been reached, as differences in levels of productivity and income in European regions continued to be significant. In particular, the analysis suggested that GDP per capita in the richest region studied was still three times the level of the poorest region studied in 1990 (whereas it was four times the level of the poorest region in the post-war period).

In response to this, Fagerberg et al (1997) argued that regional differences in innovation and the diffusion of technology might provide an explanation for these trends. Their analysis therefore focused on growth across regions and countries from a "technology gap" perspective, which takes account of differences in innovation efforts across countries, the potential to imitate innovation and technology developed elsewhere, and the ability to exploit advances in technology, regardless of where they originated (Fagerberg and Verspagen, 1996).

Again, central to the argument underpinning this model was an endogenous perspective, whereby technology cannot be treated as a pure public good, and technology has a joint public-private character (Fagerberg et al, 1997). Furthermore, Fagerberg et al (1997) acknowledged that regions can benefit not only from innovation that is generated within the region, but also from diffusion or copying of more advanced innovations in other regions. Innovation and knowledge can thus spread and diffuse, but how and to what extent it spreads is neither instantaneous nor costless, and it can depend on a variety of capabilities, efforts and structural factors (Fagerberg et al, 1997).

The results of the Fagerberg et al (1997) analysis – which was based on data for a sample of 64 European regions spread across the four countries of (West) Germany, France, Italy and Spain – suggested that innovation and the spread of technology were indeed key factors in determining growth in European regions during the 1980s. However, poor R&D capabilities within poorer regions and industrial structures that were less conducive to innovation (e.g. regional economies that were highly dependent on agriculture) were identified as contributory factors for the relatively static performance of GDP per capita in such regions (Fagerberg et al, 1997). Also, the authors noted that simple subsidy of R&D in poorer regions was unlikely to be enough to encourage actual R&D activity, and they contended that R&D activity needs an appropriate R&D "infrastructure" (such as a suitably qualified labour force, higher education institutions), while policies aimed at addressing such infrastructure needs are essentially long-term and structural in nature, both in terms of developing the infrastructure and getting a return on it.

4.3 “Systems of Innovation” Approaches

4.3.1 Linear v Chain-linked Models of Innovation

The discussion in Section 4.2 above has demonstrated how innovation and technological development have come to be recognised as key drivers of economic growth and change. Academic literature, however, has also highlighted the fact that promoting innovation in order to drive economic growth can be a complex task. In this regard, several authors (e.g. Morgan, 1997, Heraud, 2003) have referred to the nature of innovation as an interactive process – between firms and the basic science infrastructure, between the different functions within firms, between producers and users and between firms and the wider institutional context (Morgan, 1997). Pinto (2009), meanwhile, points to the work of Kline and Rosenberg (1986), which contends that innovation follows a “chain-linked” model, whereby innovation does not occur in society by chance, but instead can be fostered more easily if certain measures are adopted and certain kinds of environments developed.

Such a chain-linked model therefore presents an alternative to earlier “linear” models of innovation. Linear models of innovation state that innovation starts with basic research (e.g. research to improve scientific theories and understanding rather than research to develop technologies), is followed by applied R&D (e.g. research using scientific theory and understanding to develop technologies or techniques), and ends with production and diffusion (Godin, 2006). Morgan (1997) also notes that such linear models assume that innovation proceeds in a sequence, from research to marketing, due to either “technology-push” or “market-pull” forces, while Heraud (2003) states that the linear approach to innovation contends that any increase in research inputs (e.g. R&D facilities) will statistically lead to increased output of technological creation and industrial innovation.

Furthermore, it is clear that linear perspectives on innovation have largely been usurped by more chain-linked, interactive perspectives. Lundvall, Johnson, Andersen and Dalum (2002), for example, state that economic models that have sought to incorporate the impact of innovation, such as the endogenous growth theory promoted by authors such as Romer (1990), have difficulties in overcoming a linear perspective (i.e. they do not sufficiently account for an interactive perspective). Heraud (2003), meanwhile, notes the development of science and technology policies in Europe after the Second World War, which placed increased emphasis on large firms, university laboratories and national research organisations within the innovation architecture, and which he regards as an application of the linear model. By the 1980s and the 1990s, however, he also points to an increased emphasis on the networking of different actors as an input to innovation, part of a philosophy that was more aligned with the modern theories of innovation as a chain-linked, interactive process.

In addition, Morgan (1997) points to weaknesses in the linear model relative to interactive perspectives. In particular, he asserts that linear models of innovation do not allow for the possibility of "feedback loops", which give R&D activities the opportunity to learn from their effects on users. Furthermore, he supports the view put forward by Rosenberg (1976) that linear models prioritise the importance of scientific knowledge in innovation, but do not give sufficient recognition to other forms of knowledge, such as know-how in engineering or production.

4.3.2 Emergence of "Systems of Innovation"

The emergence of chain-linked and interactive ideas regarding innovation processes has in turn provided the basis for the "systems of innovation" approach (Pinto, 2009), which postulates that innovation can be fostered more easily if the right system is developed. Both Cooke et al (1997) and Morgan (1997) have acknowledged the significant body of research into systems of innovation that has been published, especially in the 1990s, with leading academics in the field including Lundvall (2010, first published in 1992), Nelson (1993) and Edquist (1997).

Discussion of the concept here focuses in particular on the contributions of Lundvall and Nelson. The Lundvall (2010) description of a system of innovation, for example, defines a system as being "… constituted by a number of elements and by the relationships between these elements" (Lundvall, 2010, p. 2), or as being "… constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge" (Lundvall, 2010, p. 2).

In their contribution, meanwhile, Nelson and Rosenberg (1993), in Nelson (1993), interpret the concept of a system of innovation as being a group of institutions or actors that interact with each other, and which thereby are a direct determinant of the innovative performance of firms, while Autio (1998) describes such systems as being "essentially social systems, composed of interacting sub-systems … (and) the interactions within and between organisations and sub-systems generate the knowledge flows that drive the evolution of the innovation systems".

At the core of these definitions or descriptions is an emphasis on the importance of knowledge and learning, interaction and networking, and institutions within systems of innovation. In this regard, Nelson and Nelson (2002) note that the concept of a system of innovation has developed mainly through the work of scholars that ascribe to an evolutionary theory of economic growth. Systems of innovation literature thus conceptualises innovation as an evolutionary and "social" process (Edquist, 2004), involving many actors and factors that are both internal and external to the firm (Dosi, 1988, Lundvall et al, 2002). Under a system of innovation, for instance, investment in science and technology could only be considered as one of a number of criteria that impacts on innovation capacity (Morgan, 1997). Such descriptions, with their emphasis on learning and the interactions associated with it, therefore provide a contrast to the linear model of innovation, where innovations are assumed to flow directly and more narrowly from scientific and R&D efforts (Lundvall, 2010).

Also, as noted in Chapter 1 earlier, according to Oughton et al (2002), the systems of innovation literature enhances our understanding of the channels, mechanisms and conditions through which innovation improves economic performance. Furthermore, the concept of "national systems of innovation" had also been adopted in a normative sense, becoming used by policy makers at both national and international levels by the 1990s (Lundvall, 2010), with organisations such as the Organisation for Economic Co-operation and Development (OECD), the European Commission and the United Nations Conference on Trade and Development (UNCTAD) all embracing it from an analytical perspective (Lundvall et al, 2002).

Importance of Learning in Systems of Innovation: Lundvall (2010) summarises the main elements of a system of innovation as including: the internal organisation of firms; the relationships between firms; the role of the public sector; the institutional set-up of the financial sector; the education and training system; and the level of intensity and organisation of R&D within the system. Nelson (1993), meanwhile, also strongly emphasises the competitive competence of firms, education and training systems and the role of government (through fiscal, monetary and trade policies alongside a diverse range of innovation and technology policies) as common features in stimulating effective innovation performance.

However, especially in Lundvall's conception, it is the learning generated and knowledge created from the interaction of these elements that is crucial. In particular, Lundvall states that two assumptions underpin his description of a system of innovation. Firstly, knowledge is assumed to be the most critical input into a modern economy and, as a result, learning is a most critical process in an economy. Secondly, learning is assumed to be principally an interactive process that is embedded in and influenced by social, institutional and cultural contexts.

Lundvall (2010) also regards innovation as being found everywhere in the modern economy, and learning processes are therefore occurring on an ongoing basis, in all parts of the economy and at all times. Lundvall's view of learning in this context, therefore, is a dynamic one, which incorporates a cumulative build-up of knowledge and feedback loops (e.g. between users and producers). Lundvall et al (2002) similarly highlight the importance of systemic feedbacks in systems of innovation, while Nelson and Rosenberg (1993) stress that "… innovation is a continuing business, with product and process engineers learning from experience and making modifications on that basis, customers feeding back complaints and suggestions, management learning how to smooth out rough spots, and so on" (Nelson and Rosenberg, 1993, p. 11).

Lundvall's conception of learning and innovation systems is also broadly-based, however (see also Freeman, 2002), and as a result, he asserts that key inputs to the innovation process do not emerge solely from science-based or R&D sources, but rather also from "routine" activities in production, distribution and consumption. In this regard, therefore, the "everyday-experiences of workers, production engineers and sales representatives influence the agenda determining the direction of innovative efforts, and they produce knowledge and insights forming crucial inputs to the process of innovation" (Lundvall, 2010, p. 10).

Networking and Interaction in Systems of Innovation: The Lundvall description of learning, as outlined above, clearly places a considerable emphasis on networking, interaction, feedback loops and so on. Iammarino (2005), meanwhile, echoes both Lundvall (2010) and Nelson (1993) by listing an array of potential actors in a system of innovation, and these include inter-organisational networks, financial and legal institutions, education and training systems, technical agencies and research infrastructures, governance structures, and innovation policies and policy makers.

It is the networking and interaction between these actors, therefore, that is considered crucial in a system of innovation. Also, the social processes surrounding such interaction are regarded as pivotal, especially learning and processes that become "embedded" within the system. In this context, for example, Lundvall (2010) notes that the learning process can be a complex process, and can involve the production and use of knowledge that is considered "tacit", and therefore difficult to codify and disseminate widely. Lundvall et al (2002) also note, when considering the boundaries of innovation systems, that the literature on the role of trust and tacit knowledge suggests that interactive learning is more readily facilitated where there is little constraint in disseminating tacit knowledge (e.g. due to language, culture). However, they acknowledge that trust is nonetheless a complex concept, and the institutions within which trust is developed (with institutions understood in the abstract, less formal sense) are critical in promoting interactive learning and therefore innovation.

Institutions in Systems of Innovation: Following on from the importance attached to embedded processes, tacit knowledge and trust, therefore, Lundvall (2010) highlights institutional structures as another important dimension of systems of innovation, with institutions described as providing "… agents and collectives with guide-posts for action" (Lundvall, 2010, p. 10). Lundvall et al (2002) also refer to the importance of institutions to economic change, while Nelson and Nelson (2002) describe the concept of innovation systems as being "… an institutional conception …" (Nelson and Nelson, 2002, p. 265).

In this regard, however, "institutions" are not interpreted solely in a physical sense, but also in an abstract sense. Morgan (1997), for example, puts forward the proposition that innovation is moulded by an array of institutional routines and social norms. This incorporates an abstract view of an institution as something that consists of recurrent patterns of behaviour, such as habits, conventions, routines and trust, which form a "social capital" that facilitates co-operation and co-ordination for mutual benefit (see Putnam, 1993). Johnson (2010), meanwhile, notes that such institutions, in the abstract sense of being norms, habits and rules, become socially embedded, and are therefore instrumental to how people relate to each other and how they absorb and exploit knowledge.

Nelson and Nelson (2002), meanwhile, in referring to the concept of institutions in the abstract sense, highlight the importance of routine in evolutionary theory, which they define as "… a way of doing something, a course of action" (Nelson and Nelson, 2002, p. 267). Also, they put forward the idea of an institution as what they call a "social technology" (Nelson and Nelson, 2002, p. 268). New social technologies, in this context, represent changes in means of interaction, for example, such as new ways of organising work, new types of markets, new laws or new kinds of collective action (Nelson and Nelson, 2002). Lundvall (2010), however, also notes that "social" institutions such as routines or norms provide a stability that is considered necessary if innovative efforts are to both happen and succeed.

4.3.3 Complexity and Diversity in Systems of Innovation

Learning, interaction and networking and institutions would therefore appear to lie at the heart of the systems of innovation approach. However, another important consideration, highlighted by some scholars in the area (e.g. Nelson, 1993, Cooke et al, 1997), is the complex and diverse nature of different systems of innovation. Furthermore, such complexity and diversity between systems of innovation can also be manifest in a number of forms, which in turn can impact on the ability to find commonality between different systems.

Cooke et al (1997), for example, highlight the complex and diverse range of national systems of innovation that were examined in Nelson's (1993) study, and concluded that it would be difficult to determine a generic model for an innovation system from the evidence available. In this regard, Nelson (1993) notes that evidence would suggest that differences in innovation systems reflects varying economic and political circumstances and priorities, such as size, wealth or endowment of natural resources.

Cooke et al (1997), meanwhile, also suggest that systems of innovation can be partly shaped by common history, language or culture, which in turn can be seen in the ways that firms are organised, in the interaction between firms, in the ways in which R&D systems are organised, in the role of the public sector in a system, and in the institutional structures. Nelson and Rosenberg (1993) likewise note the influence of common language and shared culture in shaping an innovation system, alongside government policies, laws and regulations. In the same context, however, they further point out that (national) innovation systems can be strongly influenced by the industries that exist within the system and the mix of those industries. Nelson (1993) also notes that a distinctive national character was evident in the firms, education systems, laws, politics and government of the different country innovation systems examined in the Nelson (1993) study.

Cooke et al (1997) further suggest that the degree of interaction between actors in a system can vary – it can be strong or weak, regular or irregular, intense or relaxed – and the nature of the interaction therefore impacts on the system. Similarly, Nelson and Rosenberg (1993) state that one cannot assume that a system of innovation was deliberately put in place, or that it always works in a smooth or coherent fashion.

Rather, their perception of the concept emphasises that the actors involved, by working together in whatever manner, can nonetheless have a significant influence on innovation performance. The work of Edquist (1997), meanwhile, which examines systems from a more operational context, concludes that a (national) “system” cannot be fully designed, though it is possible that some parts can, while other parts cannot (Cooke et al, 1997), while Nelson (1993) notes that innovation systems are not necessarily easily delineated by borders, with transnational considerations becoming increasingly common.

In the light of these observations, therefore, it is probably not surprising that Lundvall (2010) acknowledges that his definition of systems of innovation allows for a degree of openness and flexibility regarding what is included or excluded within a system, depending on the context. At the same time, and in the same context, Nelson and Rosenberg (1993) still describe the concept of a system of innovation as providing “… a common analytical framework, not wide enough to encompass all of the variables and relationships that likely are important, not sharp enough to tightly guide empirical work, but broad enough and pointed enough to provide a common structure in which one can have some confidence” (Nelson and Rosenberg, 1993, p. 5).

From a policy perspective, Lundvall et al (2002) further contend that the systems of innovation concept, in its broadest sense, requires a perspective of policy co-ordination across a broad range of areas, including R&D policy, social policy, labour market policy, energy policy or environmental policy, for example. Nelson and Rosenberg (1993), meanwhile, also note the need for integration and co-ordination of policy within a system, stating that any analysis of an innovation system in isolation from the economic system is artificial, as is any description of innovation policy being unconnected to policies in other areas.

Furthermore, the impact of any policy designed to improve a system of innovation may take some time to mature. For example, Cooke et al (1997) point out that institutional change is complex (see also Dalum, Johnson and Lundvall, 2010) and implementing institutional change in a system can be a slow process. As a result, policies that are designed to improve innovative capacity within a system from this perspective can also take time to show impact (Cooke et al, 1997).

4.4 Spatial Perspectives on Innovation

4.4.1 Emergence of Territorial Innovation Models

While systems of innovation approaches have undoubtedly become a popular topic of research within the academic literature, the interest in such approaches has developed alongside an increased interest in spatial perspectives on innovation and economic development, which has also become a major focus of research and debate in recent decades. Morgan (1997), for example, notes that the 1990s saw a growing convergence between researchers in economic geography and researchers in innovation, and he highlights in particular the work of authors such as Storper (e.g. 1992, 1995) in stimulating debates about innovation in the context of economic geography. Convergence, in this context, arose because students of economic geography were devoting more attention to the study of innovation capacity as a means of explaining unbalanced development across regions, while students of innovation were in turn becoming more interested in examining spatial issues in the context of technological change (Morgan, 1997).

This emergence of a "regional science" perspective and literature regarding innovation has in turn produced research on and discussion of concepts such as innovative clusters (Porter, 1998a, 1998b), knowledge spillovers (Audretsch and Feldman, 1996), learning regions (Florida, 1995, Morgan, 1997), industrial districts (Mouleart and Sekia, 2003), technological districts (Storper, 1992) and innovative milieux (Crevoisier, 2004). Mouleart and Sekia (2003) have also referred to such concepts more generally as territorial innovation models, and a brief description of some of these concepts is provided below.

Innovative Clusters: The concept of innovative clusters, for example, has been popularised by the pioneering work of Porter (1998a, 1998b), who put forward the thesis that local advantages can be instrumental in building competitive advantage in a globalised economy. Porter describes clusters as "... geographic concentrations of interconnected companies and institutions in a particular field" and also as "... critical masses – in one place – of unusual competitive success in particular fields" (Porter, 1998a, p. 78). His vision of a cluster includes firms in a particular sector or related sectors, their customers and suppliers, infrastructure providers and government and other institutions (e.g. those providing training and education, information and research, other technical support and so on). It provides better access to employees and suppliers, access to specialised information, access to institutions and public goods and opportunities for complementarity between cluster members. Crucially, clusters stimulate co-operation between companies in related sectors and local institutions (Porter, 1998a), with local suppliers and other local partners to a firm or firms, thereby often playing key roles supporting innovation at the firm level. In this regard, the cluster is "... a form of network that occurs within a geographic location, in which the proximity of firms and institutions ensures certain forms of commonality and increases the frequency and impact of interactions" (Porter 1998b, p. 227). In summarising Porter's view of clusters, Doloreux and Parto (2005) also highlight the importance of common specialisation, proximity and co-operation, which in turn generate spillovers and synergies.

Knowledge Spillovers: Theories regarding knowledge spillovers, meanwhile, put forward a hypothesis that high concentrations of knowledge in a region will promote the circulation of that knowledge throughout the region (Gössling and Rutten, 2007), thereby promoting a concentration of innovation activity. In this regard, Döring and Schnellenbach (2006) note that the literature regarding knowledge spillovers suggests that knowledge does not spread instantaneously or without boundaries, but that dissemination of knowledge is subject to regional patterns and spatial barriers, which contribute to varying rates of growth in regional wealth and output.

To illustrate knowledge spillovers, for example, Audretsch and Feldman (1996) examined data from the Innovation Data Base of the United States Small Business Administration (USSBA) in order to assess (a) the extent to which industrial activity clusters on a geographical basis and (b) the link between the spatial concentration of activity and the presence of knowledge externalities or spillovers. Their findings suggested that clustering of innovation activity was strongly linked to the existence of knowledge spillovers, even when controlling for the existence of location of production that is concentrated spatially. In addition, Audretsch and Feldman suggested that such knowledge externalities were more common in industries where "new" economic knowledge (i.e. industry R&D, university R&D, skilled labour) was important.

The literature regarding knowledge spillovers would also suggest some form of relation between key actors, though maybe to a lesser degree than is evident for other spatial perspectives on innovation. Torre and Rallet (2005), for example, note that economic actors need not necessarily have any direct relations with one another under geographical agglomeration alone, though indirect relations may exist. However, Döring and Schnellenbach (2006) nonetheless suggest that the possibility of generating knowledge spillovers will produce some degree of co-operation and co-ordination among firms, whether formal or informal.

Learning Region: Another concept that has been described in the literature on spatial perspectives on innovation is the learning region. This concept seeks to highlight the influence that knowledge and learning can have at a local level, and especially the role that institutions, networks and interactive learning play at that level (Uyarra, 2007). Florida (1995), in his description of the learning region, views such a region as one that derives competitive advantage through knowledge creation and continuous improvement, and which provides overarching infrastructures that accommodate knowledge, ideas and learning. This includes:

- a manufacturing infrastructure that promotes co-dependent networks at the firm level of customers and suppliers;
- a human infrastructure that promotes knowledge workers, continuous improvement and lifelong learning;
- a physical and communications infrastructure that facilitates continuous exchange of information and global links for the movement of people, information, goods and services;
- industrial governance structures that promote co-dependency, networking, flexibility and decentralised decision making (Florida, 1995).

In a similar vein, Morgan (1997) seeks to put forward the usefulness of a learning economy perspective, and interactive models of innovation, for the purposes of regional development, while Mouleart and Sekia (2003) compliment Morgan’s contribution to explaining the logic of learning regions, especially his emphasis on (a) innovation as an interactive process and (b) the importance of routines and norms in building innovation.

Industrial Districts: Industrial districts, meanwhile, in the context of the more recent academic literature, are an update on the concept made famous by the work of Alfred Marshall (for example, see Marshall, 1920). According to Mouleart and Sekia (2003) and Uyarra (2007), these new industrial districts are defined as productive systems in a local geographical area, where small and medium-sized enterprises (SMEs) provide expertise or proficiency in different stages of production and distribution for a sector, an activity or a number of activities. However, the school of literature on industrial districts also emphasises the importance of social, economic and political relations in a district, both of a formal and informal nature, in shaping economic development over the long-term (Mouleart and Sekia, 2003). Particular social and cultural characteristics facilitate information sharing and the dissemination of innovations by firms in the district (Uyarra, 2007), and such characteristics incorporate numerous varied relationships, both among firms and between firms and the local socio-economic community, with trust and reciprocity, co-operation and formal and informal institutions all playing a significant role (Mouleart and Sekia, 2003).

Technology Districts: Following on from this, Storper (1992) describes technology districts as industrial districts that are grounded in what he calls "product based technological learning" (Storper, 1992, p. 61). In such districts, dynamic technological change is driven by constant learning, sophisticated networking is a key organisational mechanism that facilitates such learning, while learning is also shaped by conventions, which are described by Storper as "... rules mobilizing resources and maintaining them in situations of mutual engagement" (Storper, 1992, p. 62). These conventions, as described by Storper, refer to "... routines or unwritten rules of the game" (Storper, 1992, p. 86), which lay outside more formal rules and institutions.

However, Storper also argues that industries that are grounded in such product based technological learning are often focused on distinct geographical areas, hence technology districts, because key elements of such districts, and especially their conventions, are territorially bounded. In this context, therefore, agglomeration occurs because of co-operative and networking efficiencies and the quality of such co-operation and networking, and not just because of more commonly recognised cost efficiencies (Storper, 1992).

Innovative Milieux: Finally, the innovative milieux approach, as described by Uyarra (2007), highlights the importance of non-physical resources, interaction and learning, relations emphasising co-operation and competition between key actors and an ability to identify opportunities for interaction and relationships with the external environment. Gössling and Rutten (2007), however, also assert that the approach stresses that several factors influence innovation, not just any one single factor, and these may include organisational factors (e.g. know-how) or regional factors (e.g. human capital, density). The approach, therefore, looks for an explanation of regional differences in innovative performance on the basis of differences in regional characteristics (Gössling and Rutten, 2007).

Crevoisier (2004) provides a description of the innovative milieux framework, that incorporates three different axes:

- a technological axis, which emphasises the importance of innovation, learning and know-how;
- an organisational axis, which highlights the importance of local networks, co-operation and co-ordination mechanisms and relational capital (values, trust, reciprocity and so on);
- a territorial axis, which suggests that territory can stimulate links among both the resources and the key players that are required to promote innovation (Crevoisier, 2004).

Under innovative milieux, each of these axes is considered co-equally, with no single axis being dominant over the others (Crevoisier, 2004). Also, the innovative milieux approach does not view the firm in isolation, but rather sees it as part of a broader environment that has innovative capacity (Mouleart and Sekia, 2003). In this regard, Storper (1992) equates the term “milieu” with “synergies” at work between the different actors and factors at play. Malmberg and Maskell (1997), meanwhile, note that knowledge in innovative milieux becomes grounded not only in persons’ skills, or in organisational routines, but also in inter-firm relationships and in relations with the broader institutional context. The milieu context therefore helps shared norms, values and institutions, or social capital, to evolve (Malmberg and Maskell, 1997).

4.4.2 *Similarities with System of Innovation Approaches*

As is evident from the discussion above, a common thread that runs through much of the literature regarding spatial perspectives on innovation is the importance of key factors that have also been identified as important under systems of innovation approaches. This includes not only “hard” factors but very much also “soft” factors, such as the importance of cultural factors, structures and institutions, networks and collective/interactive learning, and relational and social capital (rules, conventions, norms, trust and so on). To recap, some of key factors cited above for particular spatial models include:

- the role of co-operation between companies in related sectors and local institutions within innovative clusters;
- the role that institutions, networks and interactive learning play in learning regions, with continuous exchange and improvement, co-dependency, networking and flexibility;
- the importance of social, economic and political relations, and social and cultural characteristics in industrial districts, including trust and reciprocity, co-operation and formal and informal institutions;
- the importance of sophisticated networking and conventions as key organisational mechanisms in technology districts;
- the role of organisational routines, inter-firm relationships, social capital and relations within the broader institutional context under innovative milieux.

The particular importance of such factors generally within the spatial models discussed above has been highlighted and acknowledged by numerous commentators. Uyarra (2007), for example, asserts how the territorial innovation models summarised by Mouleart and Sekia (2003) emphasise the key role of collective learning at a local level in encouraging spatial concentration of activity, while Mouleart and Sekia themselves also highlight the importance of institutions, co-operation and partnership within processes of innovation as described in innovative milieux, industrial district or local production system models (Mouleart and Sekia, 2003). Doloreux and Parto (2005) have noted that concepts such as learning regions, industrial districts, innovative milieux or local productive systems have developed through attempts to explain the social and institutional factors underlying regional competitiveness, while Gössling and Rutten

(2007) state that “soft” characteristics such as inter-organisational relations, networks and the role of social factors have shaped more recent thinking regarding innovative milieux. In the case of knowledge spillovers, meanwhile, Döring and Schnellenbach (2006) stress that the inclination and capability to absorb technological knowledge in a region is in some way dependent on the presence of an adequate institutional framework to process and transform knowledge into actual production technologies.

4.4.3 The Importance of Place and Proximity

At the same time, alongside their focus on features that are familiar from the systems of innovation approach, much of the literature on spatial models and concepts also focuses on innovation as a process that is to a considerable degree place-specific and place-embedded. In this regard, Storper (1995) tries to explain what he considers to be “the principal dilemma” of contemporary economic geography – how regional economies experienced a rejuvenation at a time when forces of globalisation would have appeared to make the world more “placeless”. The answer to this, he suggests, lies in the association between organisational and technological learning within spatial agglomeration, based on what he calls not only “traded interdependencies” (e.g. user-producer or customer-supplier relations) but also “untraded interdependencies” (e.g. labour markets, regional conventions and norms, public or semi-public institutions). Crucially, however, he describes such interdependencies as being localised.

Doloreux and Parto (2005), meanwhile, contend that the regional science literature in general views innovation as a localised and locally embedded process, something that is therefore “... not placeless ...” (Doloreux and Parto, 2005, p. 135). In this regard, they cite authors such as Malmberg and Maskell (1997), who view geography as playing a key role in innovation and learning because the key resources, knowledge inputs and competences needed for innovation are typically found in specific places. Iammarino (2005) also suggests that the research underlying the various spatial models deals with the structural and institutional factors of innovation from a localised perspective, and how these factors build innovation capacity within explicit geographical contexts.

Uyarra (2007), in turn, points out that the literature on the various spatial models places additional emphasis on the importance of “regional coherence” (Uyarra, 2007, p. 245), i.e. the importance of explicit regional or local identities, local learning practices, or assets and capabilities that are unique to a local area or region. Similarly, Asheim and Isaksen (2002), in discussing regional clusters, suggest that socio-cultural structures and institutional environments can stimulate learning and innovation that is both socially and spatially embedded, aided by inter-firm networking, inter-personal connections and local learning processes. Moreover, in this context, Malmberg and Maskell (1997) argue that the complex nature of such specific regional capabilities reduces the potential for imitation elsewhere, which adds to competitive advantage.

Furthermore, the importance of place in the literature additionally highlights the role that geographical proximity plays in innovation processes, and its link to the local characteristics of key factors underlying the development and spread of knowledge and innovation. In this regard, for example, Doloreux and Parto (2005) state that theoretical discussion on innovation and regional development stresses that (a) innovation occurs in institutional, political and social contexts, (b) innovation is embedded in social relationships and (c) innovation occurs more readily in cases of geographic concentration and proximity.

Boschma (2005) defines geographical proximity as "… spatial and physical distance between economic actors …" (Boschma, 2005, p. 69), while Torre and Rallet (2005) describe it as the (kilometric) distance in space between two separate units (such as, for example, individuals, organisations or towns). However, geographical proximity can include not only objective physical distance (in terms of kilometres, time elapsed or cost of travel), but also people's perception of distance, which can vary according to age, gender or social background (Torre and Rallet, 2005).

Asheim and Isaksen (2002), when discussing agglomerations or clusters, note that the debate on such concepts suggests that proximity or closeness makes it possible for key players to develop, obtain, assemble and use knowledge quicker than those that are outside such clusters. When discussing geographical proximity, meanwhile, Malmberg and Maskell (1997) also assert that, in their words, "… proximity matters" (Malmberg and Maskell, 1997, p. 25), and they suggest that innovations in most cases derive from a variety of resources, knowledge, other inputs and capabilities that are place-based. In their opinion, interactive processes that support innovation are grounded in wider cultural and institutional contexts, but geographical proximity facilitates such contexts, thereby supporting interactive learning. In this regard, therefore, geographical proximity is not only more cost efficient, in the conventional sense, but it also stimulates more rapid transfer of knowledge between actors (Malmberg and Maskell, 1997).

Proximity is not only geographically focused, however, and it would be incorrect to assume that its geographical form is the only proximity impacting on innovation processes. Malmberg and Maskell (1997), for example, acknowledge that proximity is not solely spatially based, as there is also a "social" and "cultural" proximity that is important, which implies considerable levels of trust and shared values. Likewise, Torre and Rallet (2005) identify "organised" proximity, which they define as a relational proximity based on an organisation's capacity to direct its members to interact, and they highlight concepts such as industrial districts, innovative milieux and local production systems as incorporating both geographical proximity and organised proximity. Moreover, Boschma (2005) describes an even more detailed mosaic of potential proximity, which incorporates not only geographical proximity but also:

- cognitive proximity, whereby relevant actors share a broadly similar knowledge base and expertise, which helps them to learn from each other;
- organisational proximity, which is described as the level of autonomy or degree of control, or the relative strength of the ties that exist in organisational arrangements;
- social proximity, or the social embeddedness of or level of trust in relations between agents and actors;
- institutional proximity, which represents shared habits, norms, values and so on, particularly at the macro level.

Torre and Rallet (2005) note that geographical proximity makes random interactions possible and allows actors to see what others are doing and draw comparisons (see Malmberg and Maskell, 2002), but also state that this is not enough to encourage deliberate co-operation and co-ordination. Boschma (2005) similarly asserts that geographical proximity is neither necessary nor sufficient in order to stimulate interactive learning. Therefore, geographical proximity cannot be viewed in isolation from other forms of proximity. Torre and Rallet (2005), for example, suggest that geographical proximity must be framed and mobilised by organised proximity if interactions are to occur, as organised proximity dictates the rules of behaviour between actors, and how information and knowledge is shared.

Furthermore, Boschma (2005) points out that too much proximity, of whatever form, can have negative implications for innovation too, through various types of "lock-in". For example, too much cognitive proximity could deter the absorption of new knowledge that is outside the existing cognitive knowledge base, which can be detrimental to innovation. Too much social proximity, meanwhile, can stimulate too much commitment to existing ways without sufficient receptiveness to new ideas. An appropriate threshold of all forms of proximity, therefore, can help to reduce uncertainty, thereby supporting learning and innovation (Boschma, 2005).

Finally, and perhaps not surprisingly, Howells (2002) also suggests that the importance of spatial proximity can vary by sector. For example, he cites the work of Adams and Jaffe (1996), which suggested that the role of spatial proximity was important for R&D productivity in the chemicals industry, but less so for R&D productivity in the pharmaceutical industry.

Despite such qualifications to the arguments regarding the importance of geographical proximity, however, Malmberg and Maskell (1997) nonetheless contend that certain kinds of information and knowledge still need direct, face-to-face interaction, that such intense and regular personal contact and interaction (and speedy decision-making) reduces uncertainty, and that such interaction is in turn improved with geographic proximity. Similarly, while geographical proximity is neither necessary nor sufficient in this regard, Boschma (2005) also acknowledges that it can facilitate interactive learning by enhancing the other forms of proximity, e.g. by stimulating social proximity, because lack of distance promotes social interaction and trust. In this same context, Howells (2002) also acknowledges the indirect influence of geographical proximity, as it has a significant influence on the kinds of routines and practices that govern what he calls "relational" proximity.

4.4.4 Geographical Proximity and Tacit Knowledge

Allied to the emphasis on geographical proximity, meanwhile, the literature on regional science makes added reference to the importance of different types of knowledge in contributing to the innovation process. In particular, it makes a distinction between (a) “codified” knowledge and (b) “tacit” knowledge (previously referred to in Section 4.3.2 above). Howells (2002), for example, cites the original work of Polanyi (e.g. 1962) in segregating and differentiating between codified knowledge and tacit knowledge. In this regard, Polanyi describes codified knowledge as being knowledge that can be transferred through formal, standardised language, where direct experience of the knowledge being transferred is not needed. Codified knowledge, therefore, is more easily exchanged and communicated (Uyarra, 2007). Tacit knowledge, on the other hand, involves direct experience of the knowledge concerned, which cannot be formalised or standardised, but is rather learned through adoption of learned behaviour and processes (Howells, 2002). It is embedded in the know-how and practices of individuals (Uyarra, 2007), it is more “sticky” (Asheim and Isaksen, 2002) and it cannot be directly or easily transmitted (Polanyi, 1962).

Such tacit knowledge can thus be so complex that its users in an organisation, network or grouping can co-operate and co-ordinate activities competently without being able to describe how they do it (Lawson and Lorenz, 1999). In addition, organisation, co-operation and brainstorming between such actors also requires tacit knowledge through some form of understanding of other actors’ competences or problem solving methods across multiple disciplines (Lawson and Lorenz, 1999).

Several authors, in turn, emphasise the importance of the link between geographical proximity and tacit knowledge. In this regard, codified knowledge is less place-specific because it is generally more mobile, more freely available and more easily transferable, while tacit knowledge is more place-specific because it is less mobile and less easily transferable. In describing the concept of learning regions, for example, Uyarra (2007) states that the importance of geographical proximity is seen as being grounded in the importance of tacit knowledge. Furthermore, in this context, an increased contribution of tacit knowledge in delivering competitiveness makes geographical proximity more important because it facilitates the kind of personal relations that allow tacit knowledge to be more readily shared (Uyarra, 2007, Morgan, 1997). This is because such personal relations need trust, and such trust is developed not only through shared language but also through shared values and culture (Malmberg and Maskell, 1997). Under such an argument, therefore, the more tacit the knowledge involved, the more important is the level of spatial proximity between the actors involved (Malmberg and Maskell, 1997).

Furthermore, Howells (2002) also suggests that tacit knowledge can be needed in order to make efficient use of more easily available codified knowledge. For example, tacit knowledge may be needed in order to interpret codified information, and tacit knowledge, alongside the wider context of a specific situation or location, can therefore have a crucial influence on how codified knowledge is used and diffused (Howells, 2002). Thus, while codified knowledge may be more accessible per se, and less easily spatially constrained, geography can nonetheless influence how it is understood and absorbed (Howells, 2002).

4.5 Regional Innovation Systems

4.5.1 Emergence of Regional Innovation Systems

Much of the initial focus on the systems of innovation approach, as described in Section 4.3 above, concentrated on the national level as the appropriate unit for analysis of innovation systems. Key pioneers of the systems approach, for example, such as Lundvall (2010) and Nelson (1993), focused much of their study of the topic at the national level. As noted earlier, Lundvall (2010) describes a system of innovation as being "… constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge" (Lundvall, 2010, p. 2). A national innovation system, however, "… encompasses elements and relationships either located in or rooted inside the borders of a nation state" (Lundvall, 2010, p. 2).

However, the concept of "regional innovation systems" has more recently become a popular topic of research and debate, particularly since the mid- to late-1990s. Proponents of this concept, such as Cooke et al (1997), have sought to show that systems of innovation need not be limited solely to a national scale because dimensions of regional innovation systems can also be identified. In this context, Oughton et al (2002) note that such regional systems of innovation are relevant because the factors that are considered important for national systems of innovation can, by their nature, vary considerably across regions. Similarly, Cooke (1998) suggests that an increased focus on systems at a regional level might assist in answering interesting questions about the systemic nature of innovation, which prove difficult to answer at the national level, such as identifying the key relationships involved.

The origins of the regional innovation systems concept, therefore, appear to be grounded in the systems of innovation approach, but also in other spatial perspectives on innovation. Cooke et al (1997) locate the origin of the concept within the mix of theory and research devoted to both systems of innovation and regional science, but with particular emphasis placed on the influence of research interests in the spatial distribution and policy impact of high-tech industry, technology parks, innovation networks and innovation programmes in regions. Asheim and Isaksen (2002), meanwhile, contend that the focus on regional innovation systems has emerged from the study of the increased importance of place-based and sometimes non-economic factors in generating competitive advantage and variances in regional growth rates, and from a belief that local and regional resources can still play a key role in developing global competitiveness at the firm level. In this regard, Mouleart and Sekia's (2003) collective description of territorial innovation models groups regional innovation systems alongside other spatial models, as described in Section 4.4 above.

More recent contributions, such as Asheim et al (2011a), also attribute the foundations of the concept of regional innovation systems to both the systems of innovation approach and to spatial innovation concepts such as industrial districts, clusters and innovative milieux. In doing so, they acknowledge a burgeoning research output regarding regional innovation, which has developed over three decades, driven by advances in theoretical analysis, an increased interest in the role of innovation in building competitive advantage, but also an increased emphasis on policy imperatives to address regional inequalities and divergence (Asheim et al, 2011a).

4.5.2 *Influence as a Policy Tool*

The increased emphasis on policy imperatives highlighted by Asheim et al (2011a) is in turn demonstrated most readily by the prominent use of the regional innovation systems concept as a basis for innovation policy making. Doloreux and Parto (2005), for example, have pointed to its widespread use as an analytical framework for shaping innovation policy, and an ensuing growth in regional innovation policies, while Asheim and Isaksen (2002) and Cooke (1998) have similarly cited its use as a policy making tool to develop systems of innovation at a regional level.

This impact of the concept, in particular, has been especially noticeable in the EU, where it has to a large degree been adopted as a policy aid over much of the last two decades. As noted earlier in Section 2.3, for example, De Bruijn and Lagendijk (2005) have suggested that innovation had, by the early 2000s, come to be regarded as the most important driving factor for sustainable economic development across Europe. Prior to the 1990s, however, innovation policy in the EU (delivered mainly through the FPs, referred to earlier in Chapter 2) was largely targeted at existing centres of excellence for research and innovation, which were typically found in already well developed regions, while innovation was too often only associated with research and technological development (RTD) capacity, and not enough attention was paid to social, institutional and commercial elements of innovation (Morgan, 1997).

At the same time, lagging or under-developed regions in Europe were generally perceived to be lacking not only physical infrastructure but also social capital or institutional capacity (Morgan, 1997). In addition, regional policy in the EU, up to the 1990s at least, mainly addressed perceived symptoms of under-development, such as high unemployment, rather than perceived causes of under-development, such as low innovation policy (Morgan, 1997). This in turn, according to Morgan (1997), led to calls for more integration between the Structural Funds, the EU’s main investment support for regional policy, and the more innovation-centred FPs, while the 1990s also witnessed the emergence of several RTD initiatives with strong regional innovation elements, such as STRIDE, PRISMA, ENVIREG, EUROFORM, VALOREN and TELEMATIQUE (Morgan, 1997).

Thereafter, however, Asheim et al (2011a) assert that the regional innovation systems concept has had a very significant influence on innovation policy development in the EU. For example, as noted earlier in Section 2.4, this influence became evident during the 1990s through the introduction of EU policy interventions such as the RTP, the follow-up RIS Programme and the RITTS (Oughton et al, 2002). In this regard, Morgan (1997) notes that the pilot RTP, launched in 1994, encouraged lagging regions to design a regional innovation process and, in agreement with the European Commission, a strategy for RTD investment in the region, which would provide a long-term strategic framework for promoting innovation (Oughton et al, 2002). Central to the strategies developed under the RTP, however, was the intention to build collective learning and social capital in the regions, and develop new routines incorporating interaction, trust and informal transfer of know-how (Morgan, 1997). Oughton et al (2002), meanwhile, also described the RIS Programme (which sought to mainstream the objectives of the pilot RTP) as being grounded in concepts – such as analysis of regional innovation at a systemic level, the development and enhancement of institutional processes and linkages, and the formation of partnerships, consensus and increased synergies among key agents of innovation – that will be familiar from the descriptions of regional innovation systems outlined below.

Furthermore, the influence of regional innovation systems thinking, and “its persistence as both a concept and a policy blueprint” (Pugh, 2016, p. 114), has continued to permeate regional innovation policy at an EU level. The introduction of the Lisbon Strategy in 2000, for example, saw the EU focus further on improving its overall RTD and innovation capacities and capabilities by financially supporting intra- and inter-regional collaborative innovation initiatives. Moreover, support for “Research Potential” and “Regions of Knowledge” under the seventh EU Framework Programme 2007-13 (FP7) also promoted co-ordination, interaction and collaboration within and between regions, while the Horizon 2020 Programme (covering the 2014-20 period) introduced further measures aimed at spreading research excellence and widening research participation to lower-performing member states. In addition, strengthening research, technological development and innovation has been one of the four key priorities that have been pursued under the EU’s Cohesion Policy for the 2014-20 period, including the facilitation of co-operation, networking and partnership between key innovation agents, while Pugh (2016) has suggested that the core ideas and elements of the regional innovation systems concept have been embraced within the EU's requirement for regional-level "smart specialisation" strategies during the 2014-20 period (see also Section 2.4).

4.5.3 Descriptions of Regional Innovation Systems

There is no commonly agreed definition of what constitutes a regional innovation system (Doloreux and Parto, 2005), and various definitions have been used by different authors. Pinto (2009), for example, defines regional innovation systems as the group of actors and organisations (enterprises, universities and research centres) engaged in regional innovation and learning, and characterised by the existence of territorial, intangible, institutional and relational resources. Carrincazeaux and Gaschet (2006), meanwhile, describe a regional innovation system as a "… systemic and administratively supported interaction between the regional production structure … and a regional supportive structure … made up of government or private research laboratories, technology transfer agencies, technology incubators, training systems, etc" (Carrincazeaux and Gaschet, 2006, pp. 8-9).

According to Asheim and Isaksen (2002), regional innovation systems are regional clusters (firms) that are surrounded by "supporting" organisations or an institutional infrastructure of research and higher education institutions, technology transfer agencies, vocational training organisations, business associations and finance houses, which provide regional competences that can help to enhance innovation in a region. Evangelista et al (2002) define regional innovation systems as "...the localized network of actors and institutions in the public and private sectors whose activities and interactions generate, import, modify and diffuse new technologies within and outside the region" (Evangelista et al, 2002, p. 174). Finally, Doloreux and Parto (2005) describe a regional innovation system as being identified by co-operative innovation activities between firms and knowledge-creating and diffusing actors, such as universities, training organisations, R&D institutes and technology transfer agencies, and a pro-innovation culture that enables both firms and systems to evolve over time.

Several authors have also sought to in some way describe what constitutes a regional innovation system, drawing to a large degree on concepts familiar from both the systems of innovation approach and from spatial perspectives on innovation, but at the same time highlighting more conventionally familiar elements of what might be found in a "system". Asheim et al (2011a), in particular, note that the literature on regional innovation systems points to many such familiar factors influencing the system, like the strength of the science base and knowledge transfer system, the institutional setting, the financial system, the availability and quality of human capital, the education and training system and a pro-innovation public policy context. The definitions and descriptions highlighted above, however, also point to the importance to less tangible elements within the system, such as learning processes, networks and relational resources.

The elaboration of regional innovation systems as a concept was to a large degree pioneered by the work of Philip Cooke (see Cooke et al, 1997, Cooke, 1998 and Cooke, 2001). Cooke et al (1997), for example, emphasised the importance of (a) financial capacity, (b) embedded learning processes and (c) productive culture for regional systemic innovation. For example, budget availability and autonomy, and influence over investment in infrastructure, can influence the ability to impact on innovation policy at the regional level. Learning processes, in turn, can have significant local characteristics that can be improved through institutional changes or through appropriate policy intervention. Finally, a productive culture that systemises co-operative action, trust between key players and associational networks is also crucial (Cooke et al, 1997).

Cooke (2001), meanwhile, further draws on institutional and organisational dimensions of regional innovation systems, as espoused by Cooke et al (1997), to discuss key features or criteria considered advantageous for regional innovation systems. In this regard, he highlights what are termed infrastructural issues and "superstructural" issues (Cooke, 2001, p. 960). Infrastructural issues, for example, include (a) the extent to which power of control over both private and public finance lies at the regional level and (b) regional competence to influence hard infrastructure investments, including knowledge infrastructure. Superstructural issues, on the other hand, emphasise the regional "culture" in terms of the embeddedness of the region and its institutions and organisations. This incorporates elements such as co-operation, interactive learning, consensus, harmonious labour relations and progressive workforce development, openness to external interactions, inclusivity and networking.

In another attempt to describe regional innovation systems, Iammarino (2005) attempts to provide an integrated conceptual framework for the concept by considering both “top-down” and “bottom-up” characteristics of systems. Iammarino’s rationale in this regard states that the top-down conceptual perspective provides conditions that are necessary to distinguish regional innovation systems, however these are not sufficient on their own, so a bottom-up perspective that examines the inner dynamics of embedded social, economic and institutional structures at the sub-national level is also needed. Iammarino’s top-down perspective, therefore, draws on the work of Howells (1999) to incorporate the following features:

- internal organisation of firms;
- inter-organisation relationships;
- the role of the public sector and innovation policy;
- the institutional framework (in the conventional sense);
- the institutional set-up of the financial sector;
- the industrial structure;
- the spatial structure;
- the degree of openness (ability to attract and absorb external resources, links to global innovation networks);
- core/periphery hierarchical forces driven by historical evolution and path dependency (Iammarino, 2005).

Iammarino’s bottom-up perspective, on the other hand, also draws on Howells (1996, 1999) to incorporate the following characteristics:

- localised communication patterns regarding innovation processes;
- localised invention and learning patterns;
- localised knowledge sharing;
- localised search and scanning practices;
- localised network integration;

- historical path dependency within localised innovation processes (Iammarino, 2005).

Finally, in this regard, the analytical framework proposed by Tödtling and Trippl (2005) describes the structure and development of regional innovation systems according to three different "sub-systems", which are as follows:

- the "knowledge generation and diffusion sub-system", which consists of the various institutions that are engaged in the production and diffusion of knowledge and skills in a region. Elements of this sub-system, for example, might include educational institutions (e.g. universities, other higher education or vocational training institutions), public research institutions or technology mediating organisations (technology licensing offices, innovation centres);
- the "knowledge application and exploitation sub-system", which consists of companies, their clients, suppliers, competitors and co-operation partners. These actors may have developed "clusters" or similar territorial links within a region, and they are ideally linked by horizontal and vertical networking;
- the regional policy dimension, which is included as an additional "sub-system" on the basis that policy actors at the regional level can play a role in shaping regional innovation processes if there is sufficient regional autonomy, legal competencies and financial resources to formulate and implement innovation policies.

Additional to these sub-systems, however, are other elements of the Tödtling and Trippl (2005) framework, and these include:

- the regional socio-economic and cultural setting within which regional innovation systems are embedded (e.g. population, economic growth, education, sectoral specialisation), which can impact on the development of the innovation system;
- the nature of the relationships within and between the different sub-systems. In an "ideal-type" regional innovation system, for example, intensive interactive relationships would exist within and between the sub-systems, facilitating a continuous flow or exchange of knowledge, resources and human capital;

- regional innovation system links to, and interaction with, national and international actors and innovation systems. This might include links to firms outside the region, for example, or the policy influence of national and international policy actors.

4.5.4 Key Themes in Regional Innovation Systems

Regional innovation systems, therefore, would generally seem to involve public and private interests, formal institutions and other organisations, operating through organisational and institutional arrangements and relationships (Doloreux and Parto, 2005). The importance of specific regional resources, characteristics or intangible assets is often highlighted, as is interaction and learning processes between actors, localised capabilities, the importance of proximity (physical, social, cultural), tacit knowledge and some degree of "embeddedness" within the system. The concept thus clearly draws on the systems of innovation approach and other spatial models of innovation, and shares many parallels with these concepts.

Asheim et al (2011a), for example, place economic and social interactions at the core of regional innovation systems, with these interactions taking place between actors from both public and private sector arenas to stimulate and spread innovation within regions, which are in turn situated within wider national and global systems. In this regard, they also highlight what regional innovation systems have in common with other spatial or territorial innovation models, such as a focus on co-operation, networking, institutions, trust, social capital, and inter-organisational learning and knowledge transfer (Asheim et al, 2011a).

Iammarino (2005), meanwhile, considers embedded learning processes to be key to growth and competitiveness in regional innovation systems, echoing both the systems of innovation approach and other spatial perspectives on innovation. Uyarra (2007) also highlights the prominent emphasis on interactive learning, which she regards as lying at the heart of the literature on the subject.

Carrincazeaux and Gaschet (2006), on the other hand, cite the institutional context, understood in the abstract and informal sense, as being a key component of regional innovation systems. Likewise, Asheim (2007) regards a regional innovation system as being an "… institutional infrastructure supporting innovation within the productive structure of a region" (Asheim, 2007, p. 229), while Heraud (2003) similarly views the concept in terms of an institutional infrastructure (or specific interactions between different partners) inducing firms' innovation, but with innovation understood in a broader sense of improved managerial skills and organisational methods as much as R&D or technology transfer. Doloreux and Parto (2005), meanwhile, also accept the thesis that the innovative performance of regions improves when firms engage in useful interaction with the various support organisations and other firms within their region. In this sense, they regard the institutional characteristics of a region, its knowledge infrastructures and knowledge transfer systems, as well the strategies and performance of firms, as being important basic conditions and stimuli for promoting innovation activities (Doloreux and Parto, 2005).

Moreover, the definitions and descriptions of regional innovation systems, highlighted above, demonstrate the multitude of different actors and agents that are potentially part of a system. To summarise some of the key players again, Cooke and Leydesdorff (2006) have previously identified the key actors involved in networking within a regional innovation system as universities, research laboratories, research associations, industry associations, training agencies, technology transfer organisations, specialist consultancies, government development, technology and innovation advisory agencies and associated funding mechanisms, and private investors.

However, as the term suggests, regional innovation systems are regarded as different to other spatial models of innovation because they are more "systemic", with governance arrangements playing a crucial role in shaping the systemic nature of the concept. Carrincazeaux and Gaschet (2006), for example, suggest that regional innovation systems are distinguished from other territorial models of innovation by being defined by their governance structures, in administrative terms. Asheim (2007), in this context, describes regions as important bases of economic co-ordination and governance between the national and local levels, with governance not administered solely by public organisations but also by private organisations, such as industry associations or chambers of commerce. This public-private involvement is similar to what Cooke (1998) calls "associative governance" (Cooke, 1998, p. 11), which involves a degree of self-regulation by responsible groups and even the transfer of governance administration in some instances (e.g. vocational training, technology transfer) from public to private.

Both Cooke (1998) and Uyarra (2007), meanwhile, also refer to regional innovation systems as displaying a clear "collective order" (Cooke, 1998, p. 17, Uyarra, 2007, p. 245), featuring a strong interplay between territorial governance and business innovation. In this regard, Cooke (1998) stresses that the "systemness" (Cooke, 1998, p. 17) underlying the regional innovation systems concept is drawn from stable and reasonably regular flows of information between actors in the regional innovation community. Asheim (2007) suggests that relationships in a regional innovation system must involve a level of inter-dependence between actors in order to be considered systemic, with particular values, norms and routines in the region then strengthening the level of systemness involved, while Asheim and Isaksen (2002) suggest that regional innovation systems can be distinguished from clusters through (a) more formal inter-firm co-operation on innovation and (b) enhanced institutional infrastructure.

4.5.5 Regional Innovation Systems – Concept v Reality

A difficulty in the literature on regional innovation systems, however, lies in the link between conception and reality. The literature shows little consensus about what a regional innovation system looks like in reality, and different types and/or scales of system are highlighted, at different levels or stages of development. Moreover, the literature suggests that the factors that drive the systems of innovation approach can also vary across regions, or function differently at a regional level, with Doloreux and Gomez (2017) contending that there is therefore no clear accepted model of a regional innovation system or of the different processes that lead to the development and growth of a system.

Cooke (2001), for example, suggested (at the time of writing) that there were few regional innovation systems that could be regarded as fully functioning. Similarly, a study of Italian regions by Evangelista et al (2002) concluded that few if any regions could be regarded as displaying the kind of interactions and knowledge flows that would demonstrate regional innovation systems. Heraud (2003) suggests that there isn't necessarily a “system” of innovation in place, or at least whatever system is in place is often very loose. Cooke (2001) notes that a system can be more or less systemic from a real world perspective, while Cooke et al (1997) contend that there are, potentially, different “mosaics” of regional innovation systems (Cooke et al, 1997, p. 477), in various forms of development, within existing national systems of innovation.

Doloreux and Parto (2005), citing Markusen (1999), also contend that a fundamental problem in all studies of regional innovation systems is that we cannot determine what a regional innovation system might look like in reality, or in what way a specific region can be identified as a system. However, they also assert that at least some of the literature would suggest that all regions have some kind of system, and not just regions with strong innovation characteristics. In this regard, the literature would situate regional innovation systems at different points on a scale from strong to weak, and distinguish between different types of regional innovation systems (Doloreux and Parto, 2005).

In a similar vein, Asheim and Isaksen (2002), drawing on Cooke (1998), therefore contend that different types of regional innovation system can exist. The varieties of system identified by them, for example, include:

- “territorially embedded regional innovation networks”, which are generated by localised learning processes among firms, generated through geographical, social and cultural closeness among firms, but with little involvement of other knowledge organisations. This type of system is similar to what Cooke (1998) refers to as “grassroots” regional innovation systems. According to Asheim (2007), it is a market-driven and non-systemic model, where factors of demand control the pace and aim of innovation;
- “regional networked innovation systems”, where systems are of a more planned nature by means of stronger institutional infrastructures. This is considered to represent endogenous, internally driven development, though most firms would also be expected to need to access knowledge and innovation systems outside the region in the long-term. This type of system is regarded as the ideal-typical regional innovation system (Asheim and Isaksen, 2002), and is similar to Cooke’s (1998) description of a “network” regional innovation system;

- "regionalised national innovation systems", where elements of the institutional architecture of the system are more unified with national or international innovation systems, and there is more co-operation with key players outside the region. This is therefore more of an exogenous, externally influenced development model, where co-operation is more linear, more project-specific and less interactive. According to Asheim (2007), it more closely resembles a sectoral innovation system, while it is also similar to what Cooke (1998) terms a "dirigiste" regional innovation system.

The categorisation or typology above, however, largely views different regional innovation systems from a governance perspective. Cooke (1998) further expands this by providing a typology of systems from a more business innovation perspective, which includes:

- "localist regional innovation systems", where there are few if any large firms, little research outside the firm, few public innovation and R&D resources, but a high degree of interaction between entrepreneurs and local or regional policymakers;
- "interactive regional innovation systems", which have a mix of large and small firms, a balanced public and private research mix, more varied research reach between regional and outside research sources, and high levels of networking;
- "globalised regional innovation systems", which are driven by large global firms, with networking driven by the needs of these firms, and where research is generally internal.

Based on evidence for the different typologies described above, Asheim and Isaksen (2002) therefore suggest that the concept of regional innovation systems might only have a theoretical usefulness in a limited number of regions and regional clusters, which may call into question its usefulness as a policy tool across the diversity of European regions (Pugh, 2016) or in regions that are perceived to be "peripheral", economically weak or less competitive (Asheim and Isaksen, 2002, Pugh, 2016). Similarly, Tödtling and Trippl (2018) argue that there is still a poor understanding of which innovation policy mixes should be applied in which types of regions, including perceived peripheral regions, and that this knowledge gap should thus rank high on future research agendas, while Trippl et al (2016) point to specific typologies for less-developed regional innovation systems. Likewise, Njøs and Jakobsen (2018) also argue that policy for regional innovation systems should address the particular circumstances of different regions, including their different phases of evolution and the degree and type of social capital that exists in different regions.

Despite these varying views on the existence or otherwise of regional innovation systems, however, Iammarino (2005) nonetheless suggests that its validity as a concept still stands, and that a lack of real world examples simply serves to show that replicating systems is difficult and that not all regions can succeed as innovation systems.

4.5.6 Regional Innovation Systems – Critique and Debate

The concept of regional innovation systems has been the subject of considerable critique and debate regarding a perceived lack of clarity on key issues, such as issues of scale/function, the diversity of regional innovation systems and their links to other spatial levels. Doloreux and Parto (2005), for example, assert that the broad spectrum of types of regional innovation systems, such as those described above, creates a considerable amount of "definition confusion and issues of empirical validation" (Doloreux and Parto, 2005, p. 148), which in turn creates difficulties in conceptualising what a regional innovation system is or should be. Asheim et al (2011a), meanwhile, acknowledge that the regional innovation systems concept improves our comprehension of the complexities of regional innovation, but at the same time it also highlights several unresolved research questions. Some of these issues of debate are highlighted below.

Issues of Scale and Function: The scale of a regional innovation system, or indeed the region within which it operates, can be a cause of ambiguity, both in geographical terms and also in other ways, and Uyarra (2007) attributes this to the fact that the concept of a "region" is multi-faceted, with various definitions and understandings in use that combine the geographical, functional, economic, institutional and cultural.

From a geographical perspective, for example, the spatial unit of analysis for a regional innovation system might not always be clear. In this context, Doloreux and Parto (2005) suggest that there is little agreement on what is the correct geographical scale for studying regional innovation systems, with the scale used in different research studies ranging from the very local (e.g. a district within a city or metropolitan region) up to supra-regional (e.g. a combination of regions). This divergence in terms of unit of analysis is, in turn, perceived to be an impediment in building a single conceptual framework for theoretical study of the region (Doloreux and Parto, 2005).

However, there are also other distinctions and variations between regions, which might in turn influence their ability to nurture regional innovation systems. Cooke et al (1997), for instance, point to the distinction between “cultural regions” and “administrative regions”, whereby cultural regions are regions that share a common culture, language and territory, and which have also developed their own particular governance, whereas administrative regions are those that have emerged from state-led initiatives to develop some form of regional democracy (Cooke et al, 1997). Similarly, Casellas and Galley (1999) distinguish between “homogenous regions”, which are regions with unifying key characteristics of a physical, economic, social or political nature, and “administrative regions”, which are those created solely for the purpose of implementing policies.

Keating and Loughlin (1997), meanwhile, distinguish between regions that are “economic”, “historical/ethnic”, “administrative/planning” and “political”. In this regard:

- economic regions are areas defined by economic characteristics or criteria (e.g. urban or rural, industrialised or non-industrialised, dominant sectors), or territories designated for economic development, but also emerging regions that display local or endogenous development;
- historical/ethnic regions are areas distinguished by shared historical or cultural and linguistic features, which are different to those that predominate at the national level;
- administrative/planning regions are areas that have been designated solely for policy making or statistical purposes;
- political regions are areas with democratically elected assemblies and “fully-fledged” regional governments (Keating and Loughlin, 1997).

In addition, both Keating and Loughlin (1997) and Cooke et al (1997) allude to the distinction between processes of "regionalism" and "regionalisation", which distinguish between different regions and how they have come to be formed. In this instance, regionalism refers to an essentially bottom-up, decentralising political movement towards increased democratic control at the regional level, while regionalisation refers to a more top-down, centrally driven process to define or impose regional policies and structures on regions (Keating and Loughlin, 1997).

Such distinctions and variations between regions, therefore, can lead to complexities and ambiguities whereby regions with administrative boundaries do not necessarily have any obvious coherence in either an economic or political context (Asheim et al, 2011a), or indeed a cultural or historical context, leading to borders that might be termed "fuzzy" (Asheim et al, 2011a, p. 885). Borders that are "fuzzy" and lacking in coherence, in turn, might not fit well with the development of an innovation system within those borders.

Some of these complexities and ambiguities, meanwhile, are possibly evident in the experience of EU regional policy over the past two decades or so, where the designation of geographical regions for administrative purposes, a form of regionalisation of spatially bounded areas, has been commonplace. As a context to this, Uyarra (2007) notes how the process of European integration and the management and implementation of regional policy at the European level have been key stimuli for the development of increased regionalisation across Europe. This process has largely been compelled by EU regional policy, with the establishment of regional structures for administrative, policy planning and implementation purposes, sometimes in order to fulfil criteria for the funding of regional policy (Keating and Loughlin, 1997).

Furthermore, the development of the NUTS regions[17], or "Nomenclature of Territorial Units for Statistics", has also been incorporated into the regionalisation process in Europe as a means of introducing some uniformity and consistency in EU regional statistics (Uyarra, 2007). However, NUTS regions do not necessarily correspond to

[17] NUTS is the EU's Nomenclature of Territorial Units for Statistics classification. The definition of territorial units is based on the existing administrative units in the member states, and classification as NUTS I, NUTS II or NUTS III territories is based on population thresholds, with NUTS I being the largest.

homogenous and self-contained regions in the broad sense (Doloreux and Parto, 2005), and the classification lacks consistency to a degree and is rather diverse, as very different spatial entities and territories are considered to be comparable units of analysis (Casellas and Galley, 1999). Carrincazeaux and Gaschet (2006) similarly point to idiosyncrasies underlying NUTS classifications, while Cheshire and Magrini (2000) suggest that some NUTS regions can display considerable internal differences, and indeed have several distinct "regions" within them (e.g. metropolitan regions). In an analytical context, meanwhile, Crescenzi (2005), citing Cheshire and Magrini (2000), notes that the use of NUTS regions as the unit for regression analyses of innovation may lead to biases due to the arbitrary nature of the physical boundaries involved, while Leydesdorff and Cucco (2019) argue that the recent focus on innovation policies in regions may be an artifact of statistics and EU policies, and that the functionality of borders that exist for historical or administrative reasons (and their application to an innovation "system") may need to be more critically examined.

Links to Other Systems: Further critique of the regional innovation systems concept, or indeed of spatial innovation models more generally, is that they too often assume that the regional level is a strategic, internally cohesive unit, where growth is largely endogenous (Uyarra, 2007), without paying sufficient attention to the links to national or global levels and to the global innovation interdependencies and the interplay of policies that can exist at different spatial scales (Uyarra, 2007, Tödtling and Trippl, 2018). In addition, the concept has also been criticised for underplaying the importance of inter-regional and intra-regional connectivity (Pugh, 2016) or of extra-regional networks and institutions (Doloreux and Parto, 2005).

Asheim and Isaksen (2002), for example, point to a potential danger in placing too much emphasis on the regional level, without acknowledging the need for codified, more widely available knowledge in some cases alongside place-specific knowledge, and suggest that a spatial approach that combines several different levels (e.g. regional, national, international) is more prevalent. Moreover, it has been argued that the literature assumes a certain internal unity and cohesion in the region (Uyarra, 2007), which underplays both regional divisions and tensions and the existence of links to networks at higher spatial levels outside the region (see also M^{c}Kinnon, Cumbers and Chapman, 2002). Related to this, other authors (e.g. Heraud, 2003, Uyarra, 2007) have also asserted that not all regions have balanced supply and demand for innovation inputs and activities within a defined spatial boundary, despite the fact that regional innovation strategies might seek to match the two.

Furthermore, Heraud (2003) points out that the impact of scientific, technological and educational infrastructures, which are clearly geographically situated in a particular region, is not necessarily confined to that region's spatial or administrative boundaries. In the same way, any of the key players that are situated in that region (e.g. firms, university institutions, public intermediary institutions, the banking system, private business services) may have a national or even global influence, and not just a regional one. Similarly, Leydesdorff and Cucco (2019) argue that innovation systems are not "a priori" bound by administrative and political boundaries, and that innovation policy that is focused on the regional level may miss important opportunities to exploit inter-regional interactions.

Carrincazeaux and Gaschet (2006), meanwhile, assert that regional innovation systems, as a concept, can fail to fully recognise how sectoral characteristics can influence innovation at the spatial level. Uyarra (2007), in the same vein, argues that sectoral specialisation is a key factor that is often overlooked in regional innovation policy making, and that different sectors will respond differently to issues of proximity and agglomeration and the importance of extra-regional links. Related to this, Frenz and Oughton (2005) neatly summarise the various inter-relationships between regional, national and global systems of innovation, but also sectoral and technological systems of innovation, which emphasise a level of openness between systems and the extent to which their boundaries can intersect with each other (see Frenz and Oughton, 2005, p. 33, Figure 3.1).

In addition, some of the literature suggests that the role of national governments or international entities in shaping policy, governance and resources at the regional level can be understated (see De Bruijn and Lagendijk, 2005). In this regard, for example, Carrincazeaux and Gaschet (2015) contend that national institutional settings remain fundamentally important in shaping regional innovation systems, and that regional policies are not independent of national contexts, while Trippl et al (2016) also point to a need for further research to explore how institutions at various spatial scales affect new path development in different regional innovation systems.

Diversity and Path Dependency: Similarly, there has been some further criticism in the literature, which suggests that the diversity, path dependency and varying patterns of development of regions can be overlooked under the regional innovation systems concept, that such diversity can render "best practice" guidelines for regional systems to be of little benefit, and that transferring models to other regions can be difficult if not impossible.

Uyarra (2007), for example, notes that there have been numerous best practice instruments used regarding regional innovation, such as technology parks, science centres and cluster policies, which have adopted a "... mantra-like status" (Uyarra, 2007, p. 255). However, the same author contends that regions are complex entities, which are rarely homogenous, and that the ability of both firms and organisations to participate in a regional innovation system will differ significantly among different regions (Uyarra, 2007). Related to this, it has been suggested that the idiosyncratic nature of the evolutionary mechanisms that operate at the regional level rarely allows for problem solving using standardised procedures (Iammarino, 2005), e.g. such as those put forward as "best practice" instruments.

Therefore, the usefulness of best practice instruments for policy guidance across a broad spectrum of regions has been questioned, on the basis that it is not necessarily clear that such instruments can be easily replicated, or how the intangible elements of regional innovation successes can be translated elsewhere (Uyarra, 2007). In this respect, Asheim et al (2011b) similarly argue that "one size fits all" approaches to regional policy are not appropriate, but in particular, that best practice cannot be transferred without an adequate understanding of the local contexts involved and the intangible regional assets that arise from a region's historical path dependency.

Other authors, meanwhile, such as Feldman (2001) and Iammarino (2005), have also highlighted the importance of path dependency. Feldman (2001) suggests that many studies of regional innovation systems have not provided sufficient analysis of how systems have developed or evolved, and that they have instead only examined systems from a static, single point in time perspective, thereby not fully understanding the context, diversity of experience, uniqueness and adaptivity of different regional circumstances. Likewise, Iammarino (2005) highlights the importance of history in affecting the conditions for learning and knowledge accumulation, while suggesting that a deeper understanding of the path dependency of regions and their historical contingency could enhance the stock of knowledge upon which policy is built and policy learning occurs.

Furthermore, Grillitsch and Asheim (2018) point to the importance of specific regional contexts in adapting policy recommendations for regional innovation, while Njøs and Jakobsen (2018) argue that changing existing development paths can be difficult, and that there is therefore a need to gain a deeper understanding about how past choices influence subsequent choices, which can lead to differing evolutionary paths towards regional innovation systems. Similarly, Doloreux and Gomez (2017) suggest that research into the regional innovation systems concept has not taken sufficient account of the particular diversity of pathways that are evident in non-metropolitan regions, including peripheral or rural regions.

Another related issue, however, which is commonly highlighted in academic literature, is the analysis of failures as well as successes. Asheim et al (2011a), for example, suggest that further analysis of less successful systems is merited, not just successful ones, as well as further analysis of innovation systems in more historical, less high technology industries. Allied to this, Uyarra (2007) suggests that historical and low-tech (manufacturing) sectors, as well as service sectors, can often be neglected in regional innovation policy making.

In the same context, and given the importance of institutions to regional innovation systems and other spatial innovation models, Uyarra (2007) also argues that there can often be too much focus on the quantity of institutions rather than the quality of institutions in a system, and insufficient acknowledgement of the considerable time lag that may be required for successful institution building. Related to this, Doloreux and Parto (2005) suggest that there is too much emphasis placed on local institutional landscape, but insufficient emphasis on what the institutions are or how they interact in different systems, at different scales, or at different levels of inter-relation. Issues of diversity and path dependency would, in turn, impact on this.

Response to Critique: The criticisms of the regional innovation systems concept, as have been outlined above, certainly raise valid questions. At the same time, however, it should also be recognised that proponents of the concept have not been blind to such criticisms, as is clear from the diverse suite of typologies of regional innovation systems and the acknowledgement of conceptual issues presented in Section 4.5.3, Section 4.5.4 and Section 4.5.5 above. Indeed, these criticisms may be more applicable to the normative use of regional innovation systems as a policy tool, rather than the conceptual development of such system ideas per se, given its extensive use as a policy tool within the EU, going back over two decades (see Section 4.5.2).

Furthermore, it should be noted that some of the early proponents of regional innovation systems have also acknowledged inter-dependencies between different levels, with Cooke, Boekholt and Tödtling (1999) clearly suggesting that regional and national systems of innovation, for example, can play complementary roles (e.g. with national systems setting scientific priorities, funding basic research activities and university-level education). Carrincazeaux and Gaschet (2006) similarly suggest that both local and non-local relations, and thus both regional levels and other levels, can play complementary roles in innovation processes, and examples of this would include the influence, at the regional level, of institutions and policies that are implemented at a national level (Lundvall et al, 2002).

Moreover, such inter-dependencies have likewise been acknowledged by researchers of other levels of innovation systems. Lundvall (2010), for example, when discussing national systems of innovation, acknowledges that systems are often open and diverse, and that processes of innovation can be local, national or global, while Lundvall et al (2002) similarly acknowledge the legitimacy of systems of innovation concepts at regional, national, global, sectoral or technological levels.

Likewise, it would be unfair to suggest that the conceptual analysis and description of regional innovation systems has not acknowledged issues regarding the diversity and path dependency of regions. Iammarino (2005), for example, clearly acknowledges the role of path dependency in regional innovation systems, both from a top-down and bottom-up perspective, and criticisms of regional innovation systems in this regard are again probably more appropriate to its application as a policy tool rather than the concept per se, and in particular its use for best practice dissemination purposes.

Related to this, Asheim et al (2011a) point to a need to develop better means of measuring the performance of regional innovation systems, while Iammarino (2005) asserts that any attempt to use regional innovation systems as a normative tool should be grounded in evidence built from better data and indicators, with the potential value of more carefully collected data and in-depth case studies being especially noted. In this context, the author suggests that what information is available is appropriate for measuring regional performance, but that it does little for measuring regional structures, inter-regional inter-dependence, degrees of openness, innovation flows and networks, and so on (Iammarino, 2005). Trippl et al (2016), meanwhile, also suggest that regional performance still tends to be measured against narrowly defined, R&D based knowledge and modes of innovation, despite conceptual advances in understanding the specificities of regional innovation in less-developed regions.

4.6 Chapter Summary

- The review of research literature presented in Chapter 4 describes a theoretical background to the current research that is rooted in the literature on innovation's role in economic growth, and the role of place and space in innovation. However, another common thread that pervades much of this literature, and which informs the research question for the current research, is the complex nature of innovation as a concept, and of the processes underlying innovation, and how these feed into and indeed combine with the equally complex nature of regional or spatial situations and their particular characteristics.
- The literature regarding *economic perspectives on innovation*, for example, clearly points to a now widespread acceptance of the importance of innovation as a driver of economic growth and competitiveness, while also largely shifting our understanding of innovation from an exogenous view (whereby the development of

ideas cannot be modelled, and ideas appear independently of the efforts of innovators) to an endogenous view (whereby ideas and inventions can result from the innovative efforts of innovators). At the same time, the research literature highlights how innovation straddles many disciplines, how it cannot solely be defined from a narrow perspective of business or economics, and how it can be technological or non-technological, product-based or process-based/organisational/ institutional, and radical or incremental.

- Moreover, the research literature also argues that the inherent complexity in innovation is evident in its interactive nature, and how it can be fostered more easily if certain measures are adopted and certain kinds of environments developed, as espoused by systems of innovation perspectives. Such perspectives place an emphasis on knowledge and learning, interaction and networking and institutions within systems, highlighting the importance of social and cultural processes and contexts in innovation, or a “social capital” that becomes “embedded” within the system, incorporating multiple features such as cumulative build-up of knowledge, feedback loops, institutional routines, habits and norms, tacit knowledge and trust.
- Literature regarding *spatial perspectives on innovation*, meanwhile, often shares a commonality of key factors with the systems of innovation approach, and especially the importance of cultural factors, structures and institutions, networks and collective/interactive learning, and relational and social capital, while at the same time clearly emphasising a perceived place-specific and place-embedded nature in innovation processes, whereby geography and geographical proximity is viewed as a primary facilitator of innovation and learning. This, it is argued, is because key resources, knowledge inputs and competences needed for innovation are typically found in specific places, while explicit regional or local identities, local learning practices, or assets and capabilities that are unique to a local area or region can be used to develop coherent innovation processes at such spatial levels.
- The literature regarding *regional innovation systems* is, in turn, an obvious attempt to merge spatial innovation perspectives with system of innovation concepts, as it clearly resembles the systems of innovation approach and other spatial models of innovation, and shares many parallels with these concepts, while at the same time highlighting more conventionally familiar elements of what might be found in a “system”, in the form of enhanced governance arrangements and institutional

infrastructures, alongside regional or local factors. Descriptions of such regional systems thus include public and private interests, formal institutions and other organisations, operating through organisational and institutional arrangements and relationships, with the importance of specific regional resources, characteristics or intangible assets being often highlighted, alongside interaction and learning processes between multiple actors, localised capabilities, the importance of proximity (physical, social, cultural), tacit knowledge and so on.

- Further demonstration of the complexities underlying the nature of innovation, however, is evident in the considerable critique and debate that continues to permeate the academic discussion of regional innovation systems, but especially its use as a normative, policy tool in an EU regional policy context. In particular, critique of the concept suggests that:
  - it can overlook the diversity, path dependency and varying patterns of development of different regions, including "lagging" regions, even though such diversity might render it difficult if not impossible to transfer best practice, "one size fits all" models for regional innovation systems from one region to another;
  - it can assume that the local or regional level is a strategic, internally cohesive unit, without taking sufficient account of links to or the influence of the inter-regional, national or global levels;
  - related to this, it understates, or does not adequately articulate, the importance of interactions between regional governments and national governments (and the EU) in shaping policy, governance and resources at the regional level.
- The current research, therefore, seeks to add to existing knowledge of such issues by investigating whether and how lagging regions have used public policy and absorbed funding for investment to promote R&D and innovation, through the lens of a regional innovation systems approach (as recommended by Oughton et al, 2002), and to what extent influencing factors like regional heterogeneity and diversity, regional endogeneity (or lack of) or input from policymakers at different spatial levels has influenced the development of policy and innovation systems.
- To conclude, a summary overview of the research literature, highlighting key theories and perspectives, sources, propositions and critiques, is provided in Table 4.1a and Table 4.1b.

Table 4.1a: Research Literature – Summary Overview

Theories/ Perspectives	**Selected Literature**	**Propositions**	**Critique**
Economic perspectives on innovation	▪ Schumpeter (1939, 1976) ▪ Solow (1956, 1957) ▪ Romer (1986, 1990) ▪ Fagerberg and Verspagen (1996) ▪ Fagerberg et al (1997) ▪ Morgan (1997) ▪ Fagerberg (2003)	▪ Innovation drives economic change ▪ However, innovation is complex, continuous, cumulative ▪ Innovation can also occur in products, processes, organisations, institutions	▪ Shift from exogenous to endogenous perspectives ▪ Differences in innovation between countries and regions
Innovation "system" perspectives	▪ Kline and Rosenberg (1986) ▪ Nelson (1993) ▪ Nelson and Rosenberg (1993) ▪ Edquist (1997) ▪ Cooke et al (1997) ▪ Morgan (1997) ▪ Lundvall et al (2002) ▪ Nelson and Nelson (2002) ▪ Lundvall (2010)	▪ Innovation conceptualised as a complex and interactive process ▪ Innovation follows a "chain-linked" rather than linear path ▪ Innovation can be more easily fostered if the right "system" is developed ▪ "System" constituted by different elements and the relationships between these elements ▪ Emphasis on importance of knowledge and learning, interaction and networking, and institutions ▪ Influence of social, institutional and cultural contexts, tacit knowledge, trust	▪ Diversity in different systems of innovation ▪ Reflects varying economic and political circumstances and priorities ▪ Certain degree of "flexibility" regarding what is included or excluded in a system, system boundaries or degree of interaction between elements
Note: Categorisation of literature in this way, by its nature, may be subject to overlap and varying uses of terminology/perspectives etc.			

Source: Author

Table 4.1b: Research Literature – Summary Overview

Theories/ Perspectives	Selected Literature	Propositions	Critique
Spatial perspectives on innovation	▪ Storper (1992) ▪ Florida (1995) ▪ Audretsch and Feldman (1996) ▪ Morgan (1997) ▪ Porter (1998a, 1998b) ▪ Mouleart and Sekia (2003) ▪ Crevoisier (2004)	▪ Importance of local advantages in building competitive advantage ▪ Dissemination of knowledge subject to regional patterns and spatial barriers, innovation as a place-specific or place-embedded process ▪ Importance of institutions, networks and interactive learning ▪ Influence of geographical proximity, culture, trust, reciprocity, conventions	▪ Proximity is not limited solely to geography, e.g. proximity can also be social, cultural, cognitive, organisational, institutional ▪ Too much proximity can have negative implications, e.g. “lock-in” that deters absorption of new knowledge or openness to new ideas
Regional innovation systems	▪ Cooke et al (1997) ▪ Cooke (1998, 2001) ▪ Asheim and Isaksen (2002) ▪ Evangelista et al (2002) ▪ Heraud (2003) ▪ Doloreux and Parto (2005) ▪ Iammarino (2005) ▪ Tödtling and Trippl (2005, 2018) ▪ Carrincazeaux and Gaschet (2006, 2015) ▪ Asheim (2007) ▪ Uyarra (2007) ▪ Asheim et al (2011a, 2011b), ▪ Trippl et al (2016) ▪ Doloreux and Gomez (2017) ▪ Grillitsch and Asheim (2018) ▪ Njøs and Jakobsen (2018)	▪ Network of actors and institutions in the public and private sectors ▪ Knowledge base, productive system, education and training system, financial system, regional governance ▪ Specific regional resources, intangible assets, localised capabilities, proximity, tacit knowledge, embeddedness	▪ No commonly agreed definition of what constitutes or defines a regional innovation system ▪ Little consensus about what a regional innovation system looks like in reality ▪ Perceived over-assumption that the regional level is endogenous, internally cohesive, while underplaying links to other spatial levels (including government) ▪ Does not easily accommodate the diversity and complexity of regions
Note: Categorisation of literature in this way, by its nature, may be subject to overlap and varying uses of terminology/perspectives etc.			

Source: Author

CHAPTER 5 – METHODOLOGY

5.1 Introduction

The purpose of this chapter is to explain and justify the methodology and research design that has been used to carry out the research. Section 5.2 presents the conceptual framework, which is derived in particular from the description of the regional innovation paradox (Oughton et al, 2002) in Chapter 1 and the review of the research literature in Chapter 4. Section 5.3 then presents the research question and objectives, which are linked to the conceptual framework. Section 5.4 describes the research design, which includes the research philosophy underpinning the research, the research approach, the research's choice of methodology and strategy, the research time horizon and the data collection and analysis techniques used. Section 5.5 then concludes the chapter by discussing the validity and reliability of the research.

5.2 Conceptual Framework

A conceptual framework, according to Curran and Blackburn (2001), forms the basis of thinking about why and how a researcher undertakes a research project, based on the researcher's understanding and perceptions of a research problem. In this regard, a conceptual framework therefore identifies the concepts underlying a research project, states the propositions that link these concepts, and identifies interpretations about why these concepts are linked.

Yet, according to Shields (1998), conceptual frameworks can be abstract, amorphous and difficult to clarify for researchers, while being more readily associated with positivist, deductive and explanatory approaches to research (see Section 5.4). At the same time, however, Shields (1998) and Shields, Rangarajan and Casula (2019) point to the potential use of different types of conceptual frameworks across a variety of different research purposes and approaches, as outlined in Table 5.1. In doing so, moreover, they also highlight the potential use of conceptual frameworks across different research philosophical perspectives, including both pragmatist- and interpretivist-based research, not just positivist research (see Section 5.4).

Table 5.1: Research Purposes, Research Paradigms and Conceptual Frameworks

Research Purpose	**Main Underlying Paradigm**	**Conceptual Framework**	**Methods**	**Data Analysis**
Explanatory	Positivism	Formal hypotheses	Quantitative, experimental design, survey, time series, existing data	Inferential statistics
Descriptive	Positivism	Categories	Quantitative, survey, content analysis	Simple descriptive statistics
Exploratory	Pragmatism	Working hypotheses	Qualitative, mixed methods, case study	Evidence of all types, may or may not use statistics
Understanding/ gauging	Pragmatism	Practical ideal type	Qualitative, mixed methods, case study	Evidence of all types, may or may not use statistics
Predictive/ decision-making	Positivism	Models of operations research	Cost-benefit analysis, cost-effectiveness analysis, linear programming etc	Quantitative techniques of operations research
Experiential understanding	Interpretivism	-	Qualitative	Thick description
-	Interpretivism	Grounded theory	Qualitative	Constant comparative
Description	Interpretivism	-	Qualitative	Generating categories

Source: Derived from Shields (1998) and Shields et al (2019)

For the purposes of this research, the researcher has developed a conceptual framework for use as a "working hypothesis", based on a pragmatist research paradigm or philosophy and a mixed methods approach. A working hypothesis, in this context, is a provisional hypothesis or statement of expectation that is tested in action, which allows for the gathering of both quantitative and qualitative evidence (Shields and Rangarajan, 2013, Shields et al, 2019). The meaning of "working", therefore, suggests the hypothesis is subject to change, or it is provisional, with a real possibility that contradictory evidence will be found (Shields et al, 2019).

In such a framework, the researcher is thus not trying to test theory or hypotheses per se. Instead, when adopting a working hypothesis, theory is used as an instrument or tool to progress a research (Shields, 1998). According to Dewey (1938), for example, hypotheses can be useful, regardless of whether they are true or false, because “when they are taken to be provisional, working means of advancing investigation, they lead to discovery of other critical facts” (Dewey, 1938, p. 142). As such, working hypotheses provide a guide to organise an investigation (Kaplan, 1964), a “map” for the research (Dewey, 1938) and a belief about the direction of inquiry, but not necessarily its ultimate destination (Shields, 1998, Shields and Rangarajan, 2013).

Working hypotheses, according to Shields (1998), are also especially useful when conducting exploratory, qualitative research, as they help to enable and focus evidence collection, yet they nonetheless share similarities with quantitative approaches to research in being deductive and explicitly purposeful (Shields et al, 2019). As a result, the use of working hypotheses is well suited to research that is informed by a pragmatic philosophical perspective (Shields and Whetsell, 2017), as is this current research, and they are particularly applicable to deductive case studies, which use either qualitative or mixed methods (Shields et al, 2019). In this regard, the current research’s grounding in a pragmatist paradigm or research philosophy, its use of mainly deductive but also (to a lesser extent) some inductive research approaches, and its use of a methodology and research strategy that combines quantitative analysis and case studies is further discussed in Section 5.4.

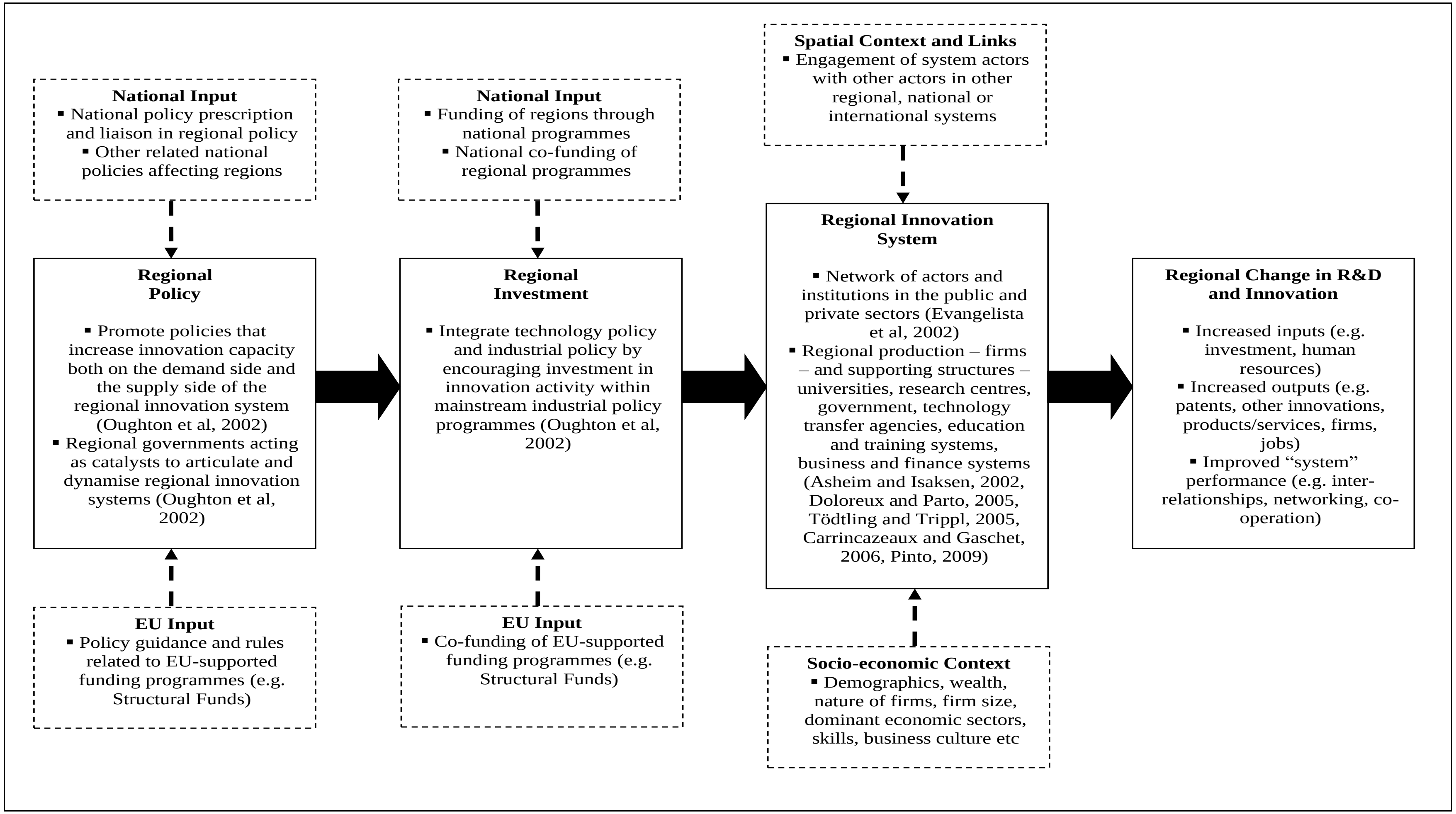
The conceptual framework for this research therefore adopts a working hypothesis that “public policy promotion of and public investment in regional innovation systems contributes to improved R&D and innovation performance in lagging regional economies”. The graphical illustration of this framework, as outlined in Figure 5.1, thus incorporates this “hypothesis”, which is inferred from the description of the regional innovation paradox (and its emphasis on the need to develop regional innovation systems), but while also embracing critique of the concept of regional innovation systems, as per the other research literature.

The concepts underlying the hypothesis are “policy”, “investment”, the “regional innovation system” and “R&D and innovation performance”, each of which are described in the boxes in Figure 5.1 as follows:

- “policy” refers to aims and objectives that are adopted by government actors to facilitate and promote the development of improved R&D and innovation performance in their regions;
- “investment” refers to financial and other support that is provided by government and associated sources in order to achieve policy aims and objectives regarding R&D and innovation;
- the “regional innovation system” refers to the networks of actors and institutions in both the public and private sectors that are involved in R&D/innovation or related activities, such as firms, universities, research centres, government departments and agencies, technology transfer entities, education and training providers, business and finance systems etc;
- “R&D and innovation performance” refers to increased inputs in R&D and innovation (e.g. investment, human resources), increased outputs (e.g. patents, other innovations, new products/services, firms, employment) and improved “system” performance (e.g. extent of inter-relationships, networking and co-operation between different actors).

The arrows connecting the boxes in Figure 5.1, meanwhile, denote the working assumption that pro-innovation policy in a region drives increased public investment in the regional innovation system, which in turn leads to improved R&D and innovation performance. However, the framework also alludes to potential influences on the boxes, as inferred from the research literature, which must be taken into account when considering how this underlying assumption might work in practice. These include:

Figure 5.1: Conceptual Framework



Source: Author

a) the influence of policy inputs from both a national government level and an EU level. As noted in Section 5.3, Oughton et al (2002) have pointed to the potential importance of regional governments (where regional autonomy exists) in providing a catalyst to dynamise regional innovation systems, through their co-ordination of R&D and innovation policy and their arbitration of public investment in R&D and innovation. At the same time, as noted previously in Chapter 2 (Section 2.3 and Section 2.4) and Chapter 4 (Section 4.5), the EU has increasingly turned its policy attention towards fostering R&D and innovation at a regional level, and providing funding for same, while national government policy and funding initiatives in R&D and innovation can similarly impact on regions, a point that has been clearly highlighted in critique of the regional innovation systems concept (see Chapter 4, Section 4.5.6). Deciding on the "right" policy for R&D and innovation in regions, therefore, might depend on liaison between government at regional, national and EU levels, and the development of a shared understanding of what types of policy intervention are appropriate in regions;
b) the influence of public investment inputs from both a national government level and an EU level. This is obviously related to the previous point, as funding for R&D and innovation initiatives, just like policy, may come not only from regional sources but also from national and EU sources;
c) the influence of underlying socio-economic contexts and spatial contexts within regions, and how they affect regional innovation systems. This alludes to further key critique of the regional innovation systems concept in the research literature (see Chapter 4, Section 4.6), which questions the extent to which it properly takes account of influences such as the spatial scale of the "region", for example, or the extent to which a region is homogenous/heterogeneous in socio-economic or spatial terms. It also takes account of levels of socio-economic development more generally, including the existing capability and/or inclination of actors (firms, universities, research centres) to engage in R&D and innovation activity within a region.

5.3 Research Question and Objectives

Chapter 1, Section 1.2 has previously described the nature of the regional innovation paradox, which has provided the inspiration for this research. As noted in Chapter 1, this perceived paradox asserts that there is an:

> *"... apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities, compared to more advanced regions" (Oughton et al, 2002, p. 98).*

Or put another way, the more that innovation is needed in lagging regions in order to improve competitiveness, the more difficult it is to invest effectively in R&D in such regions (Oughton et al, 2002), and the more likely it is that such regions will be seen to under-invest in R&D and innovation.

The main cause of the regional innovation paradox, moreover, is perceived to lie in the fragmented nature of regional innovation systems in lagging regions, and the institutional characteristics of such regions (Oughton et al, 2002). Thus, for example, such regions are perceived to lack sufficient co-operation mechanisms to match supply of innovation inputs (e.g. from universities, research institutions) to demand (e.g. from firms). The regions are perceived to lack the appropriate conditions to exploit synergies and co-operation among regional innovation actors (e.g. firms, universities, other research institutions), while the nature of the regional governance system and wider institutional framework in such regions is not considered to be conducive to regional knowledge building and transfer. As a result, Oughton et al (2002) argued that regional governance (via public policies) needs to improve the wider systemic capacity to absorb investment for innovation activities in such regions by:

- *"... increas[ing] the innovation capacity of regions by working on both the demand and the supply side of the system to increase both private and public sector investment in innovation activity";*

- *"... integrat[ing] technology policy and industrial policy by encouraging expenditure on innovation activity within mainstream industrial policy programmes" (Oughton et al, 2002, p. 108).*

Underlying the regional innovation paradox and its associated policy prescriptions, therefore, are a number of assumptions about the nature of innovation in regions. In particular:

a) it clearly subscribes to a "systems" approach to innovation, with its emphasis on exchange of knowledge and learning, and it highlights the importance of relationships between key actors in such systems (e.g. government, business and education), while at the same time acknowledging the complexity of relationships between such actors. For example, it especially argues for the need to develop the density and quality of networking between actors, or the quality of "social capital" between actors (i.e. trust, joint commitment of resources, communication and behavioural norms, proximity and repeated interaction);
b) it clearly places an emphasis on the regional dimension as being central to innovation systems, because of perceived external economies that exist at that level (e.g. regional differences in industrial structure, R&D and technology provision, business service provision, R&D and innovation policy, governance structures and institutional frameworks), while at the same time not denying the influence of global or sectoral factors. In this regard, it thus appears to reflect a largely endogenous growth perspective;
c) it clearly emphasises the importance of institutions and the need for institutional change. For example, it emphasises the importance of the role of regional government (and its development agencies) in articulating, catalysing and dynamising the regional innovation system, and the nature of the regional governance system and wider institutional framework more generally, through its provision of finance, its co-ordination of policy and its arbitration of EU Structural Fund allocations, or through regulatory powers.

Meanwhile, the wider research literature on innovation and its role in economic growth, as discussed in Chapter 4, similarly acknowledges the complex nature of innovation as a concept, and of the processes underlying innovation. Added to this, much of the literature also emphasises the interactive nature of innovation processes, as espoused in the systems approach, with its emphasis on knowledge, learning, networking and institutions, alongside the importance of social and cultural processes and contexts in innovation, or social capital.

However, the research literature's critique of the equally complex nature of regional or spatial models of innovation, and of the concept of regional innovation systems in particular, appears to argue that it too often assumes that the regional level is a strategic, internally cohesive unit. In this regard, for example, the concept is perceived to take insufficient account of links to or the influence of the inter-regional, national or global levels, including extra-regional networks and institutions, which may influence policy, governance or resources at the regional level. Moreover, further critique suggests that the diversity, path dependency and varying patterns of development of regions can be overlooked under the regional innovation systems concept, and that such diversity can render best practice or "one size fits all" guidelines for regional systems to be of little benefit. Critique of the regional innovation systems concept thus points to no commonly agreed definition of what constitutes a regional system, with little consensus about what a regional system looks like in reality, or with different types and/or scales of system being highlighted, at different levels or stages of development.

Such issues have been reflected in the conceptual framework in Section 5.2, and it is against this background and framework that the current research therefore seeks to address the following research question:

> *How has public policy towards and public investment in regional innovation systems contributed to R&D and innovation performance in lagging regional economies?*

In addition, there are a number of research objectives that are underlying the research question, which are to:

- *examine how investment in R&D and innovation in lagging regions, and outputs attributed to R&D and innovation in such regions, have changed over time;*

- *explore public policy and public investment interventions that have been used to promote the development of regional innovation systems in lagging regions;*
- *understand the elements that constitute regional innovation systems in lagging regions, and the extent to which such systems have developed over time;*
- *examine how lagging regions address their region-specific characteristics when developing policies to promote regional innovation systems;*
- *examine how interaction with other spatial levels (e.g. national, EU) influences the development of policies to promote regional innovation systems in lagging regions.*

Section 5.4, which follows, now describes the research design that has been used to address the research question/objectives and associated conceptual framework.

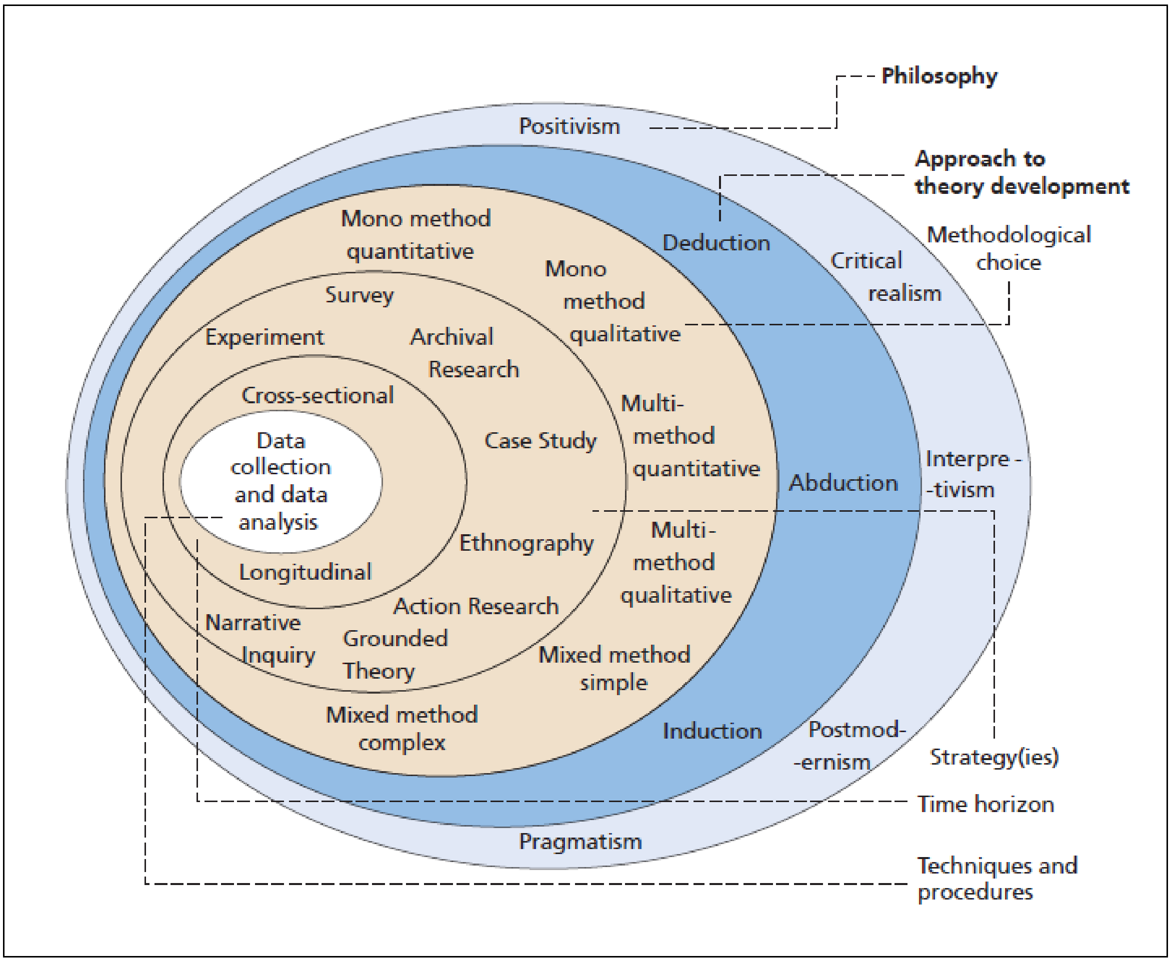
5.4 Research Design

5.4.1 Overview

The research design for the current research can be likened to what Saunders, Lewis and Thornhill (2019) have described as the "research onion", i.e. the different layers within a research process that need to be identified and articulated so as to progress the process (see Figure 5.2). The discussion of the research design provided in this section, therefore, deals with each of these "layers" in turn, including:

- the research philosophy underpinning the research;
- the mix of research approaches used;
- the core research methodologies and strategies;
- the research time horizon;
- the data collection and analysis techniques used (which in this case incorporate both quantitative and qualitative methods).

Figure 5.2: Research Design – "The Research Onion"



Source: Saunders et al (2019)

5.4.2 Research Philosophy

A research methodology, according to Wahyuni (2012), refers to a model to conduct a research, with each model being developed and adopted within the context of a particular research paradigm or philosophical perspective.

A research paradigm or philosophy, in turn, comprises the underlying set of beliefs that guide a researcher to choose one set of research methods over another, or the theoretical and ideological foundation of the method (Wahyuni, 2012). It provides a set of fundamental assumptions and beliefs as to how the researcher perceives the world, which then serves as a thinking framework that guides the researcher's behaviour (Jonker and Pennick, 2010). Or, put another way, it is the philosophical assumptions or basic set of beliefs that guide the actions of a researcher (Lincoln, Lynham and Guba, 2011), it is a "way of thinking about and making sense of the complexities of the real world" (Patton, 2002, p. 69), or it is a "set of lenses" (Burke, 2007, p. 477) that allows a researcher to view research within a particular set of established assumptions.

Therefore, it is important to understand the research paradigm or philosophy being applied when conducting any research because it significantly influences how one undertakes a study, e.g. in terms of framing and understanding social phenomena (Wahyuni, 2012). In this regard, and as outlined in Table 5.2, Saunders et al (2019) provide a summary of common research philosophies and the typical assumptions underlying these philosophies in terms of:

a) *ontology*, i.e. one's assumptions about the nature of reality, and how reality relates to social actors (people) and their interpretation of it;
b) *epistemology*, i.e. assumptions about what is acceptable and valid knowledge, and how such knowledge is generated, understood and used;
c) *axiology*, i.e. assumptions about the role of values and ethics in the research process, and how both researcher and research participant values are dealt with;
d) *research method(s)*, i.e. the means (data collection and analysis techniques) by which the research process is carried out.

The remainder of this section now briefly describes some of the main types of research philosophy that are pertinent in the context of the current research, while also identifying the principal research philosophy that guides the research.

Types of Research Philosophy: Research philosophies that are pertinent to the current research are positivism, interpretivism and pragmatism. At one extreme, for example, *positivism* applies the lens of natural science to social science. Positivists believe that social reality is external and observable (Wahyuni, 2012), measurable (Burke, 2007) and objective, i.e. social reality exists independently of how people think of it, label it or are aware of it (Saunders et al, 2019). This belief, in turn, drives positivist researchers to seek to obtain law-like generalisations by conducting value-free research to measure social phenomena, which is unhindered either by human interpretation or bias (Neuman, 2011, Saunders et al, 2019) or by historical, cultural or social contexts (Burke, 2007).

Positivists thus try to remain neutral and detached from their research (Saunders et al, 2019), asserting that only observable and verifiable phenomena can be the subject matter of science (Gillham, 2000). To achieve this, positivists also typically use highly structured methodologies and scientific (mainly quantitative) methods to develop hypotheses and look for causal relationships in pure, clearly defined data (Burke, 2007, Saunders et al, 2019), whereby different researchers observing the same factual problem will generate a similar result, through careful application of statistical tests and similar research processes using large samples (Creswell, 2009).

At the other extreme, however, *interpretivism* believes that social reality is constructed by social actors and by people's perceptions of reality (Wahyuni, 2012). Interpretivism thus emphasises that humans are different from physical phenomena because they create meanings (Saunders et al, 2019), and that people's varied backgrounds, assumptions and experiences contribute to an ongoing construction of social reality (Wahyuni, 2012). From an interpretivist perspective, social reality is complex (Saunders et al, 2019), prone to change (Hennink, Hutter and Bailey, 2011) and subject to multiple perspectives or meanings (Hennink et al, 2011, Saunders et al, 2019). As a result, interpretivist research is subjective in nature (Hennink et al, 2011, Wahyuni, 2012, Kaushik and Walsh, 2019, Saunders et al, 2019), as it contends that social reality is made from the perceptions and actions of social actors (Saunders et al, 2019).

Unlike positivists, therefore, interpretivist research is typically value-bound, i.e. both the values and beliefs of the research participants and the researcher (e.g. in interpreting research materials and data) play an important role in the research process (Saunders et al, 2019). This, in turn, makes interpretivist research less amenable to generalisation from one context to another (Gillham, 2000). It does not require the establishment of a-priori theories or hypotheses (Lancaster, 2004), and it is more likely to be shaped from a bottom-up perspective, i.e. drawing from individual perspectives to seek broad patterns and broad understandings (Creswell and Clark, 2011). It is also typically qualitative in nature (Lancaster, 2004, Wahyuni, 2012, Kaushik and Walsh, 2019), with a more flexible research design (Lancaster, 2004), and it often uses a narrative form of analysis to provide rich, detailed and specific descriptions, understandings and interpretations of social constructs and contexts (Neuman, 2011, Wahyuni, 2012, Saunders et al, 2019).

Table 5.2: Comparison of Research Paradigms or Philosophies

	Ontology	Epistemology	Axiology	Method(s)
Positivism	▪ Real, external, independent ▪ One true reality (universalism) ▪ Granular (things) ▪ Ordered	▪ Scientific method ▪ Observable and measurable facts ▪ Law-like generalisations ▪ Numbers ▪ Causal explanation and prediction as contribution	▪ Value-free research ▪ Researcher is detached, neutral and independent of what is researched ▪ Researcher maintains objective stance	▪ Typically deductive ▪ Highly structured, large samples ▪ Measurement typically quantitative analysis, but a range of data can be used
Interpretivism	▪ Complex, rich ▪ Socially constructed through culture and language ▪ Multiple meanings, interpretations, realities ▪ Flux of processes, experiences, practices	▪ Theories and concepts too simplistic ▪ Focus on narratives, stories, perceptions and interpretations ▪ New understandings and worldviews as contribution	▪ Value-bound research ▪ Researchers are part of what is researched, subjective ▪ Researcher interpretations key to contribution ▪ Researcher reflexive	▪ Typically inductive ▪ Small samples, in-depth investigations ▪ Qualitative methods of analysis, but a range of data can be interpreted
Pragmatism	▪ Complex, rich, external ▪ ‘Reality’ is the practical consequences of ideas ▪ Flux of processes, experiences and practices	▪ Practical meaning of knowledge in specific contexts ▪ “True” theories and knowledge are those that enable successful action ▪ Focus on problems, practices and relevance ▪ Problem solving and informed future practice as contribution	▪ Value-driven research ▪ Research initiated and sustained by researcher’s doubts and beliefs ▪ Researcher reflexive	▪ Following research problem and research question ▪ Range of methods: mixed, multiple, qualitative, quantitative ▪ Emphasis on practical solutions and outcomes

Source: Adapted from Saunders et al (2019)

In between, *pragmatism* is a research philosophy that refuses to join the "paradigm war" between the positivist and interpretivist philosophies (Gage, 1989, Tashakkori and Teddlie, 1998), or to get involved in contentious metaphysical debates about concepts such as truth and reality (Kaushik and Walsh, 2019). Instead, pragmatism emphasises that one should view research philosophy as a continuum (Wahyuni, 2012), which allows the researcher to abandon the separation of positivism and interpretivism as "forced dichotomies" (Kaushik and Walsh, 2019, p. 4), and which embraces both objectivist and subjectivist perspectives as being mutually inclusive (Wahyuni, 2012). Moreover, it accepts that there can be many different ways of interpreting the world (Saunders et al, 2019) as well as either single or multiple realities that are open to empirical inquiry (Creswell and Clark, 2011).

Pragmatism thus pays greater attention to the research question being addressed rather than to any overall philosophical tradition (Jones and Kennedy, 2012, Wahyuni, 2012), based on the proposition that researchers should use the philosophical and/or methodological approach that works best for the particular research problem that is being investigated (Tashakkori and Teddlie, 1998). It also allows researchers to address their research question with whatever methodological tools are available to best address the research problem at hand (Wahyuni, 2012, Kaushik and Walsh, 2019), using a pragmatist belief in "what works" (Kaushik and Walsh, 2019, p. 7). As a result, pragmatists often favour working with both quantitative and qualitative data because it enables them to better understand social reality (Wahyuni, 2012).

According to Shields (1998), therefore, pragmatism is a "philosophy of common sense". It is more interested in practical outcomes rather than abstract distinctions, and it uses theories, concepts, ideas, hypotheses and research findings as instruments of thought and action, based on their practical consequences in specific contexts (Saunders et al, 2019). It allows for multiple perspectives, including both positivism and interpretivism, and its epistemology is connected to purposeful inquiry, which steps outside debates about objective and subjective knowledge (Shields et al, 2019).

Philosophical Perspective – Current Research: The current research comes from a largely pragmatist philosophical perspective, as the pragmatist emphasis on "common sense" and practical outcomes very much reflects this researcher's pragmatist philosophical leanings, which have been nurtured over the course of more than 20 years of experience of working as an economic consultant, conducting research in non-academic environments for both the public and private sectors. In particular, this career experience has engaged the researcher in conducting different researches, which have been drawn from either positivist or interpretivist perspectives (or both), depending on the research problem or need presented. The researcher is thus “comfortable” with the use of pragmatic approaches that can combine both positivist and interpretivist perspectives, while being cognisant of the strengths and weaknesses of each.

Moreover, a pragmatist perspective is considered well suited to the current research because, in the opinion of this researcher, its conceptual framework and its research question/objectives need to draw on both positivist and interpretivist perspectives, and both quantitative and qualitative approaches. On the one hand, for example, quantitative data can tell us much about the relative R&D and innovation “performance” of regions, including inputs (e.g. investment, human resources) and outputs (e.g. patents, employment). On the other hand, however, more positivist-leaning techniques work less well in conveying the complex issues underlying regional innovation systems (e.g. co-operation, fragmentation, institutions), whereas more interpretivist-leaning techniques can provide a richer understanding and interpretation of such issues (though from a more value-bound, subjective perspective).

In this regard, further elaboration on the pragmatist nature of the research design is provided in the descriptions of research approach, research methodology and strategy and data collection/analysis, which follow.

5.4.3 Research Approach

Given its pragmatist nature, the research design for the current research draws upon elements that are found in both positivist and interpretivist research philosophies. Similarly, the research also draws on both deductive and (to a lesser extent) inductive research approaches. A summary of these research approaches, as provided by Saunders et al (2019), is outlined in Table 5.3.

Table 5.3: Deductive and Inductive Research Approaches

	Deduction	Induction
Logic	▪ In a deductive inference, when the premises are true, the conclusion must also be true	▪ In an inductive inference, known premises are used to generate untested conclusions
Generalisability	▪ Generalising from the general to the specific	▪ Generalising from the specific to the general
Use of Data	▪ Data collection is used to evaluate propositions or hypotheses related to an existing theory	▪ Data collection is used to explore a phenomenon, identify themes and patterns and create a conceptual framework
Theory	▪ Theory falsification or verification	▪ Theory generation and building

Source: Adapted from Saunders et al (2019)

According to Saunders et al (2019), for example, a deductive approach to research begins with a theory, often derived from the academic literature, which is then tested rigorously using a series of propositions. It seeks to explain causal relationships between (mostly measurable) concepts and variables, using highly structured and largely quantitative methodologies that facilitate replication and generalisation. As a scientific approach that focuses on structure, quantification, generalisation and testing hypotheses, therefore, the deductive approach is most likely to be underpinned by the positivist research philosophy (Saunders et al, 2019).

An inductive approach, on the other hand, starts by collecting data in order to explore a phenomenon and subsequently generate or build theory (e.g. in the form of a conceptual framework), with theory following data rather than vice versa (Saunders et al, 2019). Research using an inductive approach to reasoning is likely to be concerned with the context in which events take place, and it eschews attempts to make cause-effect links between variables without an understanding of the way in which humans interpret their social reality. An inductive approach to research is thus more likely to use qualitative data, and a variety of methods to collect these data, in order to establish different views of phenomena, while its emphasis on the importance of subjective interpretations ties it more closely to an interpretivist research philosophy (Saunders et al, 2019).

The influence of deductive reasoning within the current research, therefore, is especially evident in its use of a conceptual framework, in the form of a “working hypothesis”, to explore whether public policy promotion and public investment in regional innovation systems contributes to improved R&D and innovation performance in lagging regional economies. Furthermore, its pragmatic use of descriptive quantitative analysis (see Section 5.4.4 and Section 5.4.6), used as a filtering process in order to select regions for case study analysis (see Section 5.4.4 and Section 5.4.6), has drawn on a more deductive approach to research, while the use of the case study technique is itself also largely deductive in nature. At the same time, however, it should be noted that the use of a working hypothesis does not adopt any “a priori” interpretation of the influence of public policy promotion and public investment in regional innovation systems, as is often found in deductive approaches to research, while the data gathering for the case study analysis has not been solely reliant on quantitative data.

Yet, while being largely deductive in nature, elements of the data gathering for the case study analysis have nonetheless drawn on approaches that are more commonly used in inductive reasoning, e.g. the use of primary research interviews, which were used to better understand the main concepts underpinning the working hypothesis for the research, the wider context underpinning the research, and the possible varied interpretations of the nature of concepts like R&D and innovation policy and regional innovation systems in lagging regions.

5.4.4 Research Methodology and Strategy

The research methodology and strategy that has been used for this research has adopted a mixed methods approach, which combines the use of both quantitative and qualitative methods.

To begin with, quantitative methods were used, using descriptive statistics, to contribute to the investigation of the deductive, working assumption that “public policy promotion of and public investment in regional innovation systems contributes to improved R&D and innovation performance in lagging regional economies”. So, it was assumed that public policy for and public investment in R&D and innovation is intended to improve R&D and innovation performance, and quantitative data on regional R&D and innovation inputs (e.g. investment, human resources) and outputs (e.g. patents, employment) were therefore examined for levels of growth in R&D and innovation inputs and outputs in lagging regions over time. In addition, however, this quantitative analysis was also used to identify lagging regions that might provide candidates for more in-depth qualitative research, and further description of the purpose of the quantitative analysis in this regard is outlined in Section 5.4.6.

Following this, qualitative analysis was used as part of the research methodology and strategy so as to provide a richer understanding and interpretation of the complex issues underlying R&D and innovation performance within regional innovation systems. This qualitative analysis, in turn, was conducted as part of a case study analysis. According to Gillham (2000), the case study is a naturalistic style of inquiry that is particularly appropriate to the study of human phenomena, while Yin (2012) has similarly highlighted its merit as a research method that facilitates a deep investigation of real-life contemporary phenomena in their natural context. Yet, Shields et al (2019) assert that the case study showcases a qualitative yet deductive research methodology that crosses boundaries between positivist and interpretivist philosophies, though it does not promote “a priori” theoretical assumptions about the case (Gillham, 2000). Thus, it looks for subjectivity, how people understand themselves or their setting, what lies behind the more objective evidence available, or the process leading to outcomes or results (Gillham, 2000).

However, different research methodologies, types of data and research orientations are not mutually exclusive or dichotomous in a case study (Lancaster, 2004). In this regard, Gillham (2000) suggests that quantitative data and its analysis, i.e. data that can be expressed numerically or classified by some numerical value (Lancaster, 2004), adds to the overall picture in a case study as it extends the range of evidence on the topics under investigation. So, for example, descriptive statistics can be used in a case study to situate the cases in a broader empirical context. In addition, quantitative data can also be used to qualify what is learned from other sources, which can provide cross-referencing to support the validity and reliability of a study.

At the same time, the case study also typically incorporates significant use of qualitative data (e.g. descriptive accounts, observations), or data that cannot be subjected to quantitative or numerical analysis, which is associated with phenomena that cannot be quantified or are difficult to quantify (Lancaster, 2004). Through its use of qualitative data, the case study thus places considerable focus on the kind of evidence that enables the researcher to understand the meaning of what is going on (e.g. what people do, what people say), meaning that is less easily extracted from quantitative data, which can in turn illuminate issues and uncover possible explanations (Gillham, 2000).

No one source of evidence is likely to be sufficient on its own in a case study, and the use of multiple sources of evidence is a key characteristic, as any kind of evidence can be included if it is relevant or of value (Gillham, 2000). This affords the researcher a certain amount of flexibility in terms of what can or can’t be done in a case study, and the practice of collecting data from multiple sources, termed data triangulation (Gillham, 2000, Patton 2002, Lancaster, 2004), assists the researcher not only to collect more comprehensive relevant information but also to cross-check its consistency in order to enhance the robustness of findings.

Use of the case study, therefore, was chosen as a suitable strategy to address the research question and research objectives underlying this research. In particular, it was felt that the case study emphasis on real-life and people-influenced phenomena, on context and processes, on deeper investigation, on objective and subjective evidence and on multiple sources of evidence provided an appropriate means to investigate the nature of the core concepts or issues that underpin the research question and objectives for the current research, and the complexity that underlies them. This includes, for example, the nature of regional innovation systems in lagging regions, the nature of R&D and innovation policy in such regions, the relationships/processes connecting key actors inside and outside the regions, and the underlying social and cultural processes and contexts in regions, all of which might influence inputs to and outputs/outcomes from R&D and innovation.

In terms of the chosen case setting(s) for the current research, meanwhile, Gillham (2000) defines a case as being: "a unit of human activity that is embedded in the real world; which can only be studied or understood in context; which exists in the 'here and now'; and which merges in with its context so that precise boundaries are difficult to draw" (Gillham, 2000, p. 1). A case can therefore be an individual, a group (e.g. a family, a class) or a community (e.g. a place, an industry), with the case unit for this current research being a "region" (or more specifically a "lagging region", as per the definition and description provided in Chapter 3). Moreover, case study research should ideally use a multiple case study design, involving multiple sites to be studied, based on the rationale that the choice of a multiple case study over a single case study enables comparisons between observed practices, so as to obtain a more comprehensive understanding of these practices (Wahyuni, 2012).

In this regard, the decision was made to study two regions for this research, rather than three or more, which was driven by a desire to ensure that the number of case regions being studied did not dilute the depth of research conducted on each region, given the resources available to the researcher[18]. The two regions that were therefore selected for case study in the current research were Galicia (Spain) and Puglia (Italy), and an explanation of the rationale underlying the choice of these two regions is provided in Chapter 7 (Section 7.8).

5.4.5 Time Horizon

The time horizon for the research has principally focused on R&D and innovation performance and policy and institutional developments during the 2000-13 period, through a study of two different time periods within this wider timeframe. Therefore, the period of study covers the EU's 2000-06 and 2007-13 Structural Fund programming periods.

This timeframe was chosen because the 2000-06 and 2007-13 periods were the first two periods during which the EU introduced R&D and innovation as a major investment priority within its Structural Fund investment programmes (see Chapter 2, Section 2.3).

[18] This choice was also advised and endorsed through feedback received by the researcher following his participation in and presentation of research progress at the European Week of Regions and Cities (EWRC) Master Class in EU Cohesion Policy (Brussels, October 2015).

Also, investment activity across this period was well progressed at the commencement of the current research, and the period was thus considered suitable for research and analysis given the likely time lags needed to assess the influence of any investment (i.e. unlike the subsequent 2014-20 Structural Fund programming period, which had only commenced at that time).

Potential challenges arising from this time span were posed in gathering primary data to cover the full time period. For example, the collection of data through interviews (see Section 5.4.6) tried to find, as best as possible, a cohort of regional interviewees with sufficient knowledge and experience to provide useful insights on the development of R&D and innovation performance and regional innovation systems across the full study period. Moreover, it should be noted that regional, national and global economic conditions varied greatly during the period of analysis, which in turn could impinge on R&D and innovation performance in the period. In this regard, it should be noted that the global financial and economic crisis of 2008-09, in particular, occurred alongside the initial roll-out of the EU's 2007-13 Structural Fund investment programmes.

5.4.6 Data Collection and Analysis

As alluded to previously, the data collection and analysis for the research has adopted a mixed methods approach. This has included:

- descriptive quantitative analysis;
- case study research, using both quantitative and qualitative methods.

Quantitative Analysis: The use of quantitative analysis for the current research has principally employed descriptive data to help to identify lagging regions whose recent innovation activity and performance might provide suitable candidates for the deeper, more qualitative case study research.

Quantitative data has therefore been used on a pragmatic basis as a "filtering process" in order to select EU regions (which were classified as "lagging" during the 2000-13 period) for more qualitative case study analysis, given the researcher's lack of any prior knowledge about the R&D and innovation performance and/or the regional innovation systems in lagging regions. A summary of the approach to the quantitative analysis is provided in this section, while a more detailed description and explanation of the quantitative methods and analysis used is provided in Chapter 6 and Chapter 7.

In the first instance, in order to identify possible groups, the quantitative analysis reviewed EU regional data for selected "input" indicators and "output" indicators across 53 regions of the EU-15[19], based on commonly used indicators for R&D and innovation, with a focus on a dynamic perspective (i.e. comparison of growth over time) rather than a static perspective (i.e. base comparison at a single point in time). Analysis of inputs, for example, involved a review of growth trends in total R&D investment, business R&D investment, total R&D personnel and business R&D personnel. Analysis of outputs, meanwhile, involved a review of growth trends in total patent applications, employment in high/medium-high technology manufacturing, employment in knowledge intensive services and employment in high technology sectors.

Data for the 53 regions was collated from 1994 up to 2012, the most recent year available when the quantitative analysis was being completed (i.e. up to 2016). Growth trends for each of the indicators were then, in turn, calculated on a period average basis for three discrete time periods, which broadly corresponded to the EU's Structural Fund programming periods – i.e. 1994-99, 2000-06 and 2007-13 – with this approach being taken because trends in some of the indicators used can fluctuate significantly on a year-to-year basis. Lack of availability of sufficient time series data across all regions, however, meant that the sample of regions analysed was reduced to 22 regions, which were mainly situated in Spain, Italy and Portugal (see also Section 6.2.2).

The period average analysis thus allowed growth trends to be examined for 22 regions between the three programming periods, with growth comparisons in particular being made between (a) the 1994-99 period and the 2000-06 period and (b) the 2000-06 period and the 2007-13 period. A more detailed explanation of the method underlying the analysis of input and output indicators, meanwhile, is provided in Section 6.2.

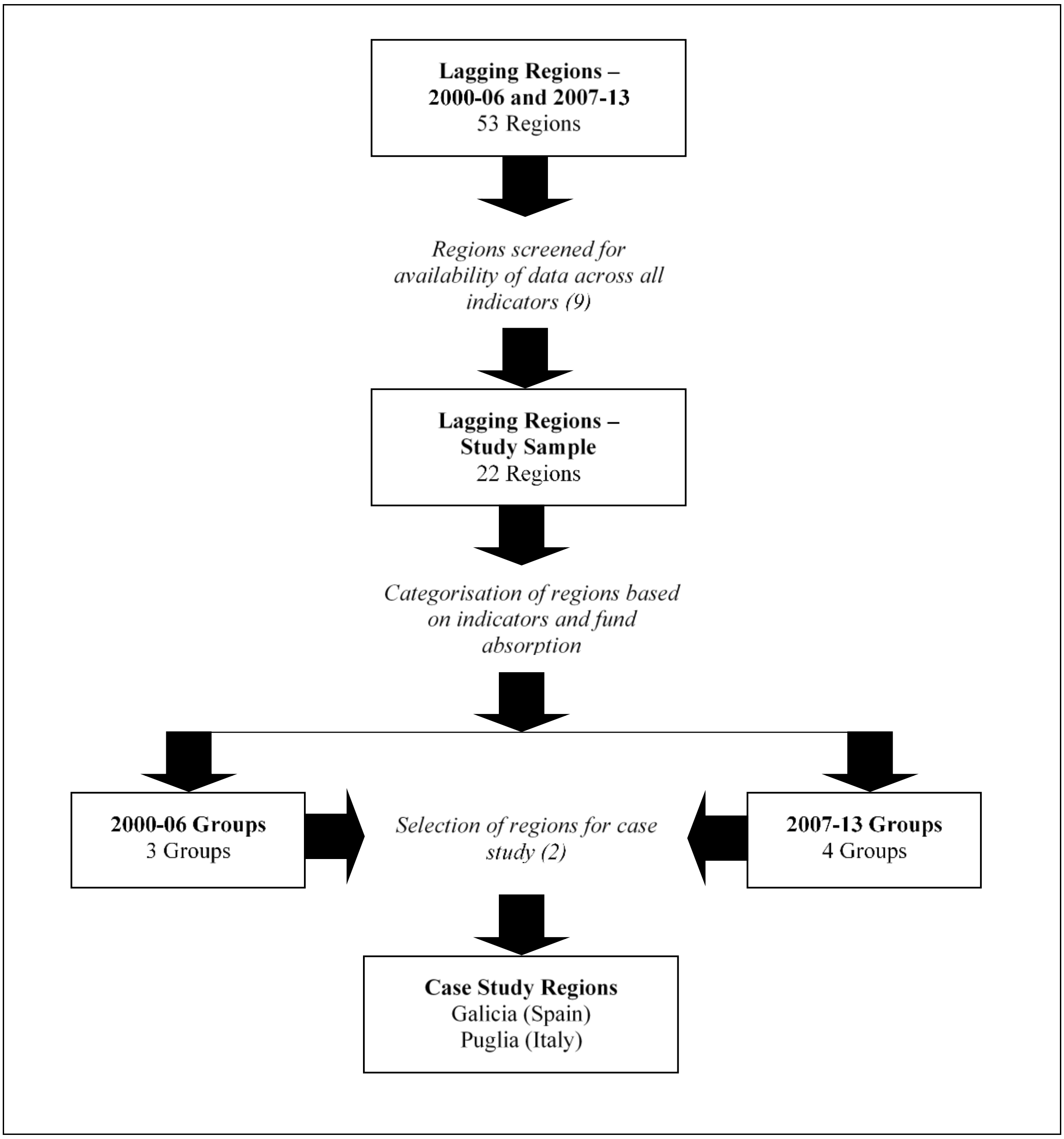
[19] As alluded to in Chapter 3 (Section 3.2), lagging regions in newer EU member states, which joined the EU from 2004 onwards, were not included in the quantitative analysis for this research because they did not become eligible for Structural Fund assistance until the middle of the 2000-06 Structural Fund programming period, and thus had less access to EU support for R&D and innovation in this period.

Furthermore, the quantitative analysis similarly took account of other data regarding regional levels of absorption of EU funds for innovation, based on analysis provided in the EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b). This data grouped EU regions according to levels of EU fund investment in R&D and innovation, for both the 2000-06 and 2007-13 periods, and suggested clear differences in the level of Structural Fund investment for R&D and innovation in regions. These fund absorption groupings, therefore, gave some further sense of which lagging regions devoted the most resources to investment in R&D and innovation during the two periods, and a more detailed explanation of this data and its use is provided in Section 6.5.

Finally, in order to categorise results for each region between the programming periods, growth in each input indicator and output indicator was indexed against the median score for that indicator, based on the sample of 22 regions studied. Using these index scores, regions were then categorised, whereby a "green" category indicated a relatively higher performance in terms of inputs or outputs, with an "orange" category indicating a relatively median performance and a "red" category indicating a relatively lower performance. In addition, regional levels of absorption of Structural Funds for innovation, as per the EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b), were categorised on a similar basis, with a "green" category representing a relatively higher level of fund absorption and a "red" category representing a relatively lower level of fund absorption. Again, a more detailed description of these categorisation methods, and a graphical illustration of the methods as applied both to growth trends between the programming periods and to fund absorption in the 2000-06 and 2007-13 periods, is provided in Chapter 7, Section 7.2-Section 7.5.

To summarise, Figure 5.3 provides a graphical illustration of the quantitative analysis used to categorise regions and to select the chosen case study regions of Galicia and Puglia. Again, an explanation of the rationale for the choice of Galicia and Puglia as case study regions is provided in Chapter 7, Section 7.8.

Figure 5.3: Quantitative Analysis – Flowchart

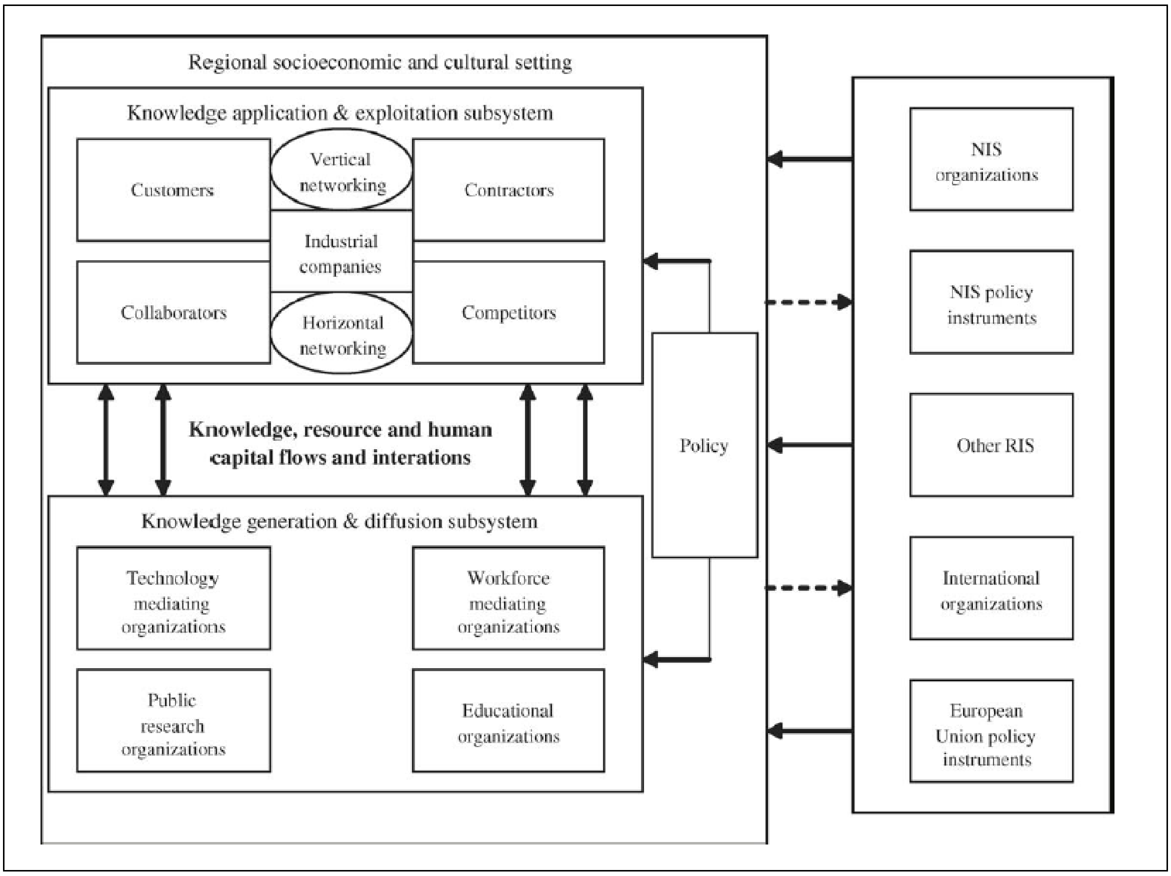


Source: Author

Case Study Research: The core purpose of the case study research has been to perform a more in-depth analysis of the development of regional innovation systems in the selected regions, and to see what changes have occurred over time and to what extent weaknesses in the systems have been addressed, given that the nature of such systems and the institutional characteristics of lagging regions was asserted by Oughton et al (2002) to be the main cause of the regional innovation paradox. The case studies, therefore, have drawn on an analytical framework for regional innovation systems (see

Figure 5.4), as devised by Tödtling and Trippl (2005), which was earlier outlined in Chapter 4 (Section 4.5) and which is further described in Chapter 8 (Section 8.3).

Figure 5.4: Analytical Framework for Analysis of Case Study Regions



Source: Tödtling and Trippl (2005)

This framework has explored each region's wider socio-economic setting, their perceived R&D and innovation performance, the nature of their regional innovation systems and the key actors within those systems, the progression of R&D and innovation investment and policy over time, and the governance arrangements that influence R&D and innovation policy. To do this, the case study research has also drawn on evidence from two main research methods or data sources:

a) secondary data gathered from more than 50 existing sources of information for each region, such as R&D/innovation and wider socio-economic datasets (including relevant data drawn from the earlier quantitative analysis), national and regional policy and strategy documents, national and regional funding programme documents or sources, or other published reports and articles on development of R&D and innovation in the case study regions;

b) primary data gathered from research interviews carried out with a sample of key stakeholders (e.g. policy makers, policy implementers, research institutions, industry representative bodies) in each region.

The evidence from the secondary data, for instance, has helped to inform the research about the inputs, outputs, outcomes and actors associated with the development of R&D and innovation in the case study regions. Using the analytical framework devised by Tödtling and Trippl (2005) as a guide, the analysis of the secondary data has thus sought to describe:

- the socio-economic context within the case study regions, based on the type of indicators and data that the EU typically uses when describing the regions that it classifies as "lagging" regions, as an input to understanding the wider regional socio-economic and cultural setting;
- the R&D and innovation performance of the regions between 2000 and 2013 (i.e. the period of study for the research), based on commonly used indicators for R&D and innovation performance, including inputs (R&D expenditure, R&D personnel) and outputs (patents, employment in related sectors)[20];
- the main elements of the regional innovation systems in the regions, with a particular focus on elements within:
  - the "knowledge generation and diffusion" sub-system (e.g. universities, research centres);
  - the "knowledge application and exploitation" sub-system (e.g. firms);
  - the "regional policy" sub-system (i.e. government and its agencies);
  - links to other national and international systems.

However, the secondary data tells us less about the processes and connections that might link inputs to outputs and outcomes, including the importance of processes and connections within regional systems or between regional systems and national or

[20] While there was a main focus on R&D and innovation performance over the 2000-13 period, however, it should be noted that the case studies have also taken account of more recent performance, where data was available.

international systems. Therefore, the use of research interviews has been crucial in aiding the interpretation of secondary data by providing insights, perceptions and opinions from a sample of knowledgeable and experienced key informants in each region. These interviews, in particular, sought to elicit interviewees' perceptions, insights and opinions regarding the development of R&D and innovation performance and regional innovation systems in each case study region over time (including their views on the processes and connections underlying investment/performance and regional innovation systems) and to gauge the extent to which such perceptions, insights and opinions either supported or contradicted the evidence provided in secondary data.

According to Gillham (2000), the use of interviews in case study research will almost certainly be worthwhile if you can identify even a small number of interviewees that are key or representative. In identifying candidates for interview, therefore, this research used a targeted, purposive sample of interviewees, which was chosen based on interviewees' background and their likely experience/knowledge of the regional innovation systems in their respective regions over a prolonged period of time, and with a particular focus on interviewees that were familiar with the regional innovation systems and the development of R&D and innovation policy over the 2000-13 period. Selection criteria that were used to identify potential interviewees, therefore, included:

a) selection of interview candidates that possessed experience related to R&D and innovation and regional innovation systems, which at least covered the 2000-06 and 2007-13 Structural Fund programming periods;
b) selection of interview candidates that were, as best as possible, representative of the different sub-systems of actors that are involved in regional innovation systems (e.g. policy makers, policy implementers, universities/research institutions, firm/industry representative bodies).

Candidates for interview were identified through desk-based research (e.g. literature searches, Internet searches) and through regional contacts in Galicia and Puglia. In total, there were seven (7) potential candidates invited to be interviewed in each region across the categories referred to above (i.e. policy makers, policy implementers, research institutions, industry representative bodies), and there were five (5) candidates that agreed to be interviewed in both regions, though one potential interview in Galicia unfortunately had to be postponed and could not be subsequently re-arranged. This left nine (9) experienced, knowledgeable informants that were interviewed for this phase of the research (including four (4) in Galicia and five (5) in Puglia), as outlined in Table 5.4.

Table 5.4: List of Interviews

Interview	Region	Sector	Role
G1	Galicia	Public	Senior official in R&D and innovation planning and strategic co-ordination, regional government agency
G2	Galicia	University	Senior executive in knowledge transfer and collaboration in the university sector
G3	Galicia	University	Senior academic with expertise in R&D and innovation policy and the regional innovation system in Galicia
G4	Galicia	Private	Senior executive in a private intermediary organisation specialising in the R&D and innovation space
P1	Puglia	Public	Senior official with expertise in R&D and innovation, regional government agency
P2	Puglia	University	Senior academic with expertise in R&D and innovation policy and the regional innovation system in Puglia
P3	Puglia	Public	Senior official with expertise in R&D and innovation, regional government agency
P4	Puglia	Private	Senior executive with expertise in R&D and innovation, regional business representative body
P5	Puglia	Public	Senior official in R&D and innovation policy, regional government department

Source: Author

Research interviews were conducted on a face-to-face basis in a semi-structured format, using a standard checklist of interview questions, and interviews were generally between 90-120 minutes in duration. Prior to the interviews, the checklist/protocol used was also “stress tested” or piloted internally with the research supervisors to gauge its suitability as a research tool, while the semi-structured nature of the checklist was designed to allow it to be adapted, if appropriate, as the interviews progressed.

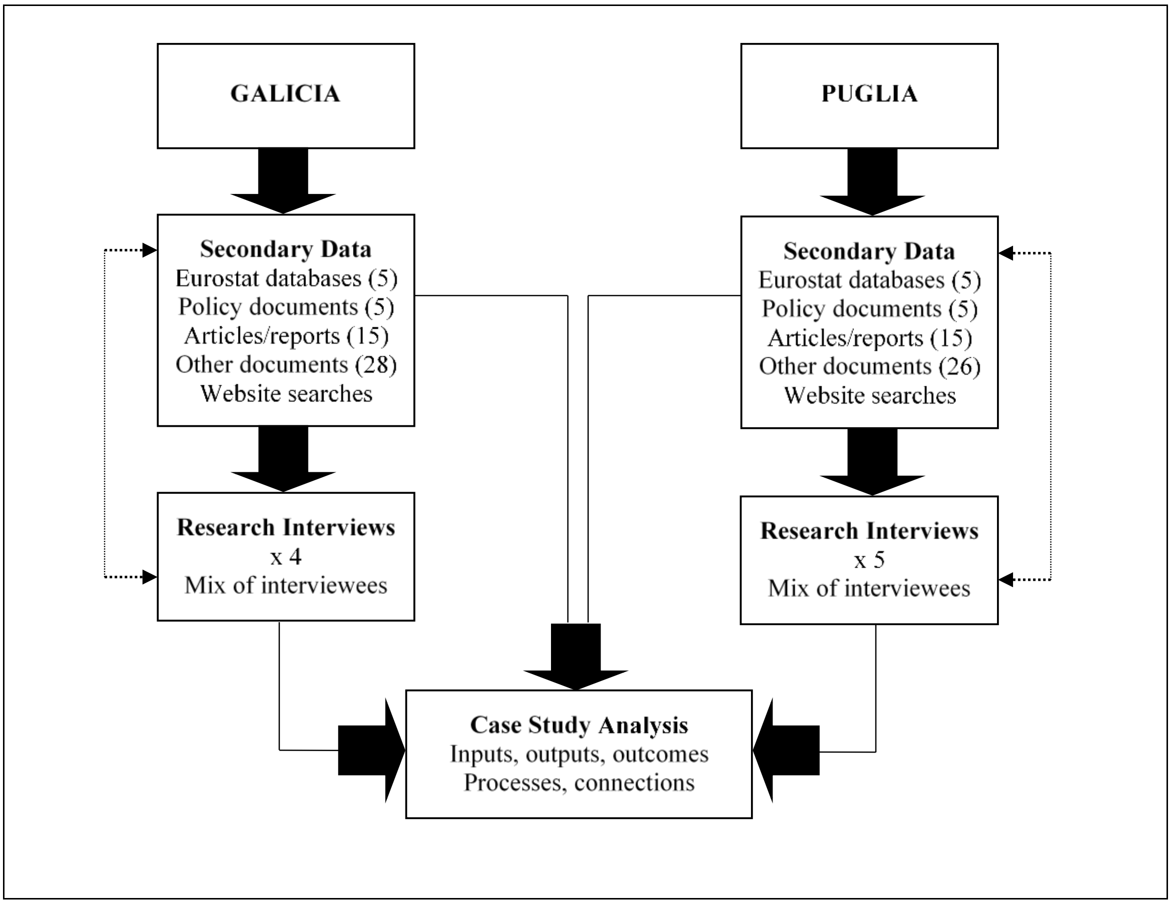
Such face-to-face interviews, according to Lancaster (2004), provide a means of collecting data that can potentially deliver substantial depth in data, or a richness in communication (Gillham, 2000), especially when researching complex issues, and while also giving flexibility to adapt lines of questioning to suit the circumstances. Semi-structured interviews, meanwhile, offer the merit of using a list of predetermined themes and questions, as in a structured interview, while keeping enough flexibility to enable the interviewee to talk freely about any topic raised during the interview (Wahyuni, 2012), and without necessarily conducting the interview in a rigid manner or a rigid order (Lancaster, 2004). Semi-structured interviews thus facilitate interviewees to share their perspectives and experience regarding the particular social phenomena being observed by the interviewer (Wahyuni, 2012), and help to get closer to the data so as to get "insider" perspectives (Oakley, 1999), though potential for respondent bias has to be acknowledged when using such techniques (Lancaster, 2004).

Interview data was collated by means of interview recording and transcription, while the interview data was analysed by means of a content analysis, using manual coding based on both the interview topics and identified themes. In this regard, the main topics that were addressed during the interviews included the following:

- interviewees' perceptions on the R&D and innovation performance of their respective region during the study period;
- interviewees' perceptions on the role of different actors within the regional innovation system, and how these roles have progressed over time, but with particular focus on the following:
    - universities and other research institutions;
    - firms, including both large enterprises and SMEs;
    - government and policy makers, including regional government, national government and the EU;
- interviewees' perceptions on the level of interaction, co-operation and collaboration developed between key actors within the regional innovation system;
- interviewees' perceptions on the development of policies to foster R&D, science and technology and innovation in industry and enterprise in their respective region over the study period, and opinions on how such policies evolved over time;
- interviewees' perceptions on the role played by the EU in fostering innovation in the regions, and the importance of the EU's role.

To summarise, Figure 5.5 provides a graphical illustration of the case study research process.

Figure 5.5: Case Study Research Process – Flowchart



Source: Author

5.5 Validity and Reliability

5.5.1 Overview

In adopting a pragmatist research philosophy, this research has by its nature engaged both positivist and interpretivist perspectives and their associated research approaches, strategies and methods. The discussion of research philosophies and approaches outlined earlier in this chapter, however, has also alluded to the various possible criticisms of different philosophies and approaches, e.g. the potential for subjectivity, researcher bias and respondent bias within interpretivist research.

With this in mind, every effort was therefore made to ensure the validity and reliability of the current research, and aspects of the research process that enhance its validity and reliability are outlined below.

5.5.2 Validity

Validity concerns the extent to which data collection methods accurately measure what they are intended to measure, i.e. validity demonstrates the extent to which research findings are really about what they claim to be about (Saunders et al, 2019). In the context of this research, and given its mixed methods approach that has combined both quantitative and qualitative techniques, the following steps were therefore taken to address research validity:

- key concepts underlying the research question and objectives were clearly articulated, and associated conceptual and analytical frameworks were adopted to guide the research process;
- multiple sources of data were used to carry out the research, with the evidence from these different data sources being triangulated so as to build a coherent articulation of findings and themes;
- the indicators that were used for the quantitative analysis, while limited, were drawn from well-recognised and commonly used data sources for R&D and innovation activity;
- the interview protocol for the case study research was designed so as to cover the key concepts and issues pertaining to the research, and it was piloted within the supervisory team prior to being used for interviews;
- research interviewees for the case study research were selected based on their experience of and familiarity with the regional innovation systems in their respective regions over a prolonged period of time, to add to the validity and credibility of the research;
- evidence was also triangulated from different cohorts of research interviewees, including policy makers, policy implementers, research institutions and industry representative bodies as well as both public and private sector entities.

5.5.3 Reliability

Reliability is the extent to which any research can yield the same results under the same conditions, and similar observations can be reached by other researchers. In the context of this research, the following steps were taken to address research reliability:

- the research was designed, as best as possible, so as to incorporate a structured research methodology, which should make it easier for other researchers to replicate the same process;
- detailed methods and processes were used to undertake the quantitative analysis, and these were reviewed by the supervisory team and by other academic colleagues in Waterford Institute of Technology, while every effort was also made to rigorously check the accuracy of the analysis;
- a standardised interview protocol was used to conduct the semi-structured interviews, which provided a consistent coverage of topics to the best extent possible, while at the same time allowing for the advantages of flexibility that the research interview affords;
- a consistent approach was used to record data from interviews, including the use of audio recording of interviews and the transcription of data following the interviews;
- interview responses were coded, based on the structure of the interview checklist and related or emerging themes;
- all data collection and analysis processes used for the research have been clearly described and explained, as outlined in this and subsequent chapters.

PART B – QUANTITATIVE ANALYSIS

CHAPTER 6 – INNOVATION PERFORMANCE IN LAGGING REGIONS

6.1 Introduction

6.1.1 Overview

The main purpose of this chapter is to present the findings of the descriptive quantitative analysis of growth in innovation performance in regions that were classified as "lagging", over the EU's 2000-06 and 2007-13 Structural Fund programming periods, which forms part of the original research that was carried out for this study.

This analysis provides evidence of the growth trends in R&D and innovation investment and performance within lagging regions over the 2000-06 and 2007-13 Structural Fund programming periods, based on an original analysis of commonly used indicators for R&D and innovation "investment" and "performance". However, the purpose of the analysis has also been to help identify lagging regions where recent innovation activity and performance might provide candidates for deeper, more qualitative case study analysis of attempts to address issues associated with the regional innovation paradox. In this regard, therefore, the data was used to help to categorise regions into groups and thereby inform the selection of case study regions, which is provided in Chapter 7.

The chapter includes five further sections. Section 6.2 outlines the indicators that have been used in the analysis and describes how these indicators have been analysed. Section 6.3 then presents the results for the analysis of "input" indicators, while Section 6.4 presents the results for the analysis of "output" indicators. Finally, Section 6.5 looks at categorisations of EU fund absorption in lagging regions for the 2000-06 and 2007-13 Structural Fund programming periods, as per the findings of the Regional Innovation Scoreboard (European Commission, 2012b, 2014b), while Section 6.6 provides a summary of the chapter findings.

6.1.2 Other Analyses of Innovation Performance in Lagging Regions

Before presenting the analysis carried out for this research, it is worth noting that the research literature includes several other studies that have sought to analyse and categorise the R&D and innovation "performance" of regions that have been classified as "lagging", and such studies provide some context for the descriptive quantitative analysis and categorisation of regions that follows in this chapter and in Chapter 7. These studies include:

- the classification of lagging regions according to the EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b, 2016, 2017b, 2019);
- evidence from selected other typologies and classifications of regions in the research literature, including the work of Navarro, Gibaja, Aguado and Bilbao-Osorio (2008), Pinto (2009) and Capello and Lenzi (2013).

A detailed overview of the findings of these studies is provided in Appendix B. However, a key message that can be drawn from such studies is that the classification of the sample of regions used for this study tends to be very similar across the different typologies and categorisations, which would suggest that these regions are sufficiently similar to be able to draw comparisons from their different experiences of using innovation inputs and delivering innovation outputs. In this regard, for example, such studies tend to group lagging regions together in terms of R&D and innovation performance, and typically in groups that are perceived to "under-perform" more advanced regions, in an EU context. This is clear from review of the findings of the EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b, 2016, 2017b, 2019), which generally classifies such regions as either "Moderate Innovators" or "Modest Innovators", i.e. regions with below par R&D and innovation performance relative to EU averages, based on the indicators used. Also, Navarro et al (2008) and Pinto (2009) have classified such regions as being "disadvantaged" in R&D and innovation terms, or having "average" or "weak" economic and technological performance.

At the same time, not all typologies or taxonomies of innovation in European regions have concluded that perceived lagging regions are simply "disadvantaged" or have "weak" or "average" economic and technological performance in R&D and innovation terms. In this regard, for example, Capello and Lenzi (2013) have highlighted possible local specificities or traits in terms of entrepreneurship, creativity and attractiveness (e.g. wage levels) in such regions, which could aid the acquisition and adaptation of external knowledge and innovation, with appropriate policy interventions.

Again, further details on the findings of these studies can be found in Appendix B.

6.2 Indicators and Approach

6.2.1 Indicators

The approach to the quantitative analysis has incorporated the use of a range of indicators for innovation activity, looking at data for lagging regions in particular, which is available from Eurostat. As noted in Section 6.1.1, this analysis has been organised into a review of:

- "inputs" to innovation activity;
- "outputs" from innovation activity.

Analysis of inputs has involved a review of growth trends in the following indicators associated with the production of R&D and innovation:

- total R&D investment per capita, expressed in PPS terms;
- business R&D investment per capita, also expressed in PPS terms;
- total R&D personnel levels per capita, expressed in full-time equivalents (FTEs)[21];
- business R&D personnel levels per capita, also expressed in FTEs.

Analysis of outputs, meanwhile, has involved a review of growth trends in the following indicators associated with outcomes from R&D and innovation activity:

- total patent applications per capita;
- employment per capita in high/medium-high technology manufacturing (FTEs);
- employment per capita in knowledge intensive services (FTEs);
- employment per capita in high technology sectors (FTEs).

[21] Analysis of R&D personnel is useful alongside the analysis of R&D investment because the relative cost of R&D personnel can vary between regions (Navarro et al, 2008).

The indicators that were used have all been widely adopted in other analyses of R&D and innovation activity (see Appendix B for examples). However, the focus of the analysis presented in the chapter adopts a dynamic perspective (i.e. comparison of growth over time) rather than a static perspective (i.e. base comparison at a single point in time). In particular, the analysis presented here looks at growth between the 1994-99, 2000-06 and 2007-13 Structural Fund programming periods.

6.2.2 Analysis

Data for most input and output indicators has in the first instance been examined from 1994 up to 2012, which was the most recent year available when the quantitative analysis part of the research was being completed (i.e. up to 2016). For patent applications, however, the analysis covers 1994 up to 2011, as 2012 data for this indicator was not available at that time.

For consistency purposes, trends in each of the indicators have, where possible, also been calculated on a period average basis for three discrete time periods – the 1994-99 period, the 2000-07 period and the 2008-12 period (with the 2008-11 period as equivalent for patent applications). This period average approach has been taken because trends in some of the indicators involved can fluctuate significantly on a year-to-year basis, which makes it problematic to choose a single base year for analysis.

Furthermore, the three time periods used broadly correspond to the three relevant periods in the EU's Structural Fund programming cycle – the 1994-99 period, the 2000-06 period and the 2007-13 period. The analysis in this research has looked at the 2000-07 period (rather than 2000-06) and the 2008-12 period (rather than 2007-12), however, for two reasons:

- an additional year is added to the 2000-06 period to allow for the fact that monies approved in the final year(s) of the 2000-06 Structural Fund programming period could be spent after the formal end of the period[22];

[22] For example, for the European Regional Development Fund (ERDF), one of the main Structural Funds, expenditure for the 2000-06 programming period had to be incurred by the end of 2008, though this deadline was subsequently extended into 2009 in response to the global financial and economic crisis (European Commission, 2010).

- the data had to be viewed within the context of the global financial and economic crisis within the world's economy, which began to impact many national and regional economies in 2008. It was thus felt that 2007 more properly belonged to the same economic cycle as the 2000-06 period, rather than the following period.

The annual average unit amount for each indicator, for each of the time periods used, has been calculated as follows:

- for 1994-99, the cumulative amount for the period was divided by six;
- for 2000-07, the cumulative amount for the period was divided by eight;
- for 2008-12 (2008-11 for patents), the cumulative amount for the period was divided by five (four for patents);
- in each case, indicators were also converted to a per capita basis using the average annual population for each region in each of the periods, which was derived from Eurostat data and was calculated on the same basis as outlined above.

The only deviation to this period average approach, however, relates to the analysis of employment data for the 2008-12 period, i.e. data for high and medium-high technology manufacturing, knowledge intensive services and high technology sectors. In these cases, average employment in the 1994-99 and 2000-07 periods could not be compared to average employment in the period from 2008 onwards due to changes in the European industrial activity classification (NACE) codes. Therefore, rather than examining growth between the 2000-07 and 2008-12 periods, per capita employment growth for each indicator was examined between the years 2008 and 2012, with some caveats.

6.2.3 Regional Coverage

Finally, it should be noted that data for all indicators was not available for all lagging regions, while there were gaps in the time series of some regions for which data was available. As a result, regions have only been included in the analysis if:

- sufficient regional data was available for both "input" and "output" indicators across the three periods;

- annual data was available for at least half of the years in each period where annual averages were being calculated, i.e. three years for the 1994-99 period, four years for the 2000-07 period and three years for the 2008-12 period. In such cases, the denominator used in calculating the annual average was also adjusted to allow for the number of years for which data was available.

Due to data availability and this associated screening process, the analysis in the research therefore covers a sample of 22 lagging regions, as noted in the earlier chapters, drawn mainly from Spain, Italy and Portugal.

6.3 Innovation Performance – Input Indicators

6.3.1 Overview

This section covers the analysis of innovation performance in lagging regions, based on the following input indicators:

- total R&D investment per capita (PPS);
- business R&D investment per capita (PPS);
- total R&D personnel levels per capita (FTEs);
- business R&D personnel levels per capita (FTEs).

For each indicator, the EU-15 average performance is also provided, for comparative purposes, where this is available[23].

6.3.2 Total R&D Investment

Table 6.1 provides details of average annual R&D investment per capita for the 22 lagging regions studied in the 1994-99 and 2000-07 periods, with the growth in average annual investment between the two periods also recorded.

[23] EU-15 averages are used for comparative purposes because this reflects the size of the EU, in terms of member states, at the start of the 2000-06 Structural Fund programming period.

It shows that most regions recorded an average growth that was higher than the EU-15 average between the two periods, with growth being at least 20 percentage points above the EU-15 average (i.e. 40% or more) in a majority of cases, and with investment growth in Spanish regions being particularly strong. Galicia in Spain shows the highest annual average growth over the two periods, with investment growth among other Spanish regions being strongest in Extremadura, Castilla y León and Comunidad Valenciana. Italian and Portuguese regions, on the other hand, tended to be at the lower end of the growth spectrum, though still above the EU-15 average, with only the Algarve, Sardinia and the Azores recording growth below the EU-15 average.

Table 6.1: Average Total R&D Investment per Capita in Lagging Regions 1994-99 and 2000-07

Region	Country	Average R&D Investment per Capita 1994-99 (PPS)	Average R&D Investment per Capita 2000-07 (PPS)	Average R&D Investment per Capita Growth (%)
Galicia	Spain	71.35	149.95	110.1%
Extremadura	Spain	43.59	91.07	108.9%
Castilla y León	Spain	93.41	183.61	96.6%
Comunidad Valenciana	Spain	98.56	180.02	82.7%
Principado de Asturias	Spain	85.47	145.06	69.7%
Molise	Italy	44.60	75.60	69.5%
Andalucía	Spain	80.35	134.50	67.4%
Región de Murcia	Spain	80.69	133.49	65.4%
Calabria	Italy	35.88	56.74	58.1%
Norte	Portugal	54.55	82.25	50.8%
Puglia	Italy	68.56	101.48	48.0%
Canarias	Spain	82.88	121.72	46.9%
Basilicata	Italy	69.82	101.52	45.4%
Sicilia	Italy	87.60	126.24	44.1%
Campania	Italy	122.77	170.14	38.6%
Castilla-la Mancha	Spain	58.63	79.76	36.0%
Corsica	France	38.54	51.19	32.8%
Cantabria	Spain	102.78	126.07	22.7%
Região Autónoma da Madeira	Portugal	61.01	73.87	21.1%
EU (15 Countries)		390.67	470.95	20.5%
Algarve	Portugal	42.42	49.396	16.4%
Sardegna	Italy	102.93	115.45	12.2%
Região Autónoma dos Açores	Portugal	131.05	58.69	-55.2%

Source: Author's calculations based on Eurostat data (dated 15-05-14, extracted 25-08-14)

Table 6.2 provides details of average annual R&D investment per capita and growth for the same regions between the 2000-07 and 2008-12 periods. Again, the majority of regions out-performed the EU-15 average for R&D investment growth between the periods, though not to the same degree as was evident between the 1994-99 and 2000-07 periods.

Investment growth between these periods was strongest in Portuguese regions (e.g. Norte, Algarve) and Spanish regions (e.g. Cantabria, Castilla-la Mancha, Extremadura). Average investment growth in most Italian regions between the 2000-07 and 2008-12 periods, however, was either at or below the EU-15 average, and this includes regions such as Puglia, Molise, Campania, Sardinia, Basilicata and Sicily.

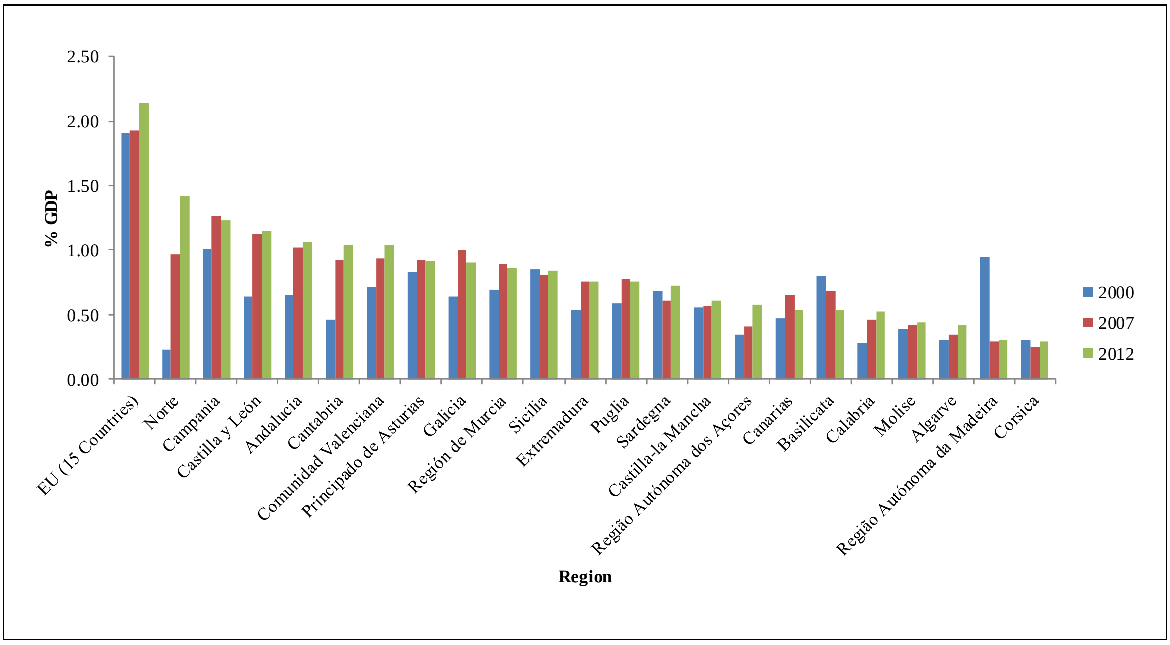
Table 6.2: Average Total R&D Investment per Capita in Lagging Regions 2000-07 and 2008-12

Region	Country	Average R&D Investment per Capita 2000-07 (PPS)	Average R&D Investment per Capita 2008-12 (PPS)	Average R&D Investment per Capita Growth (%)
Norte	Portugal	82.25	208.16	153.1%
Cantabria	Spain	126.07	241.80	91.8%
Algarve	Portugal	49.40	79.01	60.0%
Castilla-la Mancha	Spain	79.76	119.15	49.4%
Região Autónoma dos Açores	Portugal	58.69	85.67	46.0%
Extremadura	Spain	91.07	132.72	45.7%
Andalucía	Spain	134.50	191.23	42.2%
Principado de Asturias	Spain	145.06	204.33	40.9%
Castilla y León	Spain	183.61	246.96	34.5%
Galicia	Spain	149.95	190.09	26.8%
Región de Murcia	Spain	133.49	164.79	23.4%
Calabria	Italy	56.74	69.44	22.4%
Corsica	France	51.19	61.96	21.1%
Comunidad Valenciana	Spain	180.02	213.58	18.6%
EU (15 Countries)		470.95	536.74	14.0%
Puglia	Italy	101.48	114.96	13.3%
Molise	Italy	75.60	83.24	10.1%
Campania	Italy	170.14	185.27	8.9%
Sardegna	Italy	115.45	122.84	6.4%
Basilicata	Italy	101.52	103.74	2.2%
Sicilia	Italy	126.24	127.28	0.8%
Canarias	Spain	121.72	118.16	-2.9%
Região Autónoma da Madeira	Portugal	73.87	65.07	-11.9%

Source: Author’s calculations based on Eurostat data (dated 26-05-15, extracted 19-10-15)

Moreover, most of these regions also increased their R&D intensity over these periods, i.e. level of R&D investment as a percentage of GDP. However, as Figure 6.1 shows, investment as a percentage of GDP in most regions was still well below the EU-15 average, even up to 2012, so growth in these regions occurred against the backdrop of a low base of existing R&D investment activity.

Figure 6.1: R&D Investment as a % of GDP in Lagging Regions 2000, 2007 and 2012



Source: Eurostat data (dated 03-02-17, extracted 06-02-17)

6.3.3 R&D Investment in the Business Sector

Table 6.3 provides details of average annual business R&D investment and growth per capita for 20 lagging regions between the 1994-99 and 2000-07 periods. As in the case of total R&D investment, it suggests that growth in business R&D investment was very strong in Spanish regions between the 1994-99 and 2000-07 periods, with many regions increasing their average annual investment by more than 100%. Strong growth was also recorded in the Norte region in Portugal and in some Italian regions (e.g. Sicily, Basilicata), but with little business investment growth in other Italian regions (e.g. Molise, Sardinia). Moreover, strong growth in some regions (e.g. Azores, Extremadura, Calabria) also has to be viewed from the context of a very low base of existing business R&D investment activity, even when compared to other lagging regions.

Table 6.3: Average Business R&D Investment per Capita in Lagging Regions 1994-99 and 2000-07

Region	Country	Average R&D Investment per Capita 1994-99 (PPS)	Average R&D Investment per Capita 2000-07 (PPS)	Average R&D Investment per Capita Growth (%)
Região Autónoma dos Açores	Portugal	0.37	1.74	364.8%
Extremadura	Spain	5.16	16.60	221.9%
Galicia	Spain	19.38	62.03	220.0%
Castilla y León	Spain	32.29	99.11	207.0%
Canarias	Spain	8.99	27.32	203.9%
Sicilia	Italy	11.63	31.14	167.7%
Norte	Portugal	14.35	36.20	152.2%
Calabria	Italy	1.37	3.40	148.1%
Principado de Asturias	Spain	27.34	64.71	136.7%
Basilicata	Italy	14.11	30.58	116.8%
Comunidad Valenciana	Spain	30.61	65.17	112.9%
Región de Murcia	Spain	27.75	58.88	112.2%
Andalucía	Spain	21.99	46.16	109.9%
Campania	Italy	39.77	63.73	60.3%
Cantabria	Spain	32.35	44.21	36.7%
Algarve	Portugal	4.20	4.94	17.5%
Puglia	Italy	19.80	23.22	17.3%
Castilla-la Mancha	Spain	36.77	37.79	2.8%
Molise	Italy	10.60	10.62	0.2%
Sardegna	Italy	12.41	9.47	-23.6%

Source: Author's calculations based on Eurostat data (dated 16-05-15, extracted 02-11-15)

Table 6.4, meanwhile, provides details of average annual business R&D investment and growth for 21 lagging regions between the 2000-07 and 2008-12 periods. It shows that business investment in R&D was very strong in the Norte region in Portugal between these periods, with many Spanish regions also showing strong growth in business investment. Growth in business investment in R&D in Italian regions was less strong, however, while growth in some regions (e.g. Azores, Algarve, Madeira, Calabria) should again be viewed from the context of a very low base of existing business R&D investment activity.

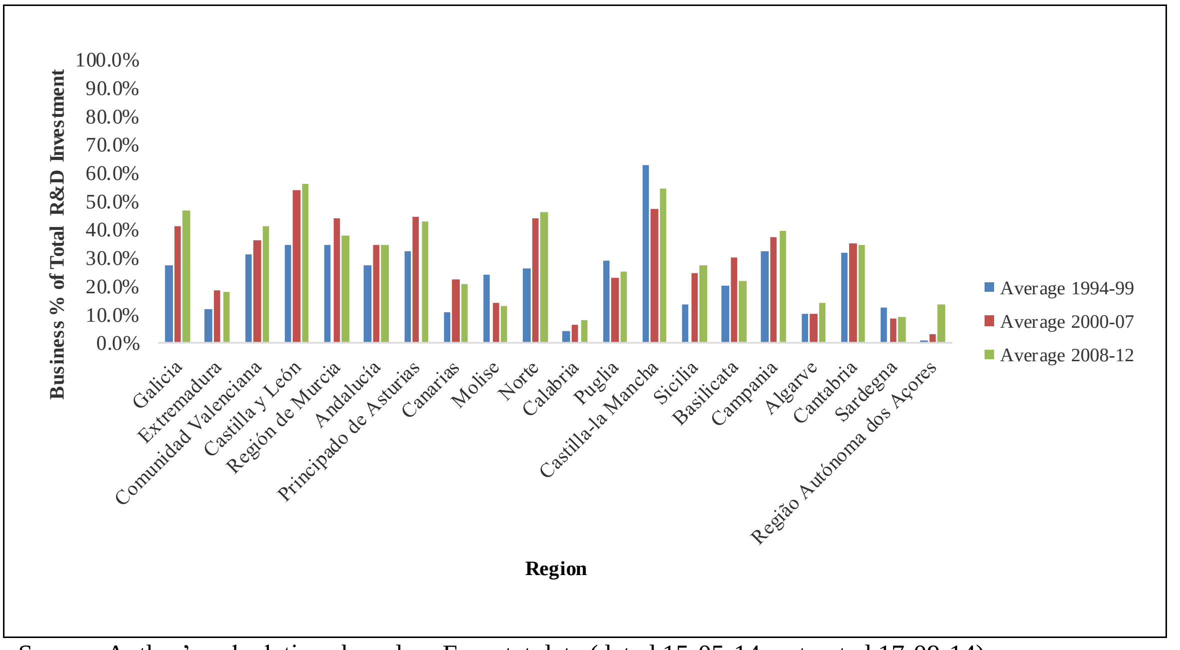
Table 6.4: Average Business R&D Investment per Capita in Lagging Regions 2000-07 and 2008-12

Region	Country	Average R&D Investment per Capita 2000-07 (PPS)	Average R&D Investment per Capita 2008-12 (PPS)	Average R&D Investment per Capita Growth (%)
Região Autónoma dos Açores	Portugal	1.74	12.43	615.4%
Norte	Portugal	36.20	99.48	174.8%
Algarve	Portugal	4.94	11.02	123.2%
Cantabria	Spain	44.21	84.31	90.7%
Castilla-la Mancha	Spain	37.79	66.49	75.9%
Região Autónoma da Madeira	Portugal	7.12	12.27	72.3%
Extremadura	Spain	16.60	24.04	44.9%
Calabria	Italy	3.40	4.91	44.5%
Andalucía	Spain	46.16	66.44	43.9%
Castilla y León	Spain	99.11	141.12	42.4%
Galicia	Spain	62.03	88.22	42.2%
Principado de Asturias	Spain	64.71	90.52	39.9%
Comunidad Valenciana	Spain	65.17	87.51	34.3%
Puglia	Italy	23.22	28.76	23.8%
Campania	Italy	63.73	73.95	16.0%
Sicilia	Italy	31.14	34.80	11.8%
Sardegna	Italy	9.47	10.48	10.6%
Región de Murcia	Spain	58.88	62.55	6.2%
Molise	Italy	10.62	10.35	-2.6%
Canarias	Spain	27.32	24.33	-10.9%
Basilicata	Italy	30.58	19.77	-35.4%

Source: Author's calculations based on Eurostat data (dated 16-05-15, extracted 02-11-15)

However, trends in business R&D investment must also be viewed in the context of its relative importance within total R&D investment. Figure 6.2, for example, shows the share of total R&D investment (in PPS terms) that was attributable to the business sector, for 20 of the regions, across the three time periods. It shows that the business share of total R&D investment was generally quite low in the regions, relative to more advanced regions, with its share in the 2008-12 period ranging from as low as 8% (Calabria) up to as high as 56% (Castilla y León). Average business share of R&D investment across the EU-15 in the same period, on the other hand, was 63%.

Figure 6.2: Business % of Total R&D Investment in Lagging Regions 1994-99, 2000-07 and 2008-12



Source: Author's calculations based on Eurostat data (dated 15-05-14, extracted 17-09-14)

6.3.4 Total R&D Personnel

Table 6.5 looks at average R&D personnel levels and growth in per capita terms (per million population) in the full sample of 22 lagging regions between the 1994-99 and 2000-07 periods.

The table shows results that are broadly similar to Table 6.1 in Section 6.3.2 (regarding annual average R&D investment per capita in the same periods). In particular, it shows that R&D personnel growth was especially strong among Spanish regions between the 1994-99 and 2000-07 periods, whereas Italian and Portuguese regions generally showed lower levels of growth in R&D personnel over this time.

Table 6.5: Average R&D Personnel per Million Population in Lagging Regions 1994-99 and 2000-07

Region	Country	Average R&D Personnel per Million Pop 1994-99 (FTE)	Average R&D Personnel per Million Pop 2000-07 (FTE)	Average R&D Personnel per Million Pop Growth (%)
Comunidad Valenciana	Spain	1,514	3,118	105.9%
Región de Murcia	Spain	1,383	2,749	98.7%
Galicia	Spain	1,372	2,719	98.2%
Molise	Italy	600	1,174	95.7%
Principado de Asturias	Spain	1,329	2,561	92.7%
Castilla y León	Spain	1,720	3,141	82.7%
Andalucía	Spain	1,372	2,275	65.9%
Extremadura	Spain	890	1,466	64.6%
Corsica	France	543	887	63.3%
Castilla-la Mancha	Spain	707	1,143	61.7%
Calabria	Italy	486	781	60.8%
Canarias	Spain	1,376	2,204	60.2%
Norte	Portugal	1,138	1,719	51.1%
Puglia	Italy	947	1,403	48.2%
Sicilia	Italy	1,167	1,592	36.4%
Basilicata	Italy	1,077	1,416	31.5%
Cantabria	Spain	1,558	2,023	29.8%
Campania	Italy	1,580	2,029	28.4%
Algarve	Portugal	905	1,123	24.2%
Região Autónoma dos Açores	Portugal	1,241	1,491	20.2%
Sardegna	Italy	1,478	1,647	11.5%
Região Autónoma da Madeira	Portugal	1,424	1,144	-19.6%

Note: EU-15 average not available for 1994-99 period.

Source: Author’s calculations based on Eurostat data (dated 15-05-14, extracted 22-08-14)

Table 6.6, meanwhile, examines average R&D personnel levels and growth in per capita terms in the same lagging regions between the 2000-07 and 2008-12 periods. Again, it shows results that are similar to Table 6.2 in Section 6.3.2 (regarding annual average R&D investment per capita in the same periods), with personnel growth being strongest in Portuguese regions (e.g. Norte, Algarve), followed by Spanish regions. Growth in R&D personnel in Italian regions, however, was somewhat lower between the 2000-07 and 2008-12 periods, though it should be noted that most lagging regions in the sample still recorded growth levels that were above the EU-15 average between the two periods.

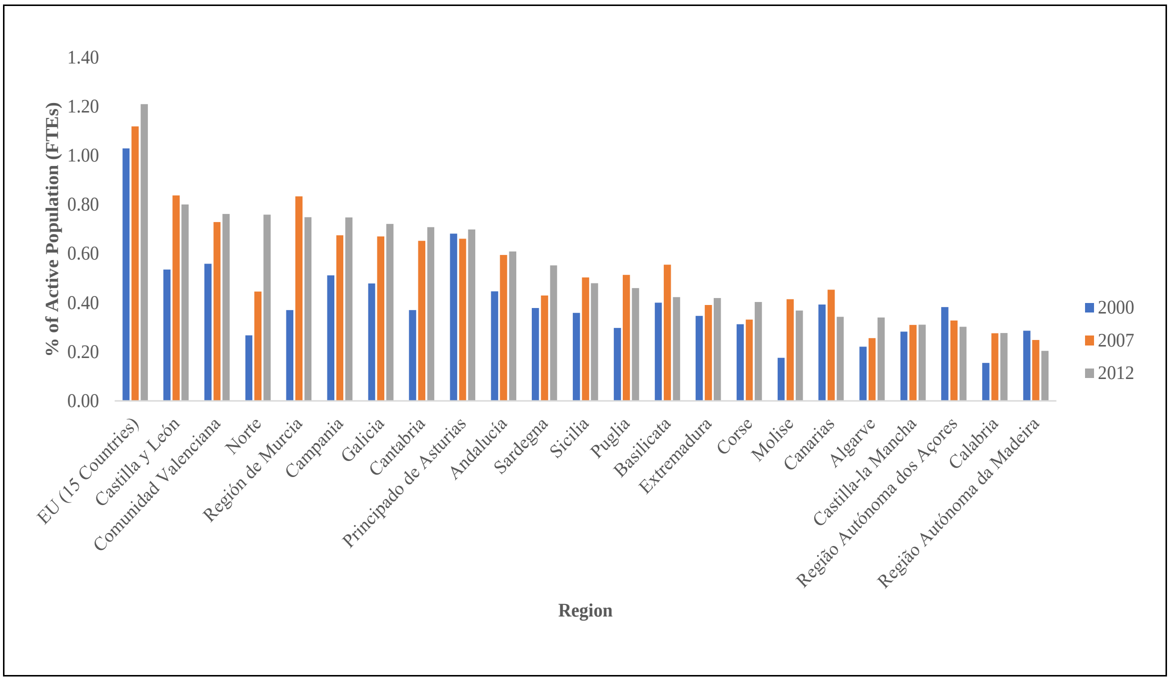
Table 6.6: Average R&D Personnel per Million Population in Lagging Regions 2000-07 and 2008-12

Region	Country	Average R&D Personnel per Million Pop 2000-07 (FTE)	Average R&D Personnel per Million Pop 2008-12 (FTE)	Average R&D Personnel per Million Pop Growth (%)
Norte	Portugal	1,719	3,919	128.0%
Algarve	Portugal	1,123	2,111	88.0%
Cantabria	Spain	2,023	3,532	74.6%
Región de Murcia	Spain	2,749	3,972	44.5%
Castilla-la Mancha	Spain	1,143	1,621	41.9%
Extremadura	Spain	1,466	2,047	39.7%
Galicia	Spain	2,719	3,621	33.2%
Principado de Asturias	Spain	2,561	3,392	32.5%
Andalucía	Spain	2,275	2,998	31.8%
Região Autónoma da Madeira	Portugal	1,144	1,449	26.6%
Basilicata	Italy	1,416	1,785	26.1%
Comunidad Valenciana	Spain	3,118	3,925	25.9%
Corsica	France	887	1,105	24.5%
Molise	Italy	1,174	1,456	24.0%
Sardegna	Italy	1,647	2,039	23.8%
Castilla y León	Spain	3,141	3,882	23.6%
Calabria	Italy	781	939	20.3%
Puglia	Italy	1,403	1,679	19.7%
Campania	Italy	2,029	2,392	17.9%
EU (15 Countries)		4,995	5,734	14.8%
Região Autónoma dos Açores	Portugal	1,491	1,683	12.9%
Sicilia	Italy	1,592	1,699	6.7%
Canarias	Spain	2,204	2,014	-8.6%

Source: Author’s calculations based on Eurostat data (dated 30-03-15, extracted 02-11-15)

Furthermore, similar to the trends evident for R&D investment as a percentage of GDP, many regions also increased their R&D intensity in terms of levels of R&D personnel, i.e. when expressed as a percentage of the active population. At the same time, however, Figure 6.3 shows a similar trend to that shown in Figure 6.1 (Section 6.3.2), with R&D personnel as a percentage of the active population in most lagging regions still lying well below the EU-15 average, which means that personnel growth in these regions again occurred against the backdrop of a low base of existing activity.

Figure 6.3: R&D Personnel (FTEs) as a % of Active Population in Lagging Regions 2000, 2007 and 2012



Source: Eurostat data (dated 03-02-17, extracted 09-02-17)

6.3.5 R&D Personnel in the Business Sector

Table 6.7 provides details of average annual business R&D personnel and growth (again expressed per million population) for 19 of the regions between the 1994-99 and 2000-07 periods. As with the case of total R&D personnel, it again suggests that growth in business R&D personnel was generally strongest in Spanish regions between these periods, with growth in Italian and Portuguese regions being generally less strong. However, it is notable that many regions increased their average levels of business R&D personnel by more than 100% between the periods, including regions such as Norte (Portugal) and Sicily (Italy), albeit from low bases of existing activity in some cases (relative to other lagging regions).

Table 6.7: Average Business R&D Personnel per Million Population in Lagging Regions 1994-99 and 2000-07

Region	**Country**	**Average R&D Personnel per Million Pop 1994-99 (FTE)**	**Average R&D Personnel per Million Pop 2000-07 (FTE)**	**Average R&D Personnel per Million Pop Growth (%)**
Galicia	Spain	250	854	242.3%
Extremadura	Spain	72	243	238.0%
Castilla y León	Spain	343	1,067	211.3%
Basilicata	Italy	142	405	186.0%
Canarias	Spain	90	257	183.8%
Principado de Asturias	Spain	268	760	183.5%
Comunidad Valenciana	Spain	406	1,093	169.3%
Algarve	Portugal	37	91	144.2%
Andalucía	Spain	241	582	141.0%
Región de Murcia	Spain	324	760	134.2%
Norte	Portugal	225	493	119.4%
Castilla-la Mancha	Spain	215	460	114.4%
Sicilia	Italy	144	297	106.9%
Calabria	Italy	22	45	103.6%
Cantabria	Spain	332	649	95.7%
Campania	Italy	395	571	44.4%
Sardegna	Italy	118	159	35.1%
Puglia	Italy	219	277	26.6%
Molise	Italy	114	126	10.4%

Source: Author's calculations based on Eurostat data (dated 15-05-14, extracted 22-08-14)

Table 6.8, meanwhile, provides details of average annual business R&D personnel and growth in the regions in the 2000-07 and 2008-12 periods. This table shows that growth in business R&D personnel was strongest in some of the Portuguese and Italian regions between these periods, although the existing base level of R&D personnel in some of the regions (e.g. Azores, Algarve, Calabria, Molise) was low when compared to other lagging regions. Many Spanish regions also continued to show reasonably strong growth, however, to build on the trends evident between the 1994-99 and 2000-07 periods.

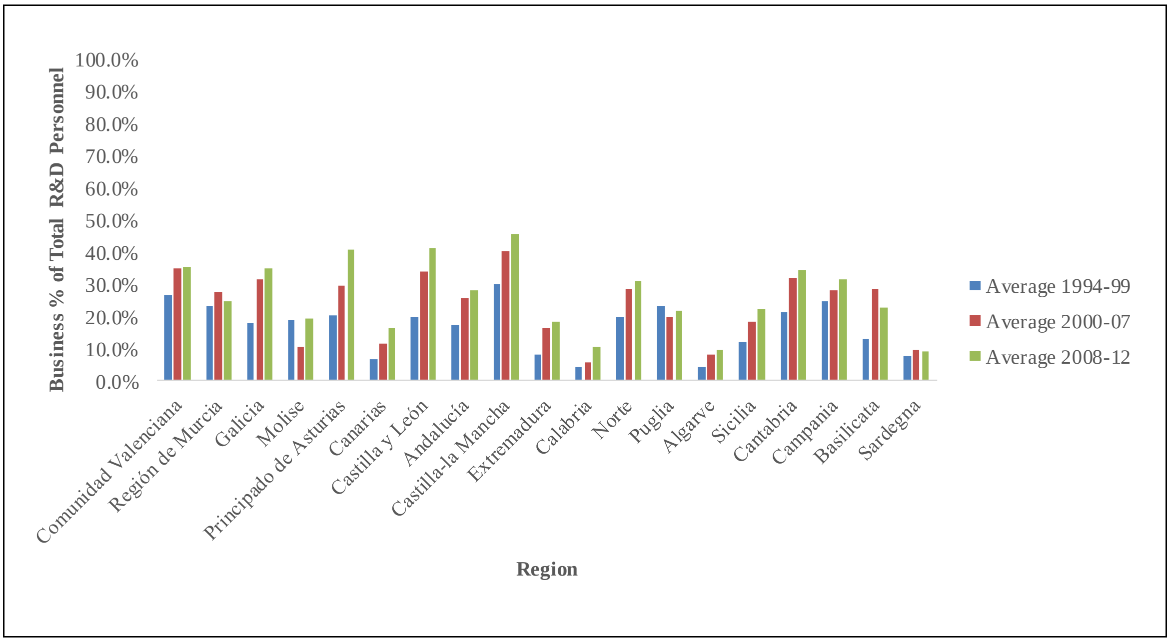
Table 6.8: Average Business R&D Personnel per Million Population in Lagging Regions 2000-07 and 2008-12

Region	Country	Average R&D Personnel per Million Pop 2000-07 (FTE)	Average R&D Personnel per Million Pop 2008-12 (FTE)	Average R&D Personnel per Million Pop Growth (%)
Região Autónoma dos Açores	Portugal	32	122	279.1%
Norte	Portugal	493	1,250	153.5%
Algarve	Portugal	91	208	127.9%
Molise	Italy	126	271	115.9%
Calabria	Italy	45	96	113.0%
Cantabria	Spain	649	1,223	88.5%
Principado de Asturias	Spain	760	1,391	82.9%
Castilla-la Mancha	Spain	460	753	63.5%
Região Autónoma da Madeira	Portugal	124	201	62.9%
Extremadura	Spain	243	392	61.1%
Castilla y León	Spain	1,067	1,635	53.1%
Galicia	Spain	854	1,285	50.4%
Andalucía	Spain	582	856	47.2%
Campania	Italy	571	793	38.9%
Puglia	Italy	277	379	36.5%
Región de Murcia	Spain	760	1,002	31.9%
Canarias	Spain	257	333	29.6%
Comunidad Valenciana	Spain	1,093	1,390	27.2%
Sicilia	Italy	297	381	28.3%
Sardegna	Italy	159	181	13.5%
Basilicata	Italy	405	363	-10.3%

Source: Author’s calculations based on Eurostat data (dated 30-03-15, extracted 02-11-15)

However, trends in business R&D personnel must again be viewed in the context of its relative importance within total R&D personnel. In this regard, Figure 6.4 shows the share of total R&D personnel that was attributable to the business sector, for 19 regions, across the three time periods. In this regard, similar to the patterns evident for business share of total R&D investment, it also shows that the business share of total R&D personnel has generally been quite low in the regions, relative to more advanced regions, with its share in the 2008-12 period ranging from as low as 9% (Sardinia) up to as high as 46% (Castilla-la Mancha). Average business share of R&D personnel across the EU-15 in the same period, on the other hand, was 54%.

Figure 6.4: Business % of Total R&D Personnel in Lagging Regions 1994-99, 2000-07 and 2008-12



Source: Author's calculations based on Eurostat data (dated 15-05-14, extracted 22-08-14)

6.4 Innovation Performance – Output Indicators

6.4.1 Overview

This section covers the analysis of innovation performance in lagging regions, based on the following output indicators:

- total patent applications per capita;
- employment per capita in high/medium-high technology manufacturing (FTEs);
- employment per capita in knowledge intensive services (FTEs);
- employment per capita in high technology sectors (FTEs).

Again, for each indicator, the EU-15 average performance is also provided, for comparative purposes, where this is available.

6.4.2 Patent Applications

Table 6.9 examines average annual patent applications in per capita terms (expressed per million population) and growth in applications for 20 lagging regions between the 1994-99 and 2000-07 periods. The data shows that growth in patent applications in the regions was generally impressive between the two periods, with most regions achieving growth above the EU-15 average. The highest growth in average patent applications between the two periods occurred in the Norte region in Portugal as well as in the Spanish regions of Galicia, Castilla-la Mancha, Región de Murcia and Castilla y León. Other regions achieving growth of 100% of more, meanwhile, included the Spanish regions of Principado de Asturias, Andalucía and Canarias, and the Italian regions of Calabria, Puglia and Campania. The only regions achieving growth below the EU-15 average, on the other hand, were the Italian regions of Sicily and Basilicata.

Table 6.9: Patent Applications per Million Population in Lagging Regions 1994-99 and 2000-07

Region	Country	Average Patent Applications per Million Pop 1994-99	Average Patent Applications per Million Pop 2000-07	Average Patent Applications per Million Pop Growth (%)
Norte	Portugal	1.47	7.10	382.1%
Galicia	Spain	3.10	8.57	176.4%
Castilla-la Mancha	Spain	3.04	8.33	173.7%
Región de Murcia	Spain	3.69	10.03	172.0%
Castilla y León	Spain	5.47	14.45	164.3%
Calabria	Italy	2.81	6.15	119.3%
Puglia	Italy	5.36	11.64	117.0%
Principado de Asturias	Spain	5.64	12.04	113.3%
Campania	Italy	5.97	12.67	112.2%
Andalucía	Spain	3.27	6.78	107.2%
Canarias	Spain	2.47	4.97	101.4%
Corsica	France	5.66	10.46	84.7%
Cantabria	Spain	5.49	9.68	76.2%
Algarve	Portugal	2.19	3.75	71.2%
Comunidad Valenciana	Spain	13.23	22.59	70.7%
Sardegna	Italy	6.11	9.13	49.5%
Extremadura	Spain	1.75	2.57	47.0%
Molise	Italy	5.15	7.30	41.6%
EU (15 Countries)		103.17	140.09	35.8%
Sicilia	Italy	10.34	13.54	30.9%
Basilicata	Italy	8.77	7.54	-14.1%

Note: EU-15 average calculated based on the sum of patent applications for the EU-15 member states.
Source: Author's calculations based on Eurostat data (dated 30-01-14, extracted 29-08-14)

Table 6.10 examines average annual patent applications and growth in applications for the same 20 regions between the 2000-07 and 2008-11 periods. In contrast to Table 6.9, it shows that growth in patent applications was less impressive than between the 1994-99 and 2000-07 periods, with several of the regions in the sample growing at less than the EU-15 average, which itself effectively showed no growth. Nonetheless, there were still also several regions that showed positive growth, well above the EU-15 average, including Spanish regions such as Cantabria, Galicia, Principado de Asturias, Andalucía and Región de Murcia, the Portuguese regions of Norte and Algarve, and the Italian regions of Basilicata, Sardinia, Puglia and Campania.

Table 6.10: Patent Applications per Million Population in Lagging Regions 2000-07 and 2008-11

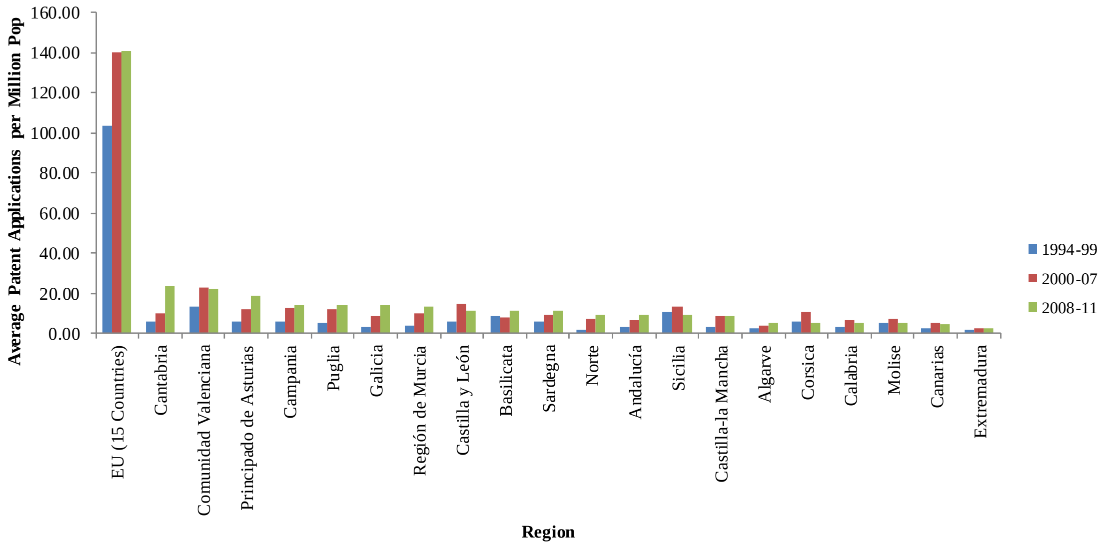
Region	Country	Average Patent Applications per Million Pop 2000-07	Average Patent Applications per Million Pop 2008-11	Average Patent Applications per Million Pop Growth (%)
Cantabria	Spain	9.68	23.65	144.3%
Galicia	Spain	8.57	13.73	60.3%
Principado de Asturias	Spain	12.04	18.57	54.3%
Basilicata	Italy	7.54	11.33	50.3%
Algarve	Portugal	3.75	5.33	42.2%
Andalucía	Spain	6.78	9.12	34.6%
Región de Murcia	Spain	10.03	13.25	32.1%
Norte	Portugal	7.10	9.25	30.3%
Sardegna	Italy	9.13	11.26	23.4%
Puglia	Italy	11.64	14.10	21.1%
Campania	Italy	12.67	14.11	11.4%
EU (15 Countries)		140.09	140.46	0.3%
Castilla-la Mancha	Spain	8.33	8.30	-0.3%
Comunidad Valenciana	Spain	22.59	22.41	-0.8%
Extremadura	Spain	2.57	2.28	-11.6%
Canarias	Spain	4.97	4.26	-14.4%
Calabria	Italy	6.15	5.02	-18.5%
Castilla y León	Spain	14.45	11.46	-20.7%
Molise	Italy	7.30	4.93	-32.4%
Sicilia	Italy	13.54	8.92	-34.1%
Corsica	France	10.46	5.23	-50.0%

Note: EU-15 average calculated based on the sum of patent applications for the EU-15 member states.

Source: Author’s calculations based on Eurostat data (dated 26-01-16, extracted 09-05-16)

As in the cases of R&D investment and R&D personnel, however, despite an increase in patent activity, patent applications per million population in most of the regions were again still well below the EU-15 average in the period under review (see Figure 6.5). In the sample of regions being studied here, for example, the highest level of patent activity, based on 2008-11 data, was at just 17% of the EU-15 average.

Figure 6.5: Average Patent Applications per Million Population in Lagging Regions



Note: EU-15 average calculated from Eurostat data based on the sum of patent applications and population for the EU-15 member states.

Source: Author's calculations based on Eurostat data (dated 26-01-16, extracted 09-05-16)

Lastly, in the context of patents, it should be noted that there is much discussion in the research literature about the extent to which a time lag exists between research inputs (such as R&D investment) and research outputs (such as patent applications), i.e. the period of time one might expect to elapse between the consumption of inputs and the production of outputs. In this regard, studies by Greif (1985), Kondo (1999), Watanabe, Tsuji and Griffy-Brown (2001), Wang and Huang (2007), Niebuhr (2010), Roman (2010), Fornahl, Broekel and Boschma (2011), Thomas, Sharma and Jain (2011) and Schwartz, Peglow, Fritsch and Günther (2012) have all adopted a time lag between R&D investment and patent applications of between 1-4 years. However, Hall, Griliches and Hausman (1984) and Peters, Schneider, Griesshaber and Hoffman (2012), in contrast, found no evidence for a time lag between R&D investment and patents. For the purposes of this research, therefore, growth in average annual patent applications per capita was also examined on the basis of a one year time lag between inputs and outputs, yet the results did not differ markedly from those in Table 6.9 and Table 6.10.

6.4.3 Employment – High and Medium-High Technology Manufacturing

Table 6.11 examines average annual employment per capita (per million population) in high and medium-high technology manufacturing, and growth in employment, for 17 lagging regions between 1994-99 and 2000-07 periods. The data shows several Spanish regions, including Castilla-la Mancha, Principado de Asturias, Galicia, Región de Murcia, Andalucía and Castilla y León ranking highly in terms of average employment growth for this sector. However, a number of Italian regions, such as Calabria and Basilicata also showed positive growth between the periods. Lesser performing regions in terms of average employment growth, meanwhile, included Sicily, Sardinia and Campania (Italy) and the Norte region (Portugal), though most regions out-performed average EU-15 growth between the two periods, which was a decline of 2%.

Table 6.11: Average Employment in High and Medium-High Technology Manufacturing (per Million Population) in Lagging Regions 1994-99 and 2000-07

Region	Country	Average Employment per Million Pop 1994-99	Average Employment per Million Pop 2000-07	Average Employment per Million Pop Growth (%)
Principado de Asturias	Spain	7,386	10,610	43.7%
Castilla-la Mancha	Spain	6,876	9,839	43.1%
Calabria	Italy	3,107	4,432	42.6%
Basilicata	Italy	16,846	23,338	38.5%
Galicia	Spain	13,996	19,217	37.3%
Región de Murcia	Spain	9,125	12,304	34.8%
Andalucía	Spain	6,253	8,194	31.0%
Castilla y León	Spain	14,319	18,522	29.4%
Molise	Italy	19,207	23,606	22.9%
Puglia	Italy	9,004	10,824	20.2%
Cantabria	Spain	21,307	24,766	16.2%
Canarias	Spain	2,826	3,276	15.9%
Comunidad Valenciana	Spain	13,626	15,633	14.7%
Sicilia	Italy	6,419	6,830	6.4%
Sardegna	Italy	7,648	8,096	5.9%
Campania	Italy	12,762	13,195	3.4%
EU (15 Countries)		31,185	30,561	-2.0%
Norte	Portugal	18,227	16,204	-11.1%

Note: Based on NACE Rev 1.1 classifications.
Source: Author’s calculations based on Eurostat data (dated 26-06-13, extracted 29-08-14)

As noted in Section 6.2.2, average employment in the 2000-07 period cannot be compared to average employment in the period from 2008 onwards due to changes in the European NACE codes. Therefore, Table 6.12 shows per capita employment growth in high and medium-high technology manufacturing for 18 regions between 2008 and 2012. This data, which has to be viewed within the context of the financial and economic crisis that damaged the world economy from 2008, shows a decline in employment in the sector across the EU-15, and also very little employment growth in lagging regions.

Table 6.12: Employment Trends in High and Medium-High Technology Manufacturing (per Million Population) in Lagging Regions 2008-12

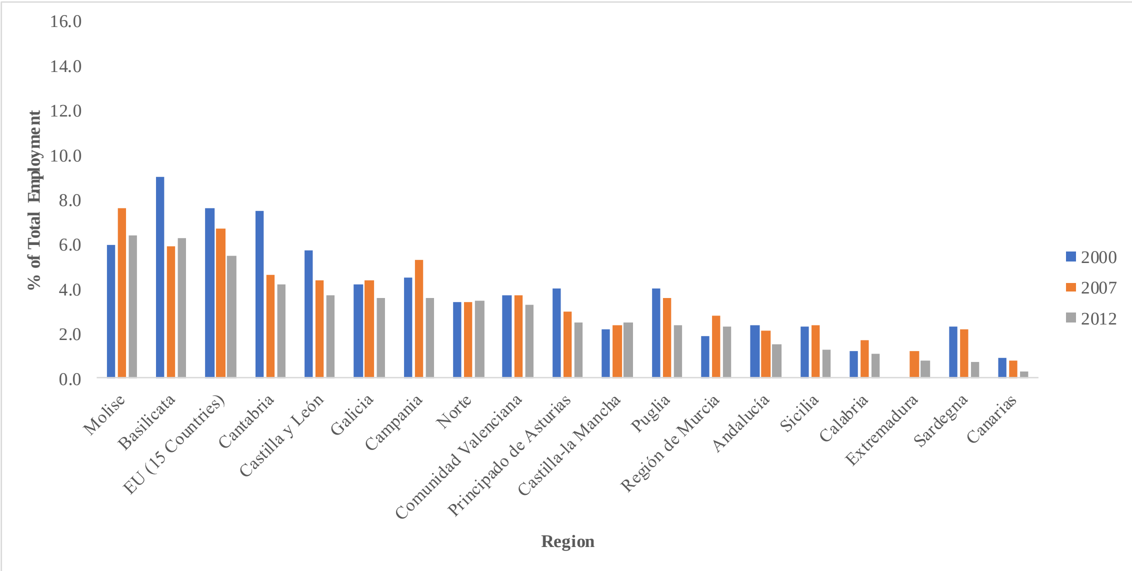
Region	Country	Employment per Million Pop 2008	Employment per Million Pop 2012	Employment Growth per Million Pop 2008-12 (%)
Extremadura	Spain	2,753	3,622	31.6%
Calabria	Italy	2,533	3,064	21.0%
Comunidad Valenciana	Spain	13,393	14,771	10.3%
Molise	Italy	22,036	22,354	1.4%
Basilicata	Italy	18,808	19,046	1.3%
Galicia	Spain	15,609	15,513	-0.6%
Región de Murcia	Spain	10,567	10,260	-2.9%
Puglia	Italy	7,672	7,407	-3.5%
Norte	Portugal	15,592	14,916	-4.3%
Castilla-la Mancha	Spain	8,859	8,072	-8.9%
Castilla y León	Spain	16,524	14,974	-9.4%
EU (15 Countries)		26,398	23,834	-9.7%
Cantabria	Spain	22,520	18,569	-17.5%
Campania	Italy	11,999	9,888	-17.6%
Sardegna	Italy	3,049	2,442	-19.9%
Sicilia	Italy	4,818	3,800	-21.1%
Andalucía	Spain	6,036	4,416	-26.8%
Canarias	Spain	2,008	1,438	-28.4%
Principado de Asturias	Spain	11,204	5,585	-50.2%

Note: Based on NACE Rev 2 classifications. EU-15 average calculated from Eurostat data based on the sum of employment for the EU-15 member states.

Source: Author's calculations based on Eurostat data (dated 06-10-15, extracted 02-11-15)

In most of the regions, the share of total employment that was attributable to high and medium-high technology manufacturing during the period was also relatively low. In this regard, for example, Figure 6.6 shows that the sector's share of employment was below the EU-15 average for most of the regions in the sample, even in the most recent period. Only two regions, the Italian regions of Molise and Basilicata, countered this trend in 2012.

Figure 6.6: Employment in High and Medium-High Technology Manufacturing as a % of Total Employment in Lagging Regions



Source: Author's calculations based on Eurostat data (dated 24-01-17, extracted 16-02-17)

6.4.4 Employment – Knowledge Intensive Services

Table 6.13 examines average annual employment in knowledge intensive services (per million population) and growth in employment among the full sample of 22 regions between the 1994-99 and 2000-07 periods. It shows that there was employment growth across all the regions under review between the two periods, with growth ranging from between 5% and 50%, depending on the region.

Growth in average annual employment was again particularly strong in many Spanish regions, however, followed by growth in the smaller Portuguese regions (Algarve, Madeira) and the Italian regions. Moreover, growth in most of the regions in the sample again out-performed the EU-15 average for growth between the periods, which was about 17%.

Table 6.13: Average Employment in Knowledge Intensive Services (per Million Population) in Lagging Regions 1994-99 and 2000-07

Region	Country	Average Employment per Million Pop 1994-99	Average Employment per Million Pop 2000-07	Average Employment per Million Pop Growth (%)
Castilla-la Mancha	Spain	55,164	83,166	50.8%
Cantabria	Spain	66,189	96,612	46.0%
Galicia	Spain	62,089	88,576	42.7%
Andalucía	Spain	62,206	87,899	41.3%
Principado de Asturias	Spain	62,394	88,048	41.1%
Comunidad Valenciana	Spain	70,330	99,061	40.9%
Región de Murcia	Spain	61,204	86,016	40.5%
Extremadura	Spain	55,935	77,726	39.0%
Canarias	Spain	80,244	109,560	36.5%
Castilla y León	Spain	67,151	90,653	35.0%
Sardegna	Italy	71,048	94,666	33.2%
Região Autónoma da Madeira	Portugal	68,329	89,692	31.3%
Basilicata	Italy	63,371	82,703	30.5%
Sicilia	Italy	69,220	87,024	25.7%
Campania	Italy	70,614	86,430	22.4%
Algarve	Portugal	79,393	96,915	22.1%
Molise	Italy	74,833	89,805	20.0%
Puglia	Italy	67,588	80,843	19.6%
EU (15 Countries)		125,295	147,068	17.4%
Corsica	France	63,882	73,720	15.4%
Calabria	Italy	77,468	88,897	14.8%
Região Autónoma dos Açores	Portugal	75,378	83,799	11.2%
Norte	Portugal	79,234	82,841	4.6%

Note: Based on NACE Rev 1.1 classifications.
Source: Author’s calculations based on Eurostat data (dated 26-06-13, extracted 29-08-14)

Table 6.14 shows per capita employment growth in knowledge intensive services for the 22 regions between 2008 and 2012. This data, which again has to be viewed within the context of the financial and economic crisis that affected the world economy from 2008, shows a slight growth in employment in the sector across the EU-15, but with relatively few lagging regions showing employment growth above the EU-15 average. In this regard, Portuguese regions appeared to perform strongest in the period.

Table 6.14: Employment Trends in Knowledge Intensive Services (per Million Population) in Lagging Regions 2008-12

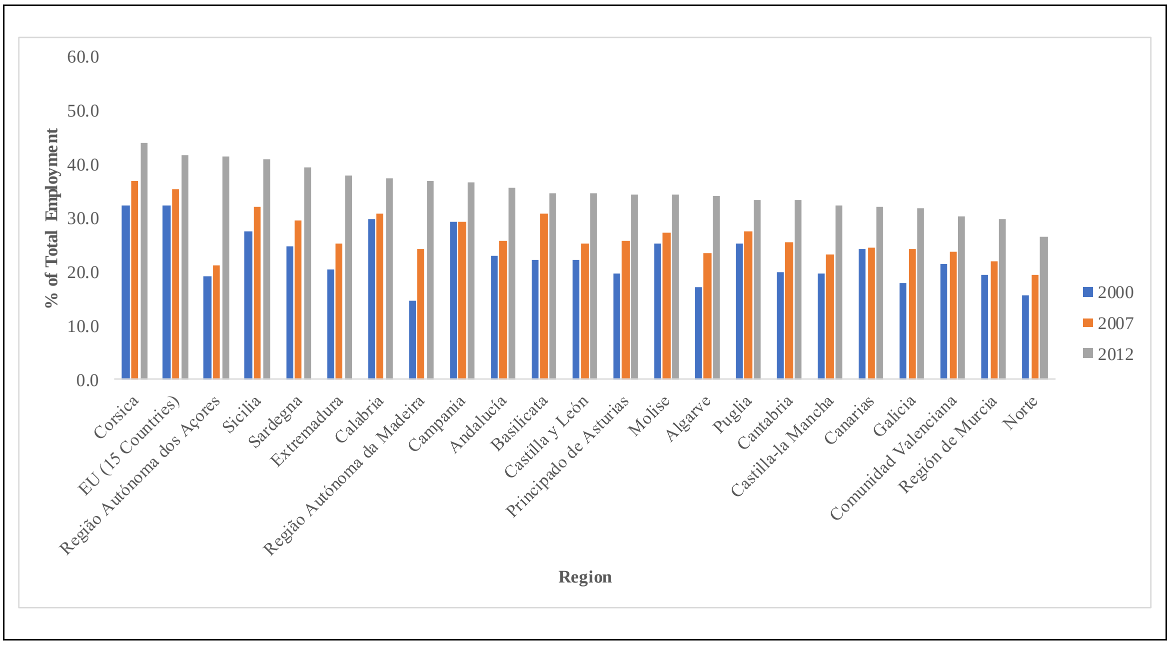
Region	Country	Employment per Million Pop 2008	Employment per Million Pop 2012	Employment Growth per Million Pop 2008-12 (%)
Região Autónoma dos Açores	Portugal	133,943	169,907	26.9%
Algarve	Portugal	128,867	143,453	11.3%
Norte	Portugal	105,920	113,364	7.0%
Sardegna	Italy	134,775	140,428	4.2%
Cantabria	Spain	124,726	129,983	4.2%
Comunidad Valenciana	Spain	110,185	113,581	3.1%
Principado de Asturias	Spain	124,174	127,524	2.7%
EU (15 Countries)		176,287	179,497	1.8%
Castilla y León	Spain	128,653	130,828	1.7%
Campania	Italy	99,821	100,964	1.1%
Região Autónoma da Madeira	Portugal	151,834	151,380	-0.3%
Región de Murcia	Spain	114,120	113,549	-0.5%
Sicilia	Italy	118,839	114,803	-3.4%
Castilla-la Mancha	Spain	121,073	114,913	-5.1%
Puglia	Italy	107,409	101,973	-5.1%
Andalucía	Spain	118,986	111,366	-6.4%
Molise	Italy	122,775	114,963	-6.4%
Calabria	Italy	112,965	104,676	-7.3%
Galicia	Spain	128,505	119,051	-7.4%
Basilicata	Italy	121,394	109,079	-10.1%
Canarias	Spain	129,019	112,659	-12.7%
Extremadura	Spain	135,823	116,812	-14.0%
Corsica	France	132,028	87,963	-33.4%

Note: Based on NACE Rev 2 classifications. EU-15 average calculated from Eurostat data based on the sum of employment for the EU-15 member states.

Source: Author’s calculations based on Eurostat data (dated 06-10-15, extracted 02-10-15)

Figure 6.7, meanwhile, shows that knowledge intensive services’ share of total employment in lagging regions has tended to be below the EU-15 average, i.e. similar to the trend for high and medium-high technology manufacturing. In 2012, for example, Corsica in France was the only region, among the sample being studied, where the sector’s share of total employment was above the EU-15 average.

Figure 6.7: Employment in Knowledge Intensive Services as a % of Total Employment in Lagging Regions



Source: Author's calculations based on Eurostat data (dated 24-01-17, extracted 16-02-17)

6.4.5 Employment – High Technology Sectors

Table 6.15 examines average annual employment in high technology sectors (per million population) and growth in employment for 16 of the regions between the 1994-99 and 2000-07 periods. It again shows the highest levels of average employment growth being achieved in Spanish regions, including Andalucía, Región de Murcia, Canarias, Castilla y León, Principado de Asturias, Comunidad Valenciana, Galicia and Castilla-la Mancha. Growth among Italian regions, meanwhile, was highest in Sardinia, Calabria, Puglia and Sicily, while all but three regions (Basilicata, Campania and Norte) achieved growth that was above the EU-15 average between the periods, which was 16%.

Table 6.15: Average Employment in High Technology Sectors (per Million Population) in Lagging Regions 1994-99 and 2000-07

Region	Country	Average Employment per Million Pop 1994-99	Average Employment per Million Pop 2000-07	Average Employment Growth per Million Pop (%)
Andalucía	Spain	3,832	7,391	92.9%
Región de Murcia	Spain	3,689	6,555	77.7%
Canarias	Spain	4,834	7,911	63.6%
Castilla y León	Spain	4,833	7,811	61.6%
Principado de Asturias	Spain	5,444	8,148	49.7%
Comunidad Valenciana	Spain	6,281	9,309	48.2%
Galicia	Spain	4,915	7,260	47.7%
Castilla-la Mancha	Spain	4,482	6,533	45.7%
Sardegna	Italy	6,583	9,135	38.8%
Calabria	Italy	5,682	7,828	37.8%
Extremadura	Spain	3,954	5,357	35.5%
Puglia	Italy	5,643	7,389	30.9%
Sicilia	Italy	5,951	7,620	28.1%
EU (15 Countries)		17,655	20,428	15.7%
Basilicata	Italy	6,647	7,641	14.9%
Campania	Italy	8,200	9,238	12.7%
Norte	Portugal	7,754	6,805	-12.2%

Note: Based on NACE Rev 1.1 classifications.

Source: Author's calculations based on Eurostat data (dated 26-06-13, extracted 29-08-14)

Table 6.16, on the other hand, shows per capita employment growth in high technology sectors for 17 of the regions studied between 2008 and 2012. It shows a slight decline in employment in high technology sectors across the EU-15, and relatively few lagging regions showing employment growth above the EU-15 average. Again, however, this data must be viewed within the context of the financial and economic crisis that affected the world economy from 2008. Regions that grew employment above the EU-15 average in the period included the Spanish regions of Cantabria, Principado de Asturias and Galicia and the Italian regions of Puglia and Campania.

Table 6.16: Employment Trends in High Technology Sectors (per Million Population) in Lagging Regions 2008-12

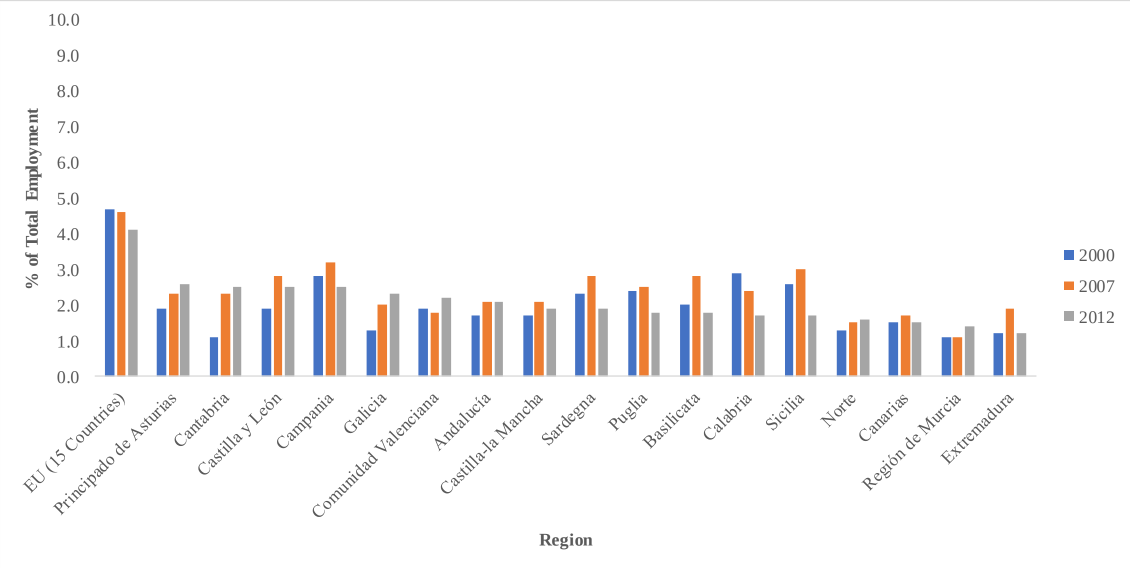
Region	Country	Employment per Million Pop 2008	Employment per Million Pop 2012	Employment Growth per Million Pop 2008-12 (%)
Cantabria	Spain	6,929	13,505	94.9%
Principado de Asturias	Spain	7,469	9,308	24.6%
Puglia	Italy	4,455	5,432	21.9%
Galicia	Spain	7,623	8,658	13.6%
Campania	Italy	6,261	6,766	8.1%
Calabria	Italy	4,559	4,596	0.8%
EU (15 Countries)		17,818	17,537	-1.6%
Norte	Portugal	7,527	6,780	-9.9%
Región de Murcia	Spain	6,340	5,472	-13.7%
Sicilia	Italy	5,621	4,800	-14.6%
Comunidad Valenciana	Spain	8,117	6,787	-16.4%
Castilla y León	Spain	10,623	8,669	-18.4%
Sardegna	Italy	8,538	6,716	-21.3%
Andalucía	Spain	7,514	5,849	-22.2%
Basilicata	Italy	6,839	5,194	-24.1%
Castilla-la Mancha	Spain	8,367	6,173	-26.2%
Canarias	Spain	5,020	2,876	-42.7%
Extremadura	Spain	6,424	2,717	-57.7%

Note: Based on NACE Rev 2 classifications. EU-15 average calculated from Eurostat data based on the sum of employment for the EU-15 member states.

Source: Author’s calculations based on Eurostat data (dated 06-10-15, extracted 02-11-15)

Figure 6.8, meanwhile, again shows that high technology sectors’ share of total employment in lagging regions, as with the case for both high and medium-high technology manufacturing and knowledge-intensive services, has tended to be below the EU-15 average. In 2012, for example, all regions among the sample being studied were below the EU-15 average in terms of sectoral share of total employment in this regard.

Figure 6.8: Employment in High Technology Sectors as a % of Total Employment in Lagging Regions



Source: Author's calculations based on Eurostat data (dated 24-01-17, extracted 16-02-17)

6.5 Categorisation of EU Fund Absorption in Lagging Regions

6.5.1 Introduction

Lastly, in addition to the data available on overall R&D investment at a regional level, past editions of the EU's Regional Innovation Scoreboard (see European Commission, 2012b, 2014b) have also sought to categorise EU regions based on the extent to which they have used Structural Funds for investment in R&D and innovation and their level of participation in the Framework Programmes for Research and Technological Development, e.g. FP6, FP7 (see Chapter 2). In this respect, these studies have therefore sought to give an overview of regions' absorption capacity regarding use of EU funds for R&D and innovation, and thereby contribute to investigation of the extent of the regional innovation paradox.

The rest of this section, therefore, looks at the findings for absorption capacity in lagging regions in this regard, with reference to both the 2000-06 and 2007-13 Structural Fund programming periods.

6.5.2 *Fund Absorption – 2000-06 Period*

Table 6.17 provides a categorisation of EU fund absorption in the 2000-06 period, i.e. expenditure of funds that were allocated for investment in R&D and innovation, for the sample of lagging regions under review, as per the analysis provided in the Regional Innovation Scoreboard 2012 (European Commission, 2012b). This analysis, which was derived from European Commission data on Structural Funds[24] and FP[25] expenditures (European Commission, 2012b), classified regions into four different categories as follows:

- *Framework Programme leading absorbers*, or regions with low use of Structural Funds for business innovation, but medium/high participation in FPs, with power to leverage other funds and FP participation from the private sector;
- *Structural Fund leading users*, or regions with medium/high use of Structural Funds for business innovation (including R&D) and services (including information and communication technologies and digital infrastructure and environmental technologies), but with low participation in FPs and low power to leverage other funds for FP participation;
- *full users/absorbers – but at lower levels*, or regions with medium/high use of Structural Funds for business innovation and services, but low use of funds for information and communication technologies and digital infrastructure and environmental technologies, low participation in FPs and low power to leverage other funds for FP participation, but medium to high importance of participation by SMEs in the private sector;

[24] Data on Structural Fund expenditure covered four main indicators, which reflected: framework conditions for business innovation (e.g. R&D infrastructure, research projects based in universities and research institutes); expenditure on information and communication technologies and digital infrastructure; expenditure on environmental technologies for eco-innovation; and expenditure on services for business innovation (e.g. advisory services, technology transfer, training).
[25] Data on FP expenditure covered four main indicators, which reflected: total amount of subsidies received (per annum, per capita); leverage power to raise additional funds to support FP projects; number of participations from the private sector (per thousand inhabitants); and percentage of SME participation in private sector involvement in the FPs.

- *low users/absorbers*, or regions with low use of Structural Funds for business innovation, low participation in FPs and low power to leverage other funds for FP participation (European Commission, 2012b).

"Framework Programme leading absorbers" tended to be more economically advanced regions, which would have lower eligibility for Structural Fund investment (and hence lower use of such funds), but which would nonetheless attract EU investment through the Framework Programmes, which are open to all EU regions and where funding is generally made available on a competitive basis. Lagging regions, on the other hand, tended to be categorised in one of the other three categories, depending on their level of Structural Fund expenditure on R&D and innovation. For example:

- average annual Structural Fund investment on R&D and innovation for "Structural Fund leading users" was estimated at €30.40 per capita per annum in the 2000-06 period;
- average annual Structural Fund investment on R&D and innovation for "full absorbers/users" was estimated at €23.90 per capita per annum in the 2000-06 period;
- average annual Structural Fund investment on R&D and innovation for "low absorbers/users" was estimated at €4.00 per capita per annum in the 2000-06 period.

Therefore, average annual Structural Fund investment in R&D and innovation was estimated to be at least six times higher in "Structural Fund leading users" and "full absorbers/users" than it was in "low absorbers/users" during the 2000-06 period, so the categorisation gives some sense of which regions devoted the most resources to investment in R&D and innovation during the 2000-06 period. In this regard, Table 6.17 shows that most Spanish and Portuguese regions in the research sample were classified as "full users/absorbers – at low levels", while most Italian regions were classified as "low users/absorbers". Exceptions to this were Sicily (Italy) and Madeira (Portugal), which were both classified as "Structural Fund leading users".

Table 6.17: Categorisation of EU Fund Absorption in Objective 1 Regions in the 2000-06 Period

Region	Country	Fund Absorption Category (RIS 2012 Rankings)
Sicilia	Italy	Structural Fund leading user
Região Autónoma da Madeira	Portugal	Structural Fund leading user
Galicia	Spain	Full user/absorber – lower levels
Principado de Asturias	Spain	Full user/absorber – lower levels
Castilla y León	Spain	Full user/absorber – lower levels
Castilla-la Mancha	Spain	Full user/absorber – lower levels
Extremadura	Spain	Full user/absorber – lower levels
Comunidad Valenciana	Spain	Full user/absorber – lower levels
Andalucía	Spain	Full user/absorber – lower levels
Región de Murcia	Spain	Full user/absorber – lower levels
Canarias	Spain	Full user/absorber – lower levels
Norte	Portugal	Full user/absorber – lower levels
Algarve	Portugal	Full user/absorber – lower levels
Cantabria	Spain	Low user/absorber
Corsica	France	Low user/absorber
Molise	Italy	Low user/absorber
Campania	Italy	Low user/absorber
Puglia	Italy	Low user/absorber
Basilicata	Italy	Low user/absorber
Calabria	Italy	Low user/absorber
Sardegna	Italy	Low user/absorber
Região Autónoma dos Açores	Portugal	Low user/absorber

Source: European Commission (2012b)

6.5.3 Fund Absorption – 2007-13 Period

Table 6.18 provides a similar categorisation of the sample of regions in the 2007-13 period, based on a similar analysis provided in the Regional Innovation Scoreboard 2014 (European Commission, 2014b). This analysis was again derived from European Commission data on Structural Funds[26] and FP[27] expenditures, and it classified regions into five different categories as follows:

[26] Data on Structural Fund expenditure covered two main indicators, which reflected: research and technological activities (e.g. R&D activities in research centres, R&D infrastructure, centres of competence, assistance to R&D, investment in R&D firms); and services for business innovation and commercialisation (e.g. technology transfer, advanced support services for firms, measures to stimulate research, innovation and entrepreneurship in SMEs, training and networking for SMEs).
[27] Data on FP expenditure again covered the four main indicators of: total amount of subsidies received (per annum, per capita); leverage power to raise additional funds to support FP projects; number of participations from the private sector (per thousand inhabitants); and percentage of SME participation in private sector involvement in the FPs.

- *Framework Programme leading absorbers*, with medium/high to very high participation in FPs;
- *Structural Fund leading users – research and technological*, with high use of Structural Funds for research and technological activities;
- *Structural Fund leading users – business innovation and commercialisation*, with high use of Structural Funds for support services for business innovation and commercialisation;
- *Structural Fund leading users – all types*, with medium/high use of Structural Funds for both research and technological activities and services for business innovation and commercialisation;
- *Structural Fund low users*, with low rates of Structural Fund use for research, technological development and innovation priorities (European Commission, 2014b).

Under this classification, "Framework Programme leading absorbers" were again typically more advanced regions that were low users of Structural Fund investment for R&D and innovation (with low eligibility for such funds), but strong users of the FPs for investment in R&D and innovation. The other categories, on the other hand, were where lagging regions were more typically found, with levels of associated Structural Fund expenditure as follows:

- average annual Structural Fund investment on R&D and innovation for "Structural Fund leading users for research and technological activities" was estimated at €28.60 per capita per annum in the 2007-13 period;
- average annual Structural Fund investment on R&D and innovation for "Structural Fund leading users for business innovation and commercialisation activities" was estimated at €31.80 per capita per annum in the 2007-13 period;
- average annual Structural Fund investment on R&D and innovation for "Structural Fund leading users for both research and technological and business innovation and commercialisation activities" was estimated at €26.90 per capita per annum in the 2007-13 period;

- average annual Structural Fund investment on R&D and innovation for "Structural Fund low users" was estimated at €6.10 per capita per annum in the 2007-13 period.

Therefore, average annual Structural Fund investment in R&D and innovation was estimated to be at least four times higher in the three "leading user" categories than it was for the "low user" category during the 2007-13 period. In this regard, Table 6.18 shows that regions such as Norte (Portugal), Puglia and Sardinia (Italy) were categorised as "Structural Fund leading users", either for research and technological activities or for business innovation and commercialisation, whereas all Spanish regions and most other Italian regions, however, were generally identified as "Structural Fund low users".

Table 6.18: Categorisation of EU Fund Absorption in Objective 1 Regions in the 2007-13 Period

Region	**Country**	**Fund Absorption Category (RIS 2014 Rankings)**
Norte	Portugal	Structural Fund leading user – research/technological
Corsica	France	Structural Fund leading user – business innovation
Puglia	Italy	Structural Fund leading user – business innovation
Sardegna	Italy	Structural Fund leading user – business innovation
Região Autónoma dos Açores	Portugal	Structural Fund leading user – business innovation
Região Autónoma da Madeira	Portugal	Structural Fund leading user – business innovation
Galicia	Spain	Structural Fund low user
Principado de Asturias	Spain	Structural Fund low user
Cantabria	Spain	Structural Fund low user
Castilla y León	Spain	Structural Fund low user
Castilla-la Mancha	Spain	Structural Fund low user
Extremadura	Spain	Structural Fund low user
Comunidad Valenciana	Spain	Structural Fund low user
Andalucía	Spain	Structural Fund low user
Región de Murcia	Spain	Structural Fund low user
Canarias	Spain	Structural Fund low user
Molise	Italy	Structural Fund low user
Campania	Italy	Structural Fund low user
Basilicata	Italy	Structural Fund low user
Calabria	Italy	Structural Fund low user
Sicilia	Italy	Structural Fund low user
Algarve	Portugal	n/a

Note: "n/a" = not available.
Source: European Commission (2014b)

6.6 Chapter Summary

- The principal goal of the quantitative analysis outlined in this chapter has been to use descriptive data to identify perceived lagging regions whose recent innovation activity and performance, according to commonly used indicators for R&D and innovation, might provide candidates for deeper, more qualitative case study research. In particular, the data was used to help to categorise regions into a number of groups, as is described in Chapter 7, and this in turn helped to inform the selection of case study regions, which is also described in Chapter 7.
- The quantitative analysis described in this chapter shows that many of the lagging regions in the research sample (drawn mainly from Italy, Spain and Portugal) were able to grow R&D and innovation inputs and outputs across the study period, and in many cases at a faster rate than EU averages, though the rate of growth across regions varied. However, growth was more evident between the 1994-99 and 2000-06 Structural Fund programming periods, which preceded the wider effects of the global financial and economic crisis, which began to take hold in 2008, while base levels of activity (for the indicators for inputs and outputs examined) also generally remained below EU averages at the end of the 2000-13 period, despite any growth recorded in the intervening period.
- Furthermore, lagging regions demonstrated varying levels of absorption of Structural Funds for R&D and innovation purposes, in both the 2000-06 and 2007-13 periods, based on the evidence provided in the EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b).
- In general, but especially in the earlier part of the study period, growth in R&D and innovation activity appeared to be higher in Spanish regions, followed by Portuguese regions and then Italian regions. Structural Fund absorption also appeared to be higher in Spanish regions in the 2000-06 period, although this was not the case in the 2007-13 period.

CHAPTER 7 – CATEGORISATION OF LAGGING REGIONS

7.1 Introduction

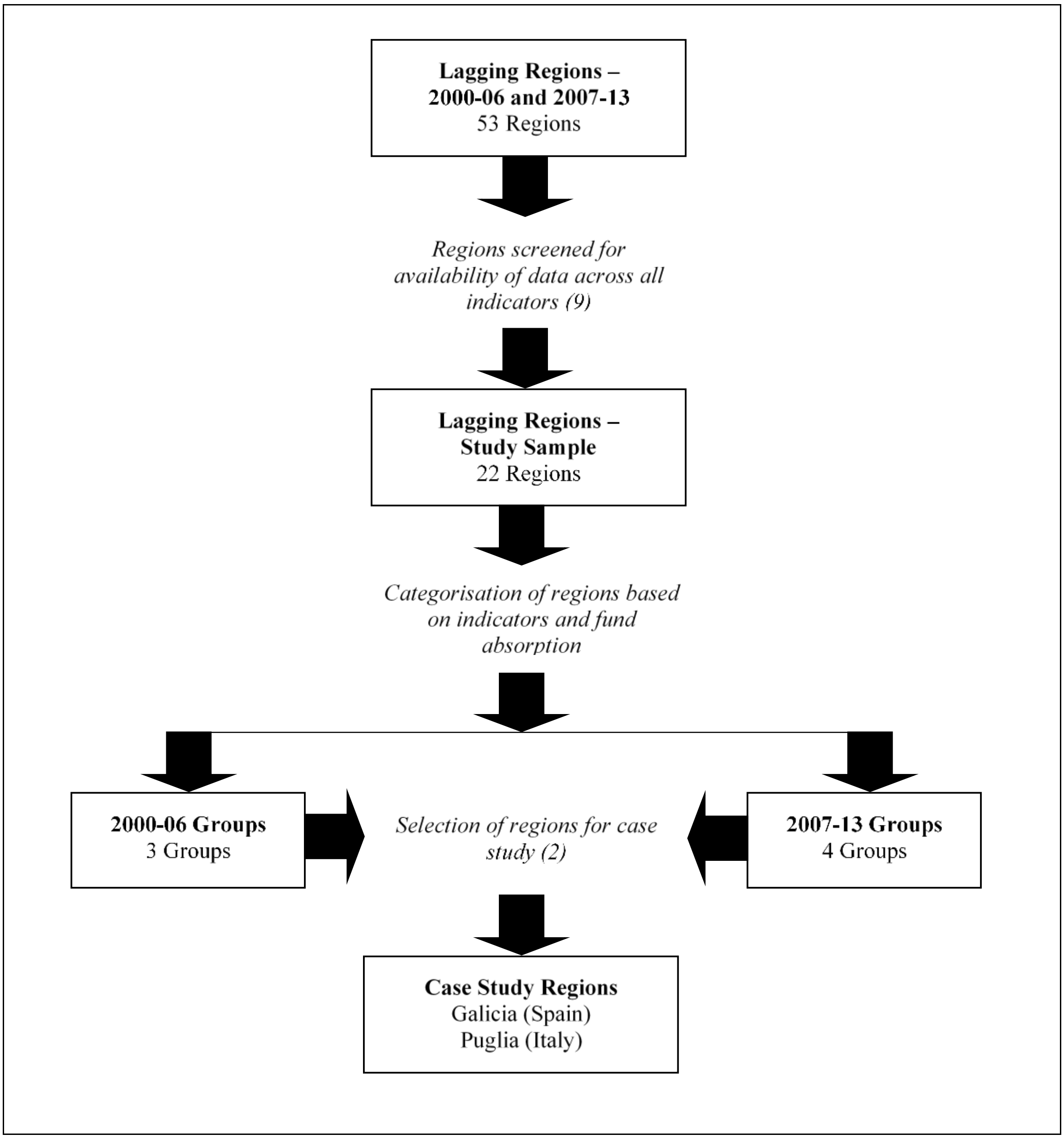
The purpose of this chapter is to present the categorisation of innovation performance in regions that were classified as “lagging” over the EU’s 2000-06 and 2007-13 Structural Fund programming periods, which was carried out for this study. To do this, the chapter uses the findings of the quantitative analysis of innovation performance, described in Chapter 6, to categorise regions into different groups, with these groups in turn being used to inform the selection of the case study regions, which are the subject of Chapters 8-11.

The purpose of the categorisation has been to help identify lagging regions where recent innovation activity and performance might provide candidates for deeper, more qualitative case study analysis of attempts to address issues associated with the regional innovation paradox. In this regard, therefore, the grouping of regions sought to take account of changes in R&D and innovation activity and performance over time (e.g. increases in investment, increases in outputs or outcomes), and not just recent base levels of R&D and innovation activity, so as to better highlight regions where public policy and public investment might have been used to stimulate increased R&D and innovation activity. Regions have thus been categorised based on their R&D and innovation growth over different time periods, based on commonly used indicators for R&D and innovation, and in line with the analysis of innovation performance described in Chapter 6. Firstly, regions have been categorised based on growth between the 1994-99 and 2000-07 periods, and secondly they have been categorised based on growth between the 2000-07 and 2008-12 periods.

The chapter includes eight further sections. Section 7.2 outlines the approach to categorising regions based on growth between the 1994-99 and 2000-07 periods, while Section 7.3 presents the categorisation of regions for these periods. Similarly, Section 7.4 outlines the approach to categorising regions based on growth between the 2000-07 and 2008-12 periods, while Section 7.5 presents the categorisation of regions for the periods. Section 7.6 and Section 7.7 look at base period levels of R&D and innovation activity and other wider socio-economic indicators, which are thought to influence levels of R&D and innovation activity in a region, while Section 7.8 outlines the choice of case study regions. Lastly, Section 7.9 provides a summary of the chapter findings.

Figure 7.1, which was previously presented in the description of methodology in Chapter 5 (Figure 5.3), again summarises the process used to carry out the quantitative analysis described across Chapter 6 and Chapter 7, which has in turn led to the selection of the case study regions that are the topic of Chapters 8-11.

Figure 7.1: Quantitative Analysis – Flowchart



Source: Author

7.2 Categorisation Approach – Growth Between 1994-99 and 2000-07 Periods

7.2.1 Overview

The method used to categorise growth in lagging regions between the 1994-99 and 2000-07 periods has involved:

- analysis of growth data for a selection of "input" and "output" indicators (as described in Chapter 6);
- categorisation of the results of this analysis, using indices based on the median score for each indicator;
- comparison of these categorisations with the regional classifications for absorption of EU Structural Funds in the 2000-06 period, as provided in the EU's Regional Innovation Scoreboard 2012 (European Commission, 2012b), and as earlier described in Chapter 6.

Each of these steps is discussed in more detail in the remainder of this section.

7.2.2 Analysis of Growth Data

The approach used to categorise regions' growth between the 1994-99 and 2000-07 periods has firstly drawn on the analysis of data for the selected input indicators and output indicators, which were discussed in Chapter 6. To recap, the input indicators used for growth between the 1994-99 and 2000-07 periods were:

- growth in total R&D investment per capita (PPS);
- growth in business R&D investment per capita (PPS);
- growth in total R&D personnel levels per capita (FTEs);
- growth in business R&D personnel levels per capita (FTEs).

Meanwhile, the indicators used for outputs of growth between the 1994-99 and 2000-07 periods were:

- growth in total patent applications per capita;
- growth in employment per capita in high/medium-high technology manufacturing (FTEs);
- growth in employment per capita in knowledge intensive services (FTEs);
- growth in employment per capita in high technology sectors (FTEs).

Also, as noted in Chapter 6, data for both input and output indicators were sourced from the Eurostat statistical databases, growth trends were calculated on a period average basis, while data for some indicators was not available for all regions and/or there were gaps in the time series for some regions. As a result, the sample of regions being categorised has therefore included the 22 lagging regions that were examined in Chapter 6.

7.2.3 Categorisation of Results

In order to categorise results for each region, growth in each input indicator and output indicator was indexed against the median score for that indicator, based on the sample of regions studied. An example of this, which shows (a) growth in average annual R&D investment and (b) growth in average annual patent applications between the 1994-99 and 2000-07 periods, indexed against the median growth, is provided in Table 7.1[28].

[28] In the context of growth between the 1994-99 and 2000-07 periods, this exercise was applied to the results of Tables 6.1, 6.3, 6.5, 6.7, 6.9, 6.11, 6.13 and 6.15, as per Chapter 6.

Table 7.1: Index of Median Scores – Sample

	Growth in Average Annual Per Capita R&D Investment 1994-99 v 2000-07	Index of R&D Investment Growth (Median = 100)	Growth in Average Annual Patent Applications per Mn Pop 1994-99 v 2000-07	Index of Patent Applications Growth (Median = 100)
Galicia	110.1%	*232.2*	176.4%	*169.1*
Extremadura	108.9%	*229.6*	47.0%	*45.1*
Castilla y León	96.6%	*203.6*	164.3%	*157.5*
Comunidad Valenciana	82.7%	*174.2*	70.7%	*67.8*
Principado de Asturias	69.7%	*146.9*	113.3%	*108.7*
Molise	69.5%	*146.5*	41.6%	*39.9*
Andalucía	67.4%	*142.0*	107.2%	*102.8*
Región de Murcia	65.4%	*137.9*	172.0%	*164.9*
Calabria	58.1%	*122.6*	119.3%	*114.4*
Norte	50.8%	*107.1*	382.1%	*366.3*
Puglia	48.0%	*101.2*	117.0%	*112.2*
MEDIAN	47.4%	*100.0*	104.3%	*100.0*
Canarias	46.9%	*98.8*	101.4%	*97.2*
Basilicata	45.4%	*95.7*	-14.1%	*-13.5*
Sicilia	44.1%	*93.0*	30.9%	*29.6*
Campania	38.6%	*81.3*	112.2%	*107.6*
Castilla-la Mancha	36.0%	*76.0*	173.7%	*166.5*
Corsica	32.8%	*69.1*	84.7%	*81.2*
Cantabria	22.7%	*47.8*	76.2%	*73.1*
Madeira	21.1%	*44.4*	n/a	*n/a*
Algarve	16.4%	*34.6*	71.2%	*68.3*
Sardegna	12.2%	*25.6*	49.5%	*47.4*
Açores	-55.2%	*-116.4*	n/a	*n/a*

Note: “n/a” = not available.

Source: Authors’ own elaboration based on Eurostat data

Using these index scores, regions were then categorised, according to each indicator, on the basis outlined in Table 7.2. In this table, the “green” categories indicate a relatively higher performance in terms of inputs or outputs (i.e. 120% or more of the median), with the “orange” category indicating a relatively median performance (i.e. between 80% and 120% of the median) and the “red” categories indicating a relatively lower performance (i.e. under 80% of the median). A bold emphasis, in turn, indicates a higher and/or lower performance within the broader “green” and “red” categories (i.e. 150% or more of the median in the case of “green”, less than 50% of the median in the case of “red”).

Table 7.2: Categorisation of Inputs/Outputs – 1994-99 to 2000-07

Rating	Description
High Range	Input or output at 150% or more of the median
High Range	Input or output at between 120% and 150% of the median
Median Range	Input or output at between 80% and 120% of the median
Low Range	Input or output at between 50% and 80% of the median
Low Range	Input or output at less than 50% of the median

Source: Authors' own elaboration

7.2.4 Regional Absorption of EU Structural Funds

Lastly, the categorisation has taken account of regional levels of absorption of EU funds for innovation in the 2000-06 period, i.e. whether each region was a "Structural Fund leading user", a "full absorber/user" or a "low absorber/user" of EU supports for innovation, based on analysis and categorisations provided in the EU's Regional Innovation Scoreboard 2012 (European Commission, 2012b), which were described earlier in Chapter 6. As noted previously in Section 6.5, this is important because:

- average annual Structural Fund investment for "Structural Fund leading users" was estimated at €30.40 per capita per annum in the 2000-06 period;
- average annual Structural Fund investment for "full absorbers/users" was estimated at €23.90 per capita per annum in the 2000-06 period;
- average annual Structural Fund investment for "low absorbers/users" was estimated at €4.00 per capita per annum in the 2000-06 period.

Regional levels of absorption of Structural Funds for innovation have therefore been categorised on a similar basis to the categorisation used for the growth indicators. As outlined in Table 7.3 below, however, the "green" categories in this case represent a relatively higher level of fund absorption and the "red" category represents a relatively lower level of fund absorption.

Table 7.3: Categorisation of Structural Fund Absorption – 2000-06 Period

Categorisation	Description
Structural Fund Leading User	Regions with medium/high use of Structural Funds for business innovation (including R&D) and services (including information and communication technologies and digital infrastructure and environmental technologies), but with low participation in FPs and low power to leverage other funds for FP participation
Full Absorber or User	Regions with medium/high use of Structural Funds for business innovation and services, but low use of funds for information and communication technologies and digital infrastructure and environmental technologies, low participation in FPs and low power to leverage other funds for FP participation, but medium to high importance of participation by SMEs in the private sector
Low Absorber or User	Regions with low use of Structural Funds for business innovation, low participation in FPs and low power to leverage other funds for FP participation

Source: Authors' own elaboration based on European Commission (2012b)

7.3 Categorisation of Regions – Growth Between 1994-99 and 2000-07 Periods

Table 7.4a and Table 7.4b present a matrix of how each of the regions studied were categorised for each of the input and output indicators examined between the 1994-99 and 2000-07 periods, using the categories outlined in Table 7.2. The table shows that:

- Spanish regions like Galicia, Castilla y León, Región de Murcia, Andalucía, Principado de Asturias and Castilla-la Mancha displayed relatively higher levels of output performance across most of the indicators, and this occurred mostly in tandem with relatively higher inputs;
- in contrast, Italian regions like Molise, Puglia, Sicilia, Basilicata, Campania or Sardegna generally displayed relatively lower levels of output performance, or a more mixed performance, across most of the indicators, irrespective of whether the regions attracted relatively higher or lower inputs;

- the Norte region in Portugal showed relatively higher levels of output performance for patent applications, but relatively lower levels of performance for employment growth. Other regions examined in Portugal, however, such as Algarve or Madeira, showed relatively lower growth in R&D investment or R&D personnel, and more mixed growth in terms of outputs.

Regarding output performance, however, it should also be noted that some Spanish regions experienced very high growth in total employment between the two periods, higher than growth experienced in either Italian or Portuguese regions, so share of total employment for key sectors in Spanish regions did not necessarily grow.

In addition, Table 7.4a and Table 7.4b show levels of absorption of EU funds for innovation in these regions during the 2000-06 period, based on the analysis and categorisations provided in the EU’s Regional Innovation Scoreboard 2012 (European Commission, 2012b), and which were discussed previously in Section 6.5. In this regard, among the 22 regions analysed, most of the Spanish regions were “full absorbers/users”, most of the Italian regions were “low absorbers/users” (with the exception of Sicilia, which was a “Structural Fund leading user”), while most Portuguese regions examined (Norte, Algarve, Madeira) were either “full absorber/users” or “Structural Fund leading users”.

Table 7.4a: Matrix of Regional Categorisations – 1994-99 v 2000-07

	MEDIAN	Galicia	Extremadura	Comunidad Valenciana	Castilla y Leon	Region de Murcia	Andalucia	Principado de Asturias	Canarias	Castilla-la Mancha	Cantabria
Category of Structural Fund absorption for innovation (2000-06)		FULL ABSORBER OR USER	FULL ABSORBER OR USER	FULL ABSORBER OR USER	FULL ABSORBER OR USER	FULL ABSORBER OR USER	FULL ABSORBER OR USER	FULL ABSORBER OR USER	FULL ABSORBER OR USER	FULL ABSORBER OR USER	LOW ABSORBER OR USER
Growth in R&D investment per capita (1994-99 v 2000-07)	47.4%	High Range Input	High Range Input	High Range Input	High Range Input	High Range Input	High Range Input	High Range Input	Median Range Input	Median Range Input	Low Range Input
Growth in business R&D investment per capita (1994-99 v 2000-07)	114.9%	High Range Input	High Range Input	Median Range Input	High Range Input	Median Range Input	Median Range Input	High Range Input	High Range Input	Low Range Input	Low Range Input
Growth in R&D personnel per capita (1994-99 v 2000-07)	60.5%	High Range Input	Median Range Input	High Range Input	High Range Input	High Range Input	Median Range Input	High Range Input	Median Range Input	Median Range Input	Low Range Input
Growth in business R&D personnel per capita (1994-99 v 2000-07)	134.2%	High Range Input	High Range Input	High Range Input	High Range Input	Median Range Input	Median Range Input	High Range Input	High Range Input	Median Range Input	Low Range Input
Growth in patent applications per capita (1994-99 v 2000-07)	104.3%	High Range Output	Low Range Output	Low Range Output	High Range Output	High Range Output	Median Range Output	Median Range Output	Median Range Output	High Range Output	Low Range Output
Growth in high and medium-high tech manufacturing employment (1994-99 v 2000-07)	28.2%	High Range Output		Median Range Output	Median Range Output	High Range Output	High Range Output	High Range Output	Median Range Output	High Range Output	Low Range Output
Growth in knowledge intensive services employment (1994-99 v 2000-07)	34.4%	High Range Output	Median Range Output	High Range Output	Median Range Output	High Range Output	High Range Output	Median Range Output	High Range Output	High Range Output	High Range Output
Growth in high technology sectors employment (1994-99 v 2000-07)	42.6%	Median Range Output	Median Range Output	High Range Output	High Range Output	High Range Output	High Range Output	Median Range Output	High Range Output	High Range Output	

Source: Authors' own elaboration

Table 7.4b: Matrix of Regional Categorisations – 1994-99 v 2000-07

		MEDIAN		Molise	Calabria	Puglia	Sicilia	Basilicata	Campania	Sardegna		Norte	Algarve	Madeira	Acores		Corsica
Category of Structural Fund absorption for innovation (2000-06)				LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	SF LEADING USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER		FULL ABSORBER OR USER	FULL ABSORBER OR USER	SF LEADING USER	LOW ABSORBER OR USER		LOW ABSORBER OR USER
Growth in R&D investment per capita (1994-99 v 2000-07)		47.4%		High Range Input	High Range Input	Median Range Input	Median Range Input	Median Range Input	Median Range Input	Low Range Input		Median Range Input	Low Range Input	Low Range Input	Low Range Input		Low Range Input
Growth in business R&D investment per capita (1994-99 v 2000-07)		114.9%		Low Range Input	High Range Input	Low Range Input	High Range Input	Median Range Input	Low Range Input	Low Range Input		High Range Input	Low Range Input		High Range Input		
Growth in R&D personnel per capita (1994-99 v 2000-07)		60.5%		High Range Input	Median Range Input	Median Range Input	Low Range Input	Low Range Input	Low Range Input	Low Range Input		Median Range Input	Low Range Input	Low Range Input			Median Range Input
Growth in business R&D personnel per capita (1994-99 v 2000-07)		134.2%		Low Range Input	Low Range Input	Low Range Input	Median Range Input	High Range Input	Low Range Input	Low Range Input		Median Range Input	Median Range Input				
Growth in patent applications per capita (1994-99 v 2000-07)		104.3%		Low Range Output	Median Range Output	Median Range Output	Low Range Output	Low Range Output	Median Range Output	Low Range Output		High Range Output	Low Range Output				Median Range Output
Growth in high and medium-high tech manufacturing employment (1994-99 v 2000-07)		28.2%		Low Range Output	High Range Output	Low Range Output	Low Range Output	High Range Output	Low Range Output	Low Range Output		Low Range Output					
Growth in knowledge intensive services employment (1994-99 v 2000-07)		34.4%		Low Range Output	Low Range Output	Low Range Output	Low Range Output	Median Range Output	Low Range Output	Median Range Output		Low Range Output	Median Range Output	Median Range Output	Low Range Output		Low Range Output
Growth in high technology sectors employment (1994-99 v 2000-07)		42.6%			Median Range Output	Low Range Output	Low Range Output	Low Range Output	Low Range Output	Median Range Output		Low Range Output					

Source: Authors' own elaboration

Finally, based on the analysis and categorisation outlined in Table 7.4a and Table 7.4b above, Table 7.5 divides the regions examined into three differing groups, based on Structural Fund absorption and relative input and output growth performance. These groups are described as:

- *"high absorbers (of EU Structural Funds) and high growth performers (relative to other lagging regions)"* – regions allocated to this group are the Spanish regions of Galicia, Castilla y León, Región de Murcia, Andalucía, Principado de Asturias, Castilla-la Mancha and Comunidad Valenciana;
- *"high absorbers (of EU Structural Funds) and mixed to low growth performers (relative to other lagging regions)"* – regions allocated to this group are the regions of Extremadura and Canary Islands (Spain), Sicily (Italy) and Norte, Algarve and Madeira (Portugal);
- *"low absorbers (of EU Structural Funds) and mixed to low growth performers (relative to other lagging regions)"* – regions allocated to this group are the Italian regions of Molise, Puglia, Sardinia, Basilicata, Campania and Calabria, plus Cantabria (Spain) and Corsica (France).

Table 7.5: Innovation Performance – Grouping of Lagging Regions – 2000-07 Period

Rating	**Description**
High Absorbers and High Growth Performers	Galicia, Castilla y León, Región de Murcia, Andalucía, Principado de Asturias, Castilla-la Mancha, Comunidad Valenciana
High Absorbers and Mixed to Low Growth Performers	Extremadura, Canarias, Sicilia, Norte, Algarve, Madeira
Low Absorbers and Mixed to Low Growth Performers	Molise, Puglia, Sardegna, Basilicata, Campania, Cantabria, Calabria, Corsica

Source: Authors' own elaboration

7.4 Categorisation Approach – Growth Between 2000-07 and 2008-12 Periods

7.4.1 Overview

The method used to categorise growth in lagging regions between the 2000-07 and 2008-12 periods has again involved the same steps used to categorise growth between the 1994-99 and 2000-07 periods, which were:

- analysis of growth data for the same selection of input and output indicators (as described in Chapter 6);
- categorisation of the results of this analysis, using indices based on the median score for each indicator;
- comparison of these categorisations with the regional classifications for absorption of EU Structural Funds in the 2007-13 period, as provided in the EU's Regional Innovation Scoreboard 2014 (European Commission, 2014b), and as earlier described in Chapter 6.

This method has also been applied to analysis of the same set of regions that were analysed between the 1994-99 and 2000-07 periods.

7.4.2 Analysis of Growth Data

The approach used to categorise regions' growth between the 2000-07 and 2008-12 periods has again drawn on the analysis of data for the same selected input indicators and output indicators, which were discussed in Chapter 6, i.e.:

- input indicators for growth in total R&D investment per capita (PPS), business R&D investment per capita (PPS), total R&D personnel levels per capita (FTEs) and business R&D personnel levels per capita (FTEs);
- output indicators for growth in total patent applications per capita, employment per capita in high/medium-high technology manufacturing (FTEs), employment per capita in knowledge intensive services (FTEs) and employment per capita in high technology sectors (FTEs).

Again, as noted in Chapter 6, data for both input and output indicators were sourced from the Eurostat statistical databases, while growth trends for the input indicators and patent applications were calculated on a period average basis. As previously noted in Section 6.4, however, analysis of employment growth in key sectors could not be carried out on the same basis used when examining growth between the 1994-99 and 2000-07 periods – because of changes, from 2008 onwards, in the NACE sectoral codes. Therefore, employment growth in the high and medium-high technology manufacturing, knowledge intensive services and high technology sectors was instead examined on a single year basis, between the years 2008 and 2012.

7.4.3 Categorisation of Results

In order to categorise results for each region, growth in input and output indicators was again converted into an index against the median score for that indicator, based on the sample of regions studied[29]. Using these index scores, regions were categorised in the same manner as for growth between the 1994-99 and 2000-07 periods, with the "green" categories indicating a relatively higher performance in terms of inputs or outputs, the "orange" category indicating a relatively median performance and the "red" categories indicating a relatively lower performance, as outlined before in Table 7.2.

However, estimates of employment growth in medium-high and high technology manufacturing, knowledge intensive services and high technology sectors between 2008 and 2012 were categorised in a different manner than previously. This was because the "median" growth in each case between 2008 and 2012 was negative, presumably due to the very challenging economic circumstances following the global financial and economic crisis of 2008. Therefore, the categorisation used in these cases was as per Table 7.6 below, with the "green" category representing positive growth, the "orange" category representing no growth and the "red" category representing negative growth.

[29] In the context of growth between the 2000-07 and 2008-12 periods, this exercise was applied to the results of Tables 6.2, 6.4, 6.6, 6.8, 6.10, 6.12, 6.14 and 6.16, as per Chapter 6.

Table 7.6: Categorisation of Employment Outputs – 2008 to 2012

Rating	Description
Positive Growth	Regions that recorded positive growth in relevant sector employment between 2008 and 2012
No Growth	Regions that recorded no growth in relevant sector employment between 2008 and 2012
Negative Growth	Regions that recorded negative growth in relevant sector employment between 2008 and 2012

Source: Authors' own elaboration

7.4.4 Regional Absorption of EU Structural Funds

Lastly, the categorisation of growth between the 2000-07 and 2008-12 periods has, as with the analysis of growth between the 1994-99 and 2000-07 periods, taken account of regional levels of absorption of EU funds for R&D and innovation. In this case, however, the categorisation was based on the regional classifications as either "Structural Fund leading users" (whether for research and technological activities, for support services for business innovation and commercialisation, or for both) or "Structural Fund low users" during the 2007-13 period, as per the analysis and categorisations provided in the EU's Regional Innovation Scoreboard 2014 (European Commission, 2014b), as outlined in Chapter 6. Again, as noted in Section 6.5, this is important because:

- average annual Structural Fund investment for "Structural Fund leading users" for research and technological activities was estimated at €28.60 per capita per annum in the 2007-13 period;
- average annual Structural Fund investment for "Structural Fund leading users" for business innovation and commercialisation activities was estimated at €31.80 per capita per annum in the 2007-13 period;
- average annual Structural Fund investment for "Structural Fund leading users" for both research and technological and business innovation and commercialisation activities was estimated at €26.90 per capita per annum in the 2007-13 period;

- average annual Structural Fund investment for "Structural Fund low users" was estimated at €6.10 per capita per annum in the 2007-13 period.

Regional levels of absorption of Structural Funds for innovation in the 2007-13 period, therefore, have been categorised according to Table 7.7 below, with the "green" categories representing a relatively higher level of fund absorption and the "red" category representing a relatively lower level of fund absorption.

Table 7.7: Categorisation of Structural Fund Absorption – 2007-13 Period

Categorisation	Description
Structural Fund Leading User – R&D	Regions with high use of Structural Funds for research and technological activities
Structural Fund Leading User – Business Innovation	Regions with high use of Structural Funds for support services for business innovation and commercialisation
Structural Fund Leading User – R&D and Business Innovation	Regions with use of Structural Funds for all types of research, technological development and innovation priorities, with medium-to-high use of Structural Funds for both research and technological activities and support services for business innovation and commercialisation
Structural Fund Low User	Regions with low rates of Structural Funds use under research, technological development and innovation priorities

Source: Authors' own elaboration based on European Commission (2014b)

7.5 Categorisation of Regions – Growth Between 2000-07 and 2008-12 Periods

Table 7.8a and Table 7.8b present a matrix of how each of the regions studied were categorised for each of the input and output indicators examined between the 2000-07 and 2008-12 periods, using the categories outlined in both Table 7.2 and Table 7.6, while also showing how regions were categorised for absorption of EU Structural Funds. In summary, the table shows that:

- there were very few “high absorbers” of Structural Funds during this period, i.e. the Portuguese regions of Norte, Madeira and Azores, the Italian regions of Puglia and Sardinia, and the French region of Corsica. Also, in contrast to the previous period, there were no Spanish regions classified in high absorber categories for Structural Fund purposes;
- regions’ performance in terms of innovation inputs and outputs was more mixed than in the previous period, especially for outputs (though this must be partly attributable to the more challenging economic circumstances during the period). In general, however, Portuguese regions and Spanish regions performed relatively better than Italian regions;
- among “high absorber” regions in Structural Fund terms, only the Portuguese regions (Norte, Madeira, Azores) were mixed-high performers in terms of innovation inputs and outputs.

Table 7.8a: Matrix of Regional Categorisations – 2000-07 v 2008-12

		MEDIAN		Galicia	Extremadura	Comunidad Valenciana	Castilla y Leon	Region de Murcia	Andalucia	Principado de Asturias	Canarias	Castilla-la Mancha	Cantabria
Category of Structural Fund absorption for innovation (2007-13)				LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER
Growth in R&D investment per capita (2000-07 v 2008-12)		22.9%		High Range Input	High Range Input	Median Range Input	High Range Input	Median Range Input	High Range Input	High Range Input	Low Range Input	High Range Input	High Range Input
Growth in business R&D investment per capita (2000-07 v 2008-12)		42.2%		Median Range Input	Median Range Input	Median Range Input	Median Range Input	Low Range Input	Median Range Input	Median Range Input	Low Range Input	High Range Input	High Range Input
Growth in R&D personnel per capita (2000-07 v 2008-12)		26.0%		High Range Input	High Range Input	Median Range Input	Median Range Input	High Range Input	High Range Input	High Range Input	Low Range Input	High Range Input	High Range Input
Growth in business R&D personnel per capita (2000-07 v 2008-12)		53.1%		Median Range Input	Median Range Input	Low Range Input	Median Range Input	Low Range Input	Median Range Input	High Range Input	Low Range Input	High Range Input	High Range Input
Growth in patent applications per capita (2000-07 v 2008-11)		16.3%		High Range Output	Low Range Output	Low Range Output	Low Range Output	High Range Output	High Range Output	High Range Output	Low Range Output	Low Range Output	High Range Output
Growth in high and medium-high tech manufacturing employment (2008-12)		-5.4%		No Growth	Positive Growth	Positive Growth	Negative Growth	No Growth	Negative Growth	Negative Growth	Negative Growth	Negative Growth	Negative Growth
Growth in knowledge intensive services employment (2008-12)		-0.8%		Negative Growth	Negative Growth	Positive Growth	Positive Growth	Positive Growth	Negative Growth	Positive Growth	Negative Growth	Negative Growth	Positive Growth
Growth in high technology sectors employment (2008-12)		-14.3%		Positive Growth	Negative Growth	Negative Growth	Negative Growth	Negative Growth	Negative Growth	Positive Growth	Negative Growth	Negative Growth	Positive Growth

Source: Authors' own elaboration

Table 7.8b: Matrix of Regional Categorisations – 2000-07 v 2008-12

	MEDIAN	Molise	Calabria	Puglia	Sicilia	Basilicata	Campania	Sardegna	Norte	Algarve	Madeira	Acores	Corsica
Category of Structural Fund absorption for innovation (2007-13)		LOW ABSORBER OR USER	LOW ABSORBER OR USER	SF LEADING USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	LOW ABSORBER OR USER	SF LEADING USER	SF LEADING USER	LOW ABSORBER OR USER	SF LEADING USER	SF LEADING USER	SF LEADING USER
Growth in R&D investment per capita (2000-07 v 2008-12)	22.9%	Low Range Input	Median Range Input	Low Range Input	Low Range Input	Low Range Input	Low Range Input	Low Range Input	High Range Input	High Range Input	Low Range Input	High Range Input	Median Range Input
Growth in business R&D investment per capita (2000-07 v 2008-12)	42.2%	Low Range Input	Median Range Input	Low Range Input	Low Range Input	Low Range Input	Low Range Input	Low Range Input	High Range Input	High Range Input	High Range Input	High Range Input	
Growth in R&D personnel per capita (2000-07 v 2008-12)	26.0%	Median Range Input	Low Range Input	Low Range Input	Low Range Input	Median Range Input	Low Range Input	Median Range Input	High Range Input	High Range Input	Median Range Input	Low Range Input	Median Range Input
Growth in business R&D personnel per capita (2000-07 v 2008-12)	53.1%	High Range Input	High Range Input	Low Range Input	Low Range Input	Low Range Input	Low Range Input	Low Range Input	High Range Input	High Range Input	High Range Input	High Range Input	
Growth in patent applications per capita (2000-07 v 2008-11)	16.3%	Low Range Output	Low Range Output	High Range Output	Low Range Output	High Range Output	Low Range Output	High Range Output	High Range Output	High Range Output			Low Range Output
Growth in high and medium-high tech manufacturing employment (2008-12)	-5.4%	No Growth	Positive Growth	Negative Growth	Negative Growth	No Growth	Negative Growth	Negative Growth	Negative Growth				
Growth in knowledge intensive services employment (2008-12)	-0.8%	Negative Growth	Negative Growth	Negative Growth	Negative Growth	Negative Growth	Positive Growth	Positive Growth	Positive Growth	Positive Growth	No Growth	Positive Growth	
Growth in high technology sectors employment (2008-12)	-14.3%		No Growth	Positive Growth	Negative Growth	Negative Growth	Positive Growth	Negative Growth	Negative Growth				

Source: Authors' own elaboration

Lastly, based on the analysis and categorisation outlined in Table 7.8a and Table 7.8b above, Table 7.9 below divides the regions examined into four differing groups, based on Structural Fund absorption and relative input and output growth performance. These groups are:

- *"high absorbers (of EU Structural Funds) and mixed to high growth performers (relative to other lagging regions)"* – regions allocated to this group are the Portuguese regions of Norte, Madeira and Azores;
- *"high absorbers (of EU Structural Funds) and mixed to low growth performers (relative to other lagging regions)"* – regions allocated to this group are the Italian regions of Puglia and Sardinia, alongside Corsica (France);
- *"low absorbers (of EU Structural Funds) and mixed to high growth performers (relative to other lagging regions)"* – regions allocated to this group are the Spanish regions of Galicia, Cantabria, Andalucía, Principado de Asturias, Extremadura, Castilla y León, Región de Murcia and Castilla-la Mancha, plus the Algarve (Portugal);
- *"low absorbers (of EU Structural Funds) and mixed to low growth performers (relative to other lagging regions)"* – regions allocated to this group are the Spanish regions of Comunidad Valenciana and the Canary Islands, plus the Italian regions of Molise, Calabria, Sicily, Basilicata and Campania.

Table 7.9: Innovation Performance – Grouping of Lagging Regions – 2008-12 Period

Rating	**Description**
High Absorbers and Mixed to High Growth Performers	Norte, Madeira, Acores
High Absorbers and Mixed to Low Growth Performers	Puglia, Sardegna, Corsica
Low Absorbers and Mixed to High Growth Performers	Galicia, Cantabria, Andalucía, Principado de Asturias, Algarve, Extremadura, Castilla y León, Región de Murcia, Castilla-la Mancha
Low Absorbers and Mixed to Low Growth Performers	Canarias, Molise, Calabria, Sicilia, Basilicata, Campania, Comunidad Valenciana

Source: Authors' own elaboration

7.6 Lagging Regions – Base Period Comparisons

When comparing innovation across regions, it is also worthwhile to consider existing levels of innovation in those regions, in the base year or period, so as to gauge whether or not the regional innovation stock has an influence on subsequent levels of growth in innovation. Therefore, Table 7.10a and Table 7.10b have examined the base year/period level of innovation in the lagging regions studied, based on the indicators used to examine innovation growth levels earlier. In particular, this has involved analysis of the following data, drawn from Eurostat databases:

- R&D investment as a percentage of GDP in 2000;
- business R&D investment as a percentage of total R&D investment (average over the 1994-99 period);
- R&D personnel as a percentage of the total active population (2000);
- business R&D personnel as a percentage of total R&D personnel (average over the 1994-99 period);
- level of patent applications per million population (average over the 1994-99 period);
- employment in high and medium-high technology manufacturing as a percentage of total employment (average over the 1994-99 period);
- employment in knowledge intensive services as a percentage of total employment (average over the 1994-99 period);
- employment in high technology sectors as a percentage of total employment (average over the 1994-99 period).

For illustrative purposes, data has again been categorised, relative to the median score, on the same basis as outlined in Table 7.2 above. The results suggest that, in broad terms, there does not appear to have been significant differences in the innovative stock of the lagging regions examined, in the base year/period, based on the indicators analysed, though it is possible to group the regions into three sub-tiers:

- an upper tier that includes Comunidad Valenciana, Castilla y Léon and Principado de Asturias in Spain and Campania, Sicilia and Basilicata in Italy;
- a middle tier that includes Galicia, Región de Murcia, Andalucía, Castilla-la Mancha and Cantabria in Spain and Puglia and Sardinia in Italy;
- a lower tier that includes Extremadura in Spain, Molise and Calabria in Italy and Norte, Algarve, Madeira and Azores in Portugal.

However, these tiers should be viewed within the context of lagging regions' innovation levels relative to EU-15 averages in the base year/period, as outlined in Chapter 6, whereby lagging regions' performance in terms of the indicators examined was well below the EU-15 averages. Therefore, while some lagging regions might have shown higher levels of innovation activity than other lagging regions in the base year/period, based on the indicators presented, all lagging regions were still nonetheless well behind the levels of innovation activity evident in leading or more advanced regions, based on the same indicators.

Table 7.10a: Matrix of Regional Categorisations – Base Period Comparisons

		MEDIAN		Galicia	Extremadura	Comunidad Valenciana	Castilla y Leon	Region de Murcia	Andalucia	Principado de Asturias	Canarias	Castilla-la Mancha	Cantabria
R&D investment as % of GDP (2000)		0.62		Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	High Range	Low Range	Median Range	Low Range
Business R&D investment as % of all R&D investment (1994-99)		26.7%		Median Range	Low Range	Median Range	High Range	High Range	Median Range	High Range	Low Range	High Range	Median Range
R&D personnel as a % of the active population (2000)		0.37		High Range	Median Range	High Range	High Range	Median Range	High Range	High Range	Median Range	Low Range	Median Range
Business R&D personnel as a % of all R&D personnel (1994-99)		19.0%		Median Range	Low Range	High Range	Median Range	High Range	Median Range	Median Range	Low Range	High Range	Median Range
Patent applications per million population (1994-99)		5.26		Low Range	Low Range	High Range	Median Range	Low Range	Low Range	Median Range	Low Range	Low Range	Median Range
Employment in high and medium-high tech manufacturing as a % of total employment (1994-99)		3.16%		High Range		High Range	High Range	Median Range	Low Range	Low Range	Low Range	Low Range	High Range
Employment in knowledge intensive services as a % of total employment (1994-99)		20.85%		Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range
Employment in high technology sectors as a % of total employment (1994-99)		1.76%		Median Range	Median Range	Median Range	Median Range	Low Range	Median Range	Median Range	Median Range	Median Range	

Source: Authors' own elaboration

Table 7.10b: Matrix of Regional Categorisations – Base Period Comparisons

		MEDIAN		Molise	Calabria	Puglia	Sicilia	Basilicata	Campania	Sardegna		Norte	Algarve	Madeira	Acores		Corsica
R&D investment as % of GDP (2000)		0.62		Low Range	Low Range	Median Range	High Range	High Range	High Range	Median Range		Low Range	Low Range		Low Range		Low Range
Business R&D investment as % of all R&D investment (1994-99)		26.7%		Median Range	Low Range	Median Range	Low Range	Low Range	High Range	Low Range		Median Range	Low Range		Low Range		
R&D personnel as a % of the active population (2000)		0.37		Low Range	Low Range	Median Range	Median Range	Median Range	High Range	Median Range		Low Range	Low Range	Low Range	Median Range		Median Range
Business R&D personnel as a % of all R&D personnel (1994-99)		19.0%		Median Range	Low Range	High Range	Low Range	Low Range	High Range	Low Range		Median Range	Low Range				
Patent applications per million population (1994-99)		5.26		Median Range	Low Range	Median Range	High Range	High Range	Median Range	Median Range		Low Range	Low Range				Median Range
Employment in high and medium-high tech manufacturing as a % of total employment (1994-99)		3.16%		High Range	Low Range	Median Range	Low Range	High Range	High Range	Median Range		High Range					
Employment in knowledge intensive services as a % of total employment (1994-99)		20.85%		Median Range	High Range	Median Range	High Range	Median Range	High Range	Median Range		Median Range	Median Range	Low Range	Median Range		High Range
Employment in high technology sectors as a % of total employment (1994-99)		1.76%			High Range	Median Range	High Range	High Range	High Range	High Range		Median Range					

Source: Authors' own elaboration

7.7 Other Factors

Also, similar to Section 7.6 above, it is worthwhile to consider a number of other factors that might influence levels of innovation activity in regions. These include the level of wealth in a region, its level of knowledge capital and its quality of governance. For example, several studies have pointed to a link between the relative wealth of regions and their levels of innovation (e.g. Rodríguez-Pose, 2001, Gössling and Rutten, 2007), and to a link between education levels and innovation (e.g. Gössling and Rutten, 2007, European Commission, 2012b, 2014b), while the importance of governance within regional innovation systems has been highlighted by authors such as Oughton et al (2002), Carrincazeaux and Gaschet (2006) and Asheim (2007). Therefore, Table 7.11a and Table 7.11b have examined relative wealth, knowledge capital and governance in the lagging regions studied using the following indicators:

- GDP per capita (2000);
- growth in GDP per capita (2000-07 and 2000-13);
- the percentage of the population aged 25-64 with completed tertiary education (2000);
- growth in the percentage of the population aged 25-64 with completed tertiary education (2000-07 and 2000-13);
- regional scores in the European Quality of Government Index, for both 2010 (Charron, Lapuente and Rothstein, 2013) and 2013 (Charron, Dijkstra and Lapuente, 2015)[30].

[30] Charron et al (2013, 2015) note that there has been much debate in the fields of both academic and practitioner research regarding how best to measure quality of government. For example, they point to debate about whether contemporary indicators present valid measures of salient concepts within the umbrella of quality of government, such as bureaucratic effectiveness, rule of law or corruption, while also pointing to disagreement over how quality of government might be evaluated with respect to objective ("hard") indicators as opposed to subjective perceptions.
Nevertheless, while acknowledging this debate, they have sought to develop a European Quality of Government Index, which draws on a large survey of EU citizens (34,000 respondents for the 2010 index, 85,000 respondents for the 2013 index), spread across more than 200 EU regions, in order to investigate perceptions and experiences of quality of government in regions and thereby index quality of government in EU regions accordingly. A further index was produced in 2017, with the next round planned for 2020.

As before, data has been categorised relative to a median score, on the same basis as outlined in Table 7.2 above. The results of this, in turn, show that:

- there were no major differences in base year (2000) levels of GDP per capita across the lagging regions studied, with all regions more or less falling within range of the median level of GDP per capita (see also Chapter 3)[31];
- however, growth in GDP per capita since 2000 has generally been higher in Spanish and Portuguese regions than in Italian regions (see also Chapter 3);
- base year (2000) levels of population aged 25-64 with completed tertiary education were clearly higher in Spanish regions than in Italian or Portuguese regions. At the same time, growth in this population since 2000 was generally highest in Portuguese regions, with growth in Spanish regions also being higher than growth in Italian regions (see also Chapter 3);
- the quality of governance was rated higher in Spanish and Portuguese regions than in Italian regions, though it should be noted that governance in lagging regions generally ranked lowly in overall EU terms[32].

[31] This is unsurprising, given that all these regions were designated by the EU as Objective 1 and Convergence regions based on levels of GDP per capita, or as regions with priority Structural Fund status, during the 2000-06 and 2007-13 Structural Fund programming periods.
[32] In 2010, for example, the highest ranking lagging region among the sample for this thesis was Galicia (Spain), which ranked 78th in EU terms. In 2013, the highest ranked region was the Azores (Portugal), which ranked 74th.

Table 7.11a: Matrix of Regional Categorisations – Other Factors

		MEDIAN		Galicia	Extremadura	Comunidad Valenciana	Castilla y Leon	Region de Murcia	Andalucia	Principado de Asturias	Canarias	Castilla-la Mancha	Cantabria
GDP per capita (2000)		€15,300		Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	High Range	Median Range	Median Range
Growth in GDP per capita (2000-07)		35.1%		High Range	High Range	Median Range	High Range	Median Range	High Range	High Range	Low Range	High Range	Median Range
Growth in GDP per capita (2000-13)		30.0%		High Range	High Range	Low Range	High Range	Median Range	Median Range	High Range	Low Range	High Range	Median Range
% population aged 25-64 with completed tertiary education (2000)		12.2		High Range	High Range	High Range	High Range	High Range	High Range	High Range	High Range	High Range	High Range
Growth in % population aged 25-64 with completed tertiary education (2000-07)		54.4%		High Range	Median Range	High Range	Low Range	Median Range	Median Range	Median Range	High Range	High Range	Median Range
Growth in % population aged 25-64 with completed tertiary education (2000-13)		88.9%		Median Range	Median Range	Median Range	Low Range	Median Range	Median Range	Median Range	Median Range	High Range	Median Range
Quality of Government Index (2010)		0.219		High Range	High Range	Median Range	Low Range	High Range	Low Range	High Range	High Range	High Range	Median Range
Quality of Government Index (2013)		-0.107		Below Median	Above Median	Below Median	Above Median	Above Median	Above Median	Above Median	Below Median	Median	Above Median

Source: Authors' own elaboration

Table 7.11b: Matrix of Regional Categorisations – Other Factors

	MEDIAN	Molise	Calabria	Puglia	Sicilia	Basilicata	Campania	Sardegna	Norte	Algarve	Madeira	Acores	Corsica
GDP per capita (2000)	€15,300	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range	Median Range
Growth in GDP per capita (2000-07)	35.1%	Low Range	Low Range	**Low Range**	Low Range	Low Range	Low Range	Low Range	Median Range	Median Range	High Range	High Range	Low Range
Growth in GDP per capita (2000-13)	30.0%	**Low Range**	**Low Range**	**Low Range**	**Low Range**	Low Range	Low Range	**Low Range**	High Range	Median Range	High Range	**High Range**	High Range
% population aged 25-64 with completed tertiary education (2000)	12.2	Low Range	Median Range	Low Range	Low Range	Low Range	Low Range	Low Range	Low Range	Low Range	**Low Range**	**Low Range**	Median Range
Growth in % population aged 25-64 with completed tertiary education (2000-07)	54.4%	Median Range	Low Range	Low Range	**Low Range**	**High Range**	Low Range	Median Range	High Range	**High Range**	**High Range**	Median Range	Low Range
Growth in % population aged 25-64 with completed tertiary education (2000-13)	88.9%	Median Range	**Low Range**	Low Range	Low Range	High Range	Median Range	Median Range	**High Range**	**High Range**	**High Range**	**High Range**	**Low Range**
Quality of Government Index (2010)	0.219	**Low Range**	**Low Range**	**Low Range**	**Low Range**	**Low Range**	**Low Range**	**Low Range**	**Low Range**	High Range	**High Range**	**High Range**	Median Range
Quality of Government Index (2013)	-0.107	Below Median	Below Median	Below Median	Below Median	Below Median	Below Median	Below Median	Median	Above Median	Above Median	Above Median	Above Median

Source: Authors' own elaboration

7.8 Case Studies – Selected Regions

Candidate regions for case study analysis were selected based on the evidence of the groups of regions defined in Section 7.3 and Section 7.5 above, while also taking account of the evidence presented in Section 7.6 and Section 7.7 above.

The two regions selected were Galicia (Spain) and Puglia (Italy). The choice of one region from each of Spain and Italy, in the first instance, reflects a clear difference in the relative performance of Spanish and Italian lagging regions over the 2000-06 and 2007-13 Structural Fund programming periods. This difference is especially evident in the quantitative analysis (see Chapter 6), whereby Spanish lagging regions appeared to perform better than Italian lagging regions across most available R&D and innovation indicators.

A summary of other reasons for the choice of Galicia and Puglia is provided in Table 7.12. In this regard, Galicia has been selected because it was categorised as a "high absorber, high performer" region relative to other lagging regions between the 1994-99 and 2000-07 periods (see Section 7.3). Importantly, this takes account of its classification as a "full user/absorber" of Structural Funds for R&D and innovation investment during the 2000-06 Structural Fund programming period, as per the analysis in the Regional Innovation Scoreboard (European Commission, 2012b). The analysis also suggests that the region maintained a relatively good performance between the 2000-07 and 2008-12 periods, even though the Regional Innovation Scoreboard (European Commission, 2014b) classified it as being more of a "low absorber" of Structural Funds during the 2007-13 programming period.

Puglia, on the other hand, was categorised as a "low absorber, mixed-low performer" region relative to other lagging regions between the 1994-99 and 2000-07 periods (see Section 7.3). However, it became a "leading user" of Structural Funds during the 2007-13 programming period, according to the Regional Innovation Scoreboard (European Commission, 2014b), though its wider innovation performance generally remained mixed relative to other lagging regions.

Table 7.12: Case Studies – Selected Regions

Galicia (Spain)	Puglia (Italy)
▪ Funded under the RIS Programme during the 1994-99 period	▪ Funded under the RIS Programme during the 1994-99 period
▪ Population nearly 2.8 mn (2013)	▪ Population over 4.0 mn (2013)
▪ Annual average R&D investment of €526 mn and annual average R&D personnel of 10,000 in the 2008-12 period	▪ Annual average R&D investment of €465 mn and annual average R&D personnel of 6,800 in the 2008-12 period
▪ "High absorber and high growth performer" region in the 2000-07 period	▪ "Low absorber and mixed to low growth performer" region in the 2000-07 period
▪ "Low absorber and mixed to high growth performer" region in the 2008-12 period	▪ "High absorber and mixed to low growth performer" region in the 2008-12 period
▪ "Middle tier" region in terms of base year/period levels of innovation activity	▪ "Middle tier" region in terms of base year/period levels of innovation activity
▪ Business share of R&D investment grew from 27% to 47% between the 1994-99 and 2008-11 periods, and business share of R&D personnel grew from 18% to 35%	▪ Business share of R&D investment declined from 29% to 25% between the 1994-99 and 2008-11 periods, and business share of R&D personnel declined from 23% to 22%
▪ Population aged 25-64 with completed tertiary education at 19% in 2000, rising to 32% by 2013	▪ Population aged 25-64 with completed tertiary education at 9% in 2000, rising to 13% by 2013

Source: Authors' own elaboration

Crucially, regional governments in both Galicia and Puglia have taken policy steps to promote R&D and innovation in the regions over the period being reviewed. In this regard, both regions also participated in early EU-funded initiatives, prior to the 2000-06 Structural Fund programming period, which promoted regional innovation system concepts, e.g. the RIS Programme, which was promoted during the 1994-99 Structural Fund programming period (see Chapter 10, Section 10.3.1 and Section 10.5.1). In addition, the two regions were broadly similar in innovation terms in the base year/period levels of activity (see Section 7.6), while they appear broadly similar in terms of structural conditions that are relevant to innovation development (for example, see European Commission, 2014a).

7.9 Chapter Summary

- The purpose of this chapter has been to present the categorisation of innovation performance in regions that were classified as “lagging” over the EU’s 2000-06 and 2007-13 Structural Fund programming periods, which was carried out for this study. Regions have been categorised based on their growth over different time periods, in line with the analysis of innovation performance described in Chapter 6, firstly based on growth between the 1994-99 and 2000-07 periods, and secondly based on growth between the 2000-07 and 2008-12 periods.
- For growth between the 1994-99 and 2000-07 periods, regions were grouped into three categories as follows, based on the evidence for investment and performance in Chapter 6:
  - *“high absorbers (of EU Structural Funds) and high growth performers (relative to other lagging regions)”* – incorporating seven Spanish regions;
  - *“high absorbers (of EU Structural Funds) and mixed to low growth performers (relative to other lagging regions)”* – including a mix of regions in Spain, Italy and Portugal;
  - *“low absorbers (of EU Structural Funds) and mixed to low growth performers (relative to other lagging regions)”* – consisting mainly of a group of six Italian regions.
- For growth between the 2000-07 and 2008-12 periods, regions were grouped into four categories as follows, based on the evidence of investment and performance in Chapter 6:
  - *“high absorbers (of EU Structural Funds) and mixed to high growth performers (relative to other lagging regions)”* – incorporating three Portuguese regions;
  - *“high absorbers (of EU Structural Funds) and mixed to low growth performers (relative to other lagging regions)”* – including the Italian regions of Puglia and Sardinia, alongside Corsica (France);
  - *“low absorbers (of EU Structural Funds) and mixed to high growth performers (relative to other lagging regions)”* – consisting of eight Spanish regions, plus the Algarve (Portugal);
  - *“low absorbers (of EU Structural Funds) and mixed to low growth performers*

(relative to other lagging regions)" – including a mix of Spanish and Italian regions.

- Arising from this, the regions of Galicia (Spain) and Puglia (Italy) were selected as case study regions out of the groups identified across the two time periods, and the detailed research findings across these two regions is presented in Chapters 8-11.

PART C – CASE STUDIES

CHAPTER 8 – CASE STUDIES: INTRODUCTION

8.1 Introduction

This chapter provides a brief introduction to the case study element of the thesis, which (as noted in Chapter 7, Section 7.8) has involved research into the two chosen regions of Galicia (Spain) and Puglia (Italy). In the following sections, the chapter outlines the purpose of the case studies, followed by the analytical framework used for the case studies. The chapter then concludes by outlining the structure of the analysis, and how it is presented across its three main chapters.

8.2 Purpose of the Case Studies

As discussed in the introduction to this thesis (see Chapter 1), the need for the research has been inspired by the hypothesis put forward in the regional innovation paradox (Oughton et al, 2002), which highlights a perceived "apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities compared to more advanced regions" (Oughton et al, 2002, p. 98). Or, put more succinctly, "the more innovation is needed in (lagging) regions to maintain and increase the competitive position of their firms in an increasingly global economy, the more difficult it is to invest effectively and therefore absorb public funds for the promotion of innovation in these regions" (Oughton et al, 2002, p. 98).

Furthermore, Oughton et al (2002) asserted that the main cause of the regional innovation paradox lies in the nature of the regional innovation system in these regions, including the fragmented nature of the co-operation and interaction between the key elements of the system (see Chapter 1). Alongside this, from a policy perspective, it was suggested that the resolution of the paradox requires policies that both:

- increase the innovation capacity of regions by working on both the demand side and the supply side of the (regional innovation) system to increase both private and public sector investment in innovation activity;

- integrate technology policy and industrial policy by encouraging expenditure on innovation within mainstream industrial policy programmes.

As noted in both Chapter 1 and Chapter 5, this research has thus sought to explore "how public policy towards and public investment in regional innovation systems have contributed to R&D and innovation performance in lagging regional economies", with research objectives underlying this question being to:

- examine how investment in R&D and innovation in lagging regions, and outputs attributed to R&D and innovation in such regions, have changed over time;
- explore public policy and public investment interventions that have been used to promote the development of regional innovation systems in lagging regions;
- understand the elements that constitute regional innovation systems in lagging regions, and the extent to which such systems have developed over time;
- examine how lagging regions address their region-specific characteristics when developing policies to promote regional innovation systems;
- examine how interaction with other spatial levels (e.g. national, EU) influences the development of policies to promote regional innovation systems in lagging regions.

The purpose of the earlier quantitative analysis in the thesis (see Chapter 6 and Chapter 7) was to try to identify regions which, in quantitative terms at least, seem to have made some progress in addressing the paradox. To recap, this analysis looked at trends in a range of indicators for investment and performance in R&D and innovation, with an explicit focus on lagging regions, so as to see which regions appear to have performed better than others, in relative terms, over the 2000-06 and 2007-13 Structural Fund programming periods[33]. The purpose of undertaking case studies, on the other hand, has been to analyse the development of regional innovation systems in a selected number of lagging regions (given that the nature of such systems is asserted to be the main cause of the regional innovation paradox) and to see what changes have occurred over time, what weaknesses in the systems have been addressed and what processes have

[33] Again, to remind the reader, this analysis included an examination of Eurostat data on indicators of growth in R&D investment and personnel, patents and employment in key sectors (high and medium-high technology manufacturing, knowledge intensive services and high-technology sectors), and it has drawn on evidence from the EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b) regarding regions' use of European funds for investment in R&D and innovation

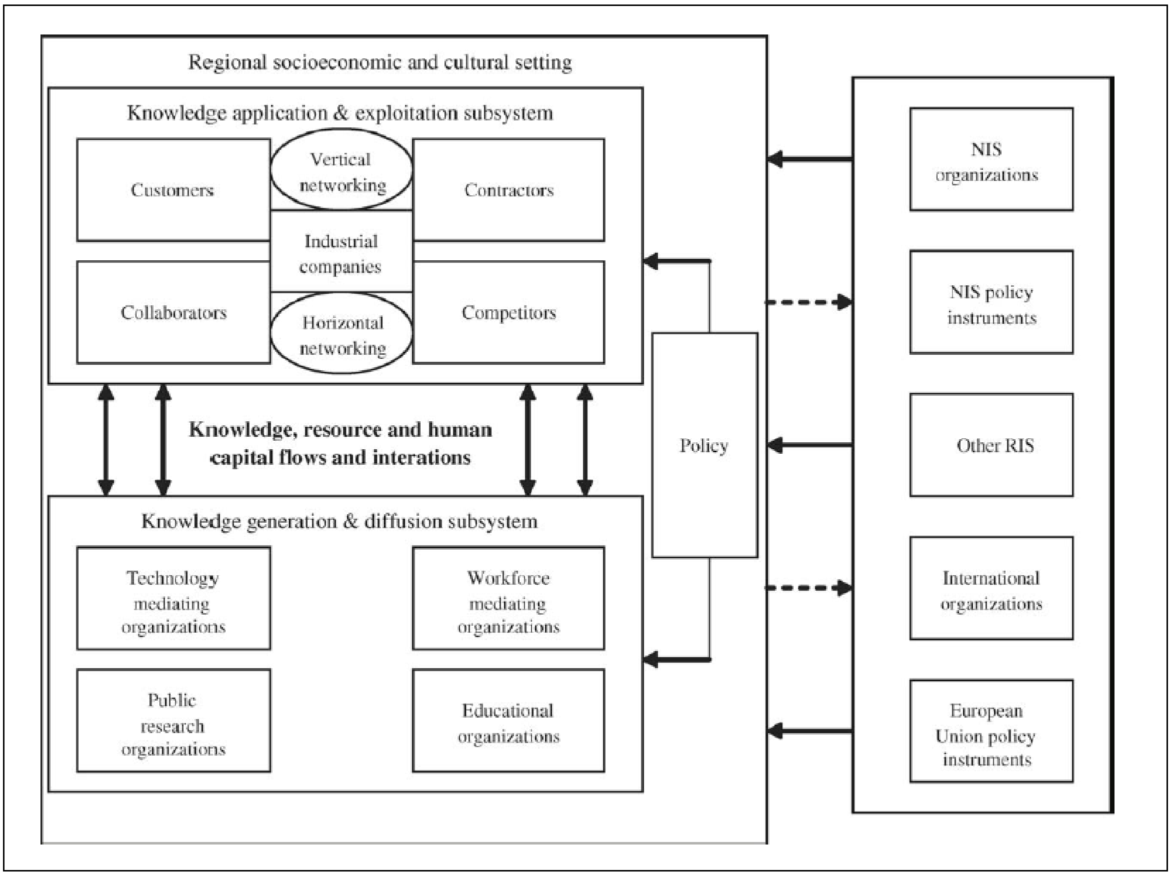
influenced change in investment and performance. The case studies, therefore, have been instrumental in addressing key issues underlying the research question, and especially the research objectives that pertain to the nature of regional innovation systems in lagging regions, the nature of public policy and public investment interventions that have been used to promote the development of regional innovation systems in such regions, and the influences of (a) the nature of lagging regional economies and (b) their interaction with other spatial levels in shaping policy making for R&D and innovation in lagging regions.

8.3 Framework for the Case Study Analysis

The analytical framework that underpins the case study analysis draws on Tödtling and Trippl (2005), as discussed previously in Chapter 4 (Section 4.5) and Chapter 5 (Section 5.4), and as outlined in Figure 8.1. Under this framework, the research examines the structure and development of regional innovation systems according to three different "sub-systems", which are as follows:

- the "knowledge generation and diffusion sub-system", which consists of the various institutions that are engaged in the production and diffusion of knowledge and skills in a region. Elements of this sub-system, for example, might include educational institutions (e.g. universities, other higher education or vocational training institutions), public research institutions or technology mediating organisations (technology licensing offices, innovation centres);
- the "knowledge application and exploitation sub-system", which consists of companies, their clients, suppliers, competitors and co-operation partners. These actors may have developed "clusters" or similar territorial links within a region, and they are ideally linked by horizontal and vertical networking;
- the regional policy dimension, which is included as an additional "sub-system" on the basis that policy actors at the regional level can play a role in shaping regional innovation processes if there is sufficient regional autonomy, legal competencies and financial resources to formulate and implement innovation policies.

Figure 8.1: Analytical Framework for Analysis of Case Study Regions



Source: Tödtling and Trippl (2005)

Added to this analysis of sub-systems, in turn, are other elements of the Tödtling and Trippl (2005) framework, which are similarly investigated within the case studies. These elements in the framework, which are also outlined in Figure 8.1, include:

- the regional socio-economic and cultural setting within which regional innovation systems are embedded (e.g. population, economic growth, education, sectoral specialisation), which can impact on the development of the innovation system;
- the nature of the relationships within and between the different sub-systems. In an "ideal-type" regional innovation system, for example, intensive interactive relationships would exist within and between the sub-systems, facilitating a continuous flow or exchange of knowledge, resources and human capital;
- regional innovation system links to, and interaction with, national and international actors and innovation systems. This might include links to firms outside the region, for example, or the policy influence of national and international policy actors, such

as the national government or the EU (via the allocation of Structural Fund support).

However, as the purpose of the case studies has also been to look at the development of regional innovation systems in lagging regions, the analytical framework adopted therefore also sought to assess the extent to which typical weaknesses attributed to regional innovation systems in lagging regions have been addressed in Galicia and Puglia. In this regard, Table 8.1 lists a menu of possible perceived weaknesses, and how they relate to different elements of the analytical framework, with the case studies exploring what progress has been made in addressing these types of weaknesses within the regions.

Table 8.1: Weaknesses Attributed to Regional Innovation Systems in Lagging Regions

Element	Weaknesses
Knowledge Generation and Diffusion Sub-system	▪ Lower quality/quantity of scientific/technological infrastructure ▪ Lack of intermediaries capable of identifying demand for R&D and innovation and matching it with sources of R&D and innovation
Knowledge Application and Exploitation Sub-system	▪ Lack of dynamic clusters/critical mass, or weakly developed clusters ▪ Lack of capacity in firms to identify their needs for innovation ▪ Lack of expression of latent demand for innovation within firms ▪ Poorly developed financial systems, e.g. few funds for risk/seed capital ▪ Lack of business services to promote dissemination of technology in areas where firms have only weak internal resources for innovation ▪ Few large firms undertaking R&D, with poor links to the local economy
Regional Policy Sub-system	▪ Low levels of public assistance for innovation ▪ Aid schemes poorly adapted to the innovation needs of local SMEs
Knowledge, Resource and Human Capital Flows and Interactions	▪ Weak co-operation links between the public and private sectors ▪ Few networks due to weak clustering, weak social capital ▪ Lack of an entrepreneurial culture prone to inter-firm co-operation ▪ Difficulties in attracting skilled labour and accessing external know-how ▪ Scarcely developed communications networks
Regional Socio-economic and Cultural Setting	▪ Specialisation in traditional sectors, with little inclination for innovation ▪ Predominance of small firms with weak links to international markets ▪ Small and relatively closed markets, with unsophisticated demand
Links to National and International Systems	▪ Little participation in international R&D networks

Source: Author’s own elaboration, derived from Oughton et al (2002) and Tödtling and Trippl (2005)

8.4 Structure of the Case Study Analysis

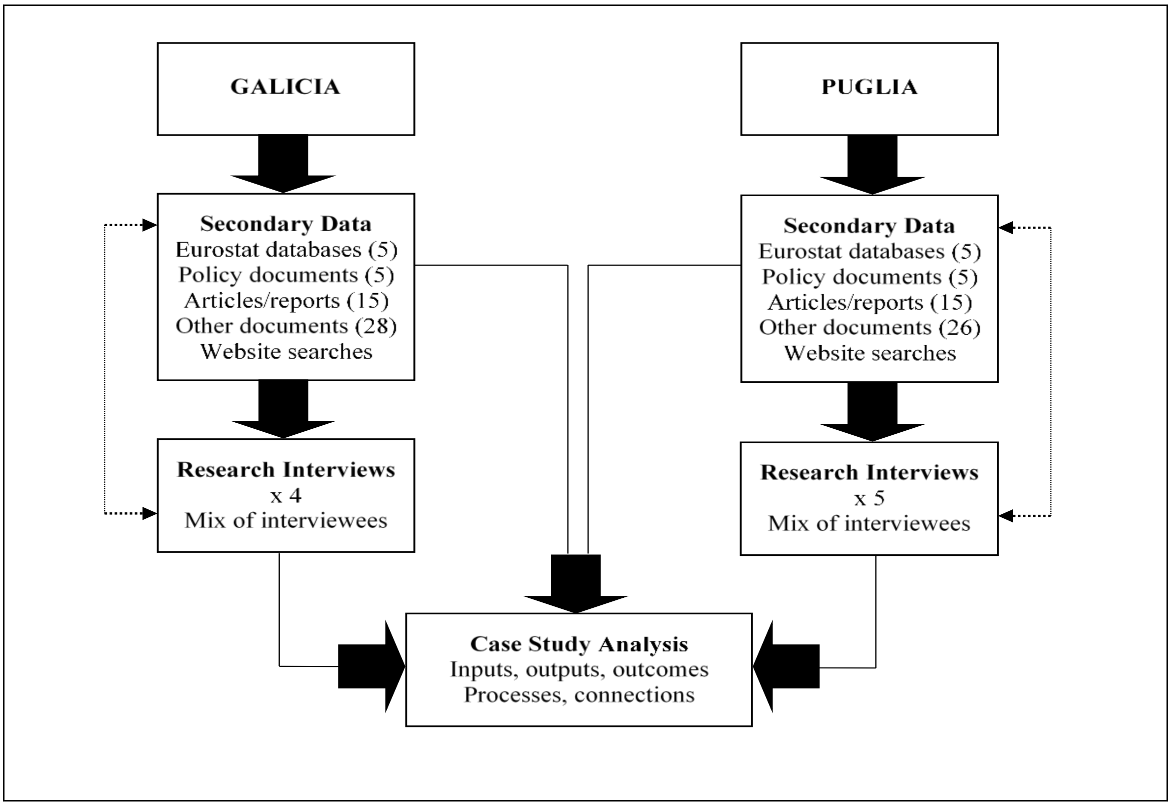
The case study analysis is provided across three main chapters, which inform the analytical framework for the case studies, as described in Section 8.3. Firstly, Chapter 9 provides context for the case studies by describing the innovation performance of the two regions, showing how the performance of the two regions has differed under commonly used indicators for R&D and innovation activity. This is based on the earlier quantitative analysis, and it focuses especially on regional trends across available R&D and innovation indicators in Galicia and Puglia, including R&D expenditure, R&D personnel, patent activity and employment in key innovating sectors. However, Chapter 9 also looks at the socio-economic context in Galicia and Puglia, as an input to understanding the regional socio-economic setting in each region (see Figure 8.1). In particular, the analysis of socio-economic context looks at both socio-economic structure and performance in Galicia and Puglia, including trends in population density and growth, GDP, labour market, employment and unemployment, education and skills, and sectoral composition.

Chapter 10 then describes the main elements of regional innovation systems in Galicia and Puglia (see Figure 8.1), and developments in these systems over time, with a focus on describing:

- the main actors in the knowledge generation and diffusion sub-system, e.g. universities, public research institutions, other research or technology centres, knowledge transfer organisations;
- the knowledge application and exploitation sub-system, which focuses mainly on the level of firm activity in innovation in the regions, and the main actors;
- the regional policy dimension, which includes (a) the regional policy "sub-system" of policy actors, which play a role in shaping regional innovation processes, and (b) the policies for innovation that have been developed in each region over the period.

Chapter 9 and Chapter 10, therefore, tell us something about the inputs, outputs and outcomes associated with the development of R&D and innovation in Galicia and Puglia over the 2000-13 period. However, the chapters tell us less about the processes, connections or other influencing factors that might link the inputs to the outputs and outcomes. To address this, Chapter 11 thus seeks to aid the interpretation of the evidence provided in Chapter 9 and Chapter 10 by presenting the findings arising from a series of interviews that were carried out in both Galicia and Puglia. In this regard, Chapter 11 presents the opinions and insights of a sample of informed actors in each region regarding the development of R&D and innovation performance and regional innovation systems over time, including their views on the processes, connections and influencing factors underlying investment/performance and regional innovation systems, which in turn provides the research with a deeper understanding of the issues underlying most of the research objectives (e.g. perceived input of different actors in the regional innovation systems, perceived appropriateness of policy prescriptions, perceived influence of links to national or other extra-regional levels, perceived influence of structural economic factors etc). Alongside this, however, the chapter gauges the extent to which opinions support or contradict the evidence provided in Chapter 9 and Chapter 10, and what this contributes to understanding the development of R&D and innovation in Galicia and Puglia. The research process for the case studies, previously outlined in Chapter 5 (Section 5.4.6), is again summarised in Figure 8.2.

Figure 8.2: Case Study Research Process – Flowchart



Source: Author

CHAPTER 9 – CASE STUDIES: SOCIO-ECONOMIC CONTEXT AND INNOVATION PERFORMANCE

9.1 Introduction

The purpose of this chapter is to describe (a) the socio-economic context in Galicia and Puglia, as an input to understanding the regional socio-economic setting in each region, and (b) the innovation performance of the two regions, which is based on the earlier quantitative analysis, and which shows how the performance of the two regions has differed under commonly used indicators for R&D and innovation activity. In particular:

- the analysis of socio-economic context looks at both socio-economic structure and performance in Galicia and Puglia, including trends in: population density and growth; GDP; labour market, employment and unemployment; education and skills; and sectoral composition. This analysis looks principally at trends over the 2000-13 period (i.e. the study period), while also taking account of more recent trends (e.g. up to 2017 or 2018, depending on data availability);
- the analysis of innovation performance looks at regional trends across available R&D and innovation indicators in Galicia and Puglia, including: R&D expenditure; R&D personnel; patent activity; and employment in key innovating sectors. Again, this analysis looks principally at trends over the 2000-13 period, based on the quantitative analysis described earlier in Chapter 6, while also taking account of more recent trends (e.g. up to 2017 or 2018, depending on data availability).

However, it is again important to remind the reader at the outset that Chapter 9 only tells us something about context, inputs, outputs and outcomes associated with the development of R&D and innovation in Galicia and Puglia over the 2000-13 period, based on commonly used indicators. At the same time, these indicators cannot tell the whole story regarding the development of R&D and innovation in the two regions (e.g. they cannot easily convey the role of processes, connections or other influencing factors in the development of R&D and innovation), and this underlies the decision to carry out case study research for this thesis.

Section 9.2 and Section 9.3, therefore, look at the socio-economic context and innovation performance in Galicia, while Section 9.4 and Section 9.5 look at the socio-economic context and innovation performance in Puglia. Section 9.6 provides a summary of the chapter.

9.2 Regional Economic Structure and Performance – Galicia

9.2.1 Introduction

Galicia is a region situated in the north-west of Spain. It is the most north-westerly region both in Spain and in the Iberian Peninsula generally. It has a surface area of about 29,600 km^2, and Eurostat estimates (for 2018) show that the region has a total population of about 2.7 mn people.

From the perspective of EU regional policy, Galicia was technically classified as a lagging region throughout the period between 1994 and 2013[34]. In particular:

- the region was designated as having "Objective 1" status for EU Structural Fund purposes in the 1994-99 and 2000-06 programming periods, being a region with a GDP per capita of less than 75% of the EU average (based on 15 member states)[35];
- similarly, for the 2007-13 programming period, Galicia was designated as a "Convergence" region, again being a region with a GDP per capita of less than 75% of the EU average (based on 25 member states)[36].

[34] Further discussion of lagging regions, and the definition of such regions that is adopted for this thesis, is provided in Chapter 3.
[35] There were 11 other Spanish regions that were designated with Objective 1 status during the 2000-06 period, including Principado de Asturias, Castilla y León, Castilla-la Mancha, Extremadura, Comunidad Valenciana, Andalucía, Región de Murcia, Ciudad Autónoma de Cueta, Ciudad Autónoma de Melilla, Canarias and Cantabria. However, Cantabria only had Objective 1 status on a transitional and reduced basis.
[36] There were seven other Spanish regions that were designated as Convergence regions during the 2007-13 period, including Principado de Asturias, Castilla-la Mancha, Extremadura, Andalucía, Región de Murcia, Ciudad Autónoma de Cueta and Ciudad Autónoma de Melilla. However, Principado de Asturias, Región de Murcia, Ciudad Autónoma de Cueta and Ciudad Autónoma de Melilla only had Convergence region status on a transitional and reduced basis.

This meant, therefore, that Galicia was among the regions afforded highest priority for EU Structural Fund assistance across the 1994-13 period. However, the region since experienced relatively high levels of economic growth over this time, bringing some convergence towards EU average levels of economic development, to the extent that it was no longer classified as a lagging region for the 2014-20 Structural Fund programming period. Instead, Galicia was classified as a transitional region for the 2014-20 period, with reduced levels of support.

The rest of this section now examines recent trends in population density and growth, GDP, labour market, employment and unemployment, education and skills, and sectoral composition in Galicia, i.e. the type of indicators that are typically used by the EU when classifying regions for Structural Fund assistance purposes[37]. In general, data presented looks firstly at the 2000-13 study period, alongside updated data for 2017 or 2018, with regional trends compared to both Spanish and EU-15 averages.

9.2.2 Population

As noted in Section 9.2.1 above, Galicia has a population of about 2.7 mn people, based on Eurostat estimates for 2018. Across the 2000-13 study period, population growth in the region was below both Spanish and EU-15 averages. Table 9.1, for example, shows that the Galician population grew by 2% between 2000 and 2013, whereas EU-15 average growth was nearly 6% and Spanish average growth was nearly 16%. Between 2013 and 2018, however, the population in Galicia declined by about 2%, whereas the Spanish population declined by less than 1% and the EU-15 population grew by over 2%.

Table 9.1: Population Growth (%) in Galicia 2000-13 and 2013-18

	2000 (000s)	**2007 (000s)**	**2013 (000s)**	**2018 (000s)**	**Growth 2000-13 (%)**	**Growth 2013-18 (%)**
Galicia	2,702	2,741	2,762	2,703	2.2%	-2.1%
Spain	40,470	44,785	46,728	46,658	15.5%	-0.2%
EU-15	377,597	391,489	400,035	408,416	5.9%	2.1%

Note: Based on Eurostat data. All estimates are dated 13-09-19 and extracted 20-12-19.
Source: Eurostat

[37] Again, see the definition and description of lagging regions provided in Chapter 3.

The size of population in Galicia in 2018, therefore, was much the same as in 2000. Related to this, Faiña, López-Rodríguez, Montes-Solla, Calvo-Porral and Bolea (2013) also note that the region has historically experienced emigration, particularly during the 1960s and 1970s, while Eurostat data shows a year-on-year decline in population in each year across the 1990-2000 period. This was followed by positive net migration into the region for each year from 2000 up to and including 2011, but with negative net migration again being evident in subsequent years.

Table 9.2, meanwhile, shows that population density in Galicia, at about 92 persons per km^2, is similar to the Spanish average (93 persons per km^2), though somewhat below the EU-15 average (123 persons per km^2). When compared to other regions that have been classified as "lagging" in Spain, population density is lower than in Comunidad Valenciana, Región de Murcia, Ciudad Autónoma de Cueta, Ciudad Autónoma de Melilla, Canarias and Cantabria (at between 110 and 6,000 persons per km^2), similar to Principado de Asturias and Andalucía (at about 97 persons per km^2), but higher than in Castilla y León, Castilla-la Mancha and Extremadura (at about 26 persons per km^2).

Table 9.2: Population Density (per Km^2) in Galicia 2000, 2007, 2013 and 2017

	2000	2007	2013	2017
Galicia	91.3	93.6	93.9	92.1
Spain	80.2	90.1	92.9	92.7
EU-15	113.6	117.8	121.0	123.0

Note: Based on Eurostat data. All estimates are dated 13-09-19 and extracted 20-12-19.
Source: Eurostat

While population density was similar to the Spanish average, however, the population is concentrated in certain parts of the Galician territory. According to Xunta de Galicia (2014), for example, more than three-quarters of the population is concentrated in the provinces of Coruña and Pontevedra, which account for about 40% of the total Galician territory, and where five of the region's seven cities are situated, i.e. Vigo, A Coruña, Santiago de Compostela, Pontevedra and Ferrol. Also, about 63% of Galicia's municipalities have a population of less than 5,000, compared to 31% of all municipalities in Spain (Xunta de Galicia, 2014), while Faiña et al (2013) suggest that

Galicia accounts for 50% of Spain’s centres of population, even though it only accounts for 6% of its total population and 6% of its land area.

Figure 9.1: Map of Galicia

Source: Rainer Lesniewski/Shutterstock.com

9.2.3 GDP

In terms of overall economic output and relative regional wealth, Faiña et al (2013) noted that the Galician economy achieved a rapid convergence towards average Spanish levels prior to the onset of financial and economic crisis in 2008, at a time when the Spanish economy generally was also achieving high growth rates and high levels of job creation in comparison to other more developed EU countries (Del Castillo, Moreno, Arriola and Barroeta, 2006).

Table 9.3, for example, shows that GDP per capita in Galicia, as measured in PPS terms, grew from 14,700 in 2000 up to 23,000 in 2007, representing a growth of over 56%, while growth in GDP per capita across Spain for the same period was 42% and growth in GDP per capita in the EU-15 was 27%. However, GDP per capita in the region subsequently fell by 8% between 2007 and 2013 (from 23,000 down to 21,200) due to the impact of the financial and economic crisis, though it increased again to 24,700 in 2017 (a growth of more than 16%).

Table 9.3: Growth in GDP per Capita (PPS) in Galicia 2000-17

	2000	**2007**	**2013**	**2017**	**Growth 2000-13 (%)**	**Growth 2013-17 (%)**
Galicia	14,700	23,000	21,200	24,700	44.2%	16.5%
Spain	18,900	26,900	24,000	27,600	27.0%	15.0%
EU-15	23,030	29,170	29,280	32,410	27.1%	10.7%
Galicia as % of Spain	77.8%	85.5%	88.3%	89.5%	-	-
Galicia as % of EU-15	63.8%	78.8%	72.4%	76.2%	-	-

Note: Based on Eurostat data. Estimates are dated 06-09-19 and extracted 23-12-19.
Source: Eurostat

GDP per capita in Galicia therefore grew from 77% to 88% of the Spanish average over the 2000-13 study period, and from 64% to 72% of the EU-15 average. By 2017, moreover, it had grown to 90% of the Spanish average and 76% of the EU-15 average. As a caveat to this, however, it should be noted that the evident convergence in GDP per capita in Galicia, i.e. towards Spanish and EU averages, was partially attributable to its relatively low population growth, particularly when compared to overall population growth in Spain. In this regard, for example, when looking at absolute GDP growth over the study period (i.e. when not expressed per head of population), Eurostat data shows that GDP growth trends in Galicia were actually very similar to the Spanish average, both in the 2000-07 period (60%) and the 2007-13 period (-8%).

Relative to other lagging regions in Spain, Galicia's GDP per capita growth in the 2000-13 period was higher than in most other lagging regions, including Extremadura (38%), Principado de Asturias (33%), Castilla y León (32%), Castilla-la Mancha (30%), Andalucía (27%), Región de Murcia (25%), Cantabria (23%), Comunidad Valenciana (16%) and Canarias (11%), while its subsequent growth up to 2017 similarly compared favourably with these regions. At the same time, it should be noted that most of these other regions also grew either at or above the Spanish average over this time (and in some cases, while recording higher levels of population growth than in Galicia).

9.2.4 Labour Market

Regarding labour market trends in Galicia, Table 9.4 shows that the labour force participation rate grew steadily between 2000 and 2013, rising from 66% in 2000 up to 70% in 2007, and up to 72% in 2013. In the 2000-13 period, therefore, Galician labour force participation rates converged towards the EU-15 average (which grew from 69% in 2000 up to 73% in 2013), while being slightly below the overall Spanish average (which grew from 65% in 2000 up to 74% in 2013). As of 2018, meanwhile, labour force participation in Galicia was also at 72%, again being slightly below both the Spanish and EU-15 averages.

Table 9.4: Labour Market Trends in Galicia 2000, 2007, 2013 and 2018

	2000	**2007**	**2013**	**2018**
Labour Force Participation (%)				
Galicia	65.0%	69.5%	72.1%	72.3%
Spain	65.1%	71.8%	74.3%	73.7%
EU-15	69.0%	71.8%	73.1%	74.3%
Employment (%)				
Galicia	55.3%	64.2%	56.1%	62.6%
Spain	56.1%	65.8%	54.8%	62.4%
EU-15	63.2%	66.7%	64.9%	68.7%
Unemployment (%)				
Galicia	14.9%	7.6%	22.2%	13.5%
Spain	13.9%	8.3%	26.2%	15.4%
EU-15	8.5%	7.2%	11.3%	7.6%

Note: Estimates derived from Eurostat data. Estimates are dated 24-04-20 and extracted 04-06-20. Economic activity rates and employment rates are expressed as a percentage of the population (aged 15-64), while unemployment rates are expressed as a percentage of the economically active population (aged 15-64).

Source: Eurostat and author's calculations (based on Eurostat data)

The movement of trends in GDP growth in Galicia, however, are also reflected in employment and unemployment trends for the region. For example, Table 9.4 shows that the unemployment rate in the region was close to 15% in 2000, above the Spanish average of nearly 14% and well above the EU-15 average of more than 8%. By 2007, however, the rate of unemployment in the region had fallen to less than 8%, which was lower than the Spanish average (of just over 8%) and close to the EU-15 average of about 7%. Yet, the severe impact of the global financial and economic crisis subsequently contributed to an increase in the rate of unemployment to 22% in 2013, a rate that was double the EU-15 average in that year, though still below the increased Spanish average of 26%. As of 2018, meanwhile, the rate of unemployment in Galicia stood at just under 14%, compared to a Spanish average rate of over 15% and an EU-15 average rate of less than 8%.

As might be expected, of course, similar patterns are evident in the employment rate in Galicia over time. In 2000, for example, the share of people in employment (expressed as a proportion of the population aged 15-64) was over 55%, just below the Spanish average of 56%, but noticeably below the EU-15 average of 63%. By 2007, in contrast, the employment rate in the region had grown to 64%, again just below the increased Spanish average of 66%, but closer to the EU-15 average of 68%. However, by 2013, the impact of the global financial and economic crisis had again led to the employment rate in Galicia falling back to 56%, well below the EU-15 average of 65%, though above the reduced Spanish average of 55%. As of 2018, meanwhile, the rate of employment in Galicia stood at just under 63%, similar to the Spanish average but below the EU-15 average of nearly 69%.

Labour market trends in Galicia, in turn, were also similar to those experienced in other lagging regions in Spain over the same period. Labour force participation rates in most of these regions, for example, saw strong growth in the 2000-13 study period, with employment and unemployment rates displaying significantly positive trends between 2000 and 2007. Between 2007 and 2013, however, all lagging regions saw a sharp fall in employment rates, alongside very sharp increases in unemployment, followed by a partial recovery in the labour market situation between 2013 and 2018.

9.2.5 Education

In relative terms, Galicia appears to have a comparatively well educated population, when compared to both the rest of Spain and the EU-15. To illustrate this, Table 9.5 shows how the level of tertiary education attainment in Galicia compares to Spanish and EU-15 averages, and how it has progressed over time between 2000 and 2018, for (a) the population aged 25-64 and (b) the population aged 30-34. It shows, in particular, that the share of the Galician population aged 25-64 with completed higher education increased significantly over the period, rising from just under 19% in 2000 to just over 32% in 2013 and just under 37% in 2018. It also converged towards the Spanish average over time, which grew from just under 23% to just over 37% in the same period, while it surpassed the EU-15 average, which grew from just over 21% to just under 34% in the period.

Furthermore, a similar pattern is also evident when looking at tertiary education attainment among the younger population cohort aged 30-34. In this regard, Table 9.5 again shows growth in the share of the Galicia population that had completed higher education, rising strongly from nearly 28% in 2000 up to more than 43% in 2013 and more than 46% in 2018, which was higher than both the Spanish average (42%) and the EU-15 average (41%) for the same year.

Table 9.5: Population with Tertiary Education Attainment in Galicia 2000-18 (%)

	2000	**2007**	**2013**	**2018**
Aged 25-64				
Galicia	18.7%	28.6%	32.1%	36.9%
Spain	22.7%	29.3%	33.7%	37.3%
EU-15	21.3%	25.2%	30.1%	33.7%
Aged 30-34				
Galicia	27.5%	44.5%	43.4%	46.1%
Spain	29.2%	40.9%	42.3%	42.4%
EU-15	24.6%	32.6%	38.3%	41.4%

Note: Based on Eurostat data. Estimates are dated 24-04-20 and extracted 04-06-20.
Source: Eurostat

In addition, Table 9.6 suggests that participation in continuous education and training among Galicia’s adult population, or lifelong learning, has also increased. In particular, participation rates in education and training in the region (either formal or non-formal) grew from 4% of the population aged 25-64 in 2000 up to more than 10% in 2013, a level that it remained at in 2018. The participation rate is therefore similar to the overall Spanish average, though somewhat below the EU-15 average (nearly 13% in 2018).

Table 9.6: Population Aged 25-64 Participating in Education and Training in Galicia 2000-18 (%)

	2000	2007	2013	2018
Galicia	3.8%	11.2%	10.4%	10.4%
Spain	4.5%	10.8%	11.4%	10.5%
EU-15	8.1%	10.8%	12.4%	12.7%

Note: Based on Eurostat data. The participation rate in education and training covers participation in formal and non-formal education and training, and is used by Eurostat as a measure of lifelong learning. The reference period for participation is four weeks prior to survey interview. All estimates are dated 24-04-20 and extracted 05-06-20.
Source: Eurostat

9.2.6 Key Sectors and Enterprise Base

Historically, in spatial terms, the economy in Galicia has consisted of a mix of large rural areas coupled with modern industrial developments (Del Castillo et al, 2006), which are mostly situated in the Vigo-Pontevedra area. The nature of the regional economy, therefore, is not homogenous, with a mixture of contrasting urban and rural elements.

In relative terms, the agriculture sector has also historically represented a significant proportion of the Galician economy, although its relative share of the economy has declined over time. This decline is most clearly evident in terms of employment. Table 9.7, for example, shows that agriculture, forestry and fishing accounted for more than 17% of employment in the Galician economy in 2000, with industry (including construction) accounting for another 30% and services accounting for the remaining 53%. In relative terms, therefore, Galicia had a much larger agricultural employment than in the Spanish economy or the EU-15 economy in 2000, while its services employment was noticeably smaller than in either the Spanish or EU-15 cases. By 2013, however, agriculture's share of total employment in Galicia had fallen to just 7%, the industry share of employment was relatively unchanged, whereas the services sector share had grown to about 70%. By 2018, moreover, agriculture's share of total employment had dropped to just over 6%, with the services share of employment increasing to just under 72%.

Table 9.7: Sectoral Shares of Total Employment in Galicia 2000, 2007, 2013 and 2018

	2000	2007	2013	2018
Agriculture				
Galicia	17.4%	8.7%	7.4%	6.3%
Spain	6.7%	4.5%	4.3%	4.2%
EU-15	4.3%	3.5%	2.9%	2.6%
Industry				
Galicia	29.6%	30.3%	22.1%	21.9%
Spain	30.8%	29.1%	19.8%	20.3%
EU-15	28.8%	26.1%	22.5%	22.0%
Services				
Galicia	53.0%	61.0%	70.5%	71.8%
Spain	62.5%	66.4%	76.0%	75.5%
EU-15	66.5%	69.8%	74.6%	75.4%

Note: Derived from Eurostat data. All estimates are dated 11-12-19 and extracted 20-12-19.

Source: Author's calculations based on Eurostat data

Table 9.8 also shows the sectoral breakdown of economic activity in Galicia between 2000 and 2018, this time according to gross value added (GVA)[38]. It shows a smaller share for agricultural output over the period, decreasing to just over 5%, with the industry share of output (excluding construction) declining from about 22% to about 18%. Construction activity, meanwhile, fell significantly between 2007 and 2013 (from 12% to 7%, or by about 40% in growth terms), owing largely to the impact of the global financial and economic crisis, and it remained at about 7% in 2018. Within the services sector, the largest shares of output were attributable to the combined wholesale/retail, transport, accommodation/food service and public administration related sectors, at between 35% and 40% of GVA. Meanwhile, share of output in information and communications, financial and insurance activities and professional or scientific/technical activities was at about 13% in 2000 and 2007, falling to about 11% in 2013 before growing to 12% in 2018.

[38] GVA is the measure of the value of goods and services produced in an area, industry or sector of an economy.

Table 9.8: Sectoral Shares of Gross Value Added in Galicia 2000, 2007, 2013 and 2018

	2000	2007	2013	2018
Agriculture, forestry, fishing	6.5%	5.0%	5.7%	5.3%
Industry	22.1%	20.8%	19.2%	18.3%
Construction	11.6%	12.4%	6.9%	7.3%
Wholesale/retail, transport, accommodation/food services	20.3%	20.2%	21.8%	23.3%
Information and communications	3.6%	2.8%	2.4%	2.2%
Financial and insurance activities	3.9%	4.1%	3.1%	3.3%
Real estate activities	5.2%	8.0%	11.0%	10.5%
Professional, scientific/technical, administrative/support	5.4%	5.4%	5.8%	6.8%
Public administration/defence, education and health	17.5%	17.6%	19.7%	18.6%
Arts, entertainment, recreation and other service	4.0%	3.6%	4.4%	4.4%

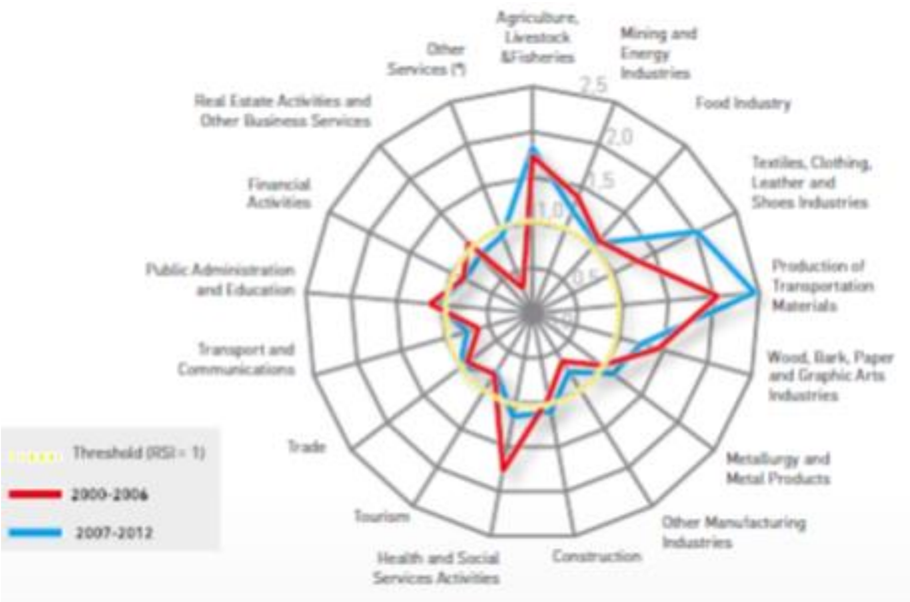
Note: Derived from Eurostat data. Estimates are dated 31-05-20 and extracted 05-06-20.
Source: Author's calculations based on Eurostat data

Analysis carried out for Xunta de Galicia (2014), and presented in Figure 9.2, gives some further insights on areas of specialisation within the Galician economy, relative to the Spanish economy, based on sectoral GVA and employment in the region. In particular, this analysis suggests that the Galician economy is relatively specialised in the following sectors:

- the fisheries sector, with Xunta de Galicia (2014) reporting that the sector accounts for more than 50% of all fisheries employment in Spain, about 10% of all fisheries employment in the EU and about 15% of all fisheries production in the EU. Pescanova, an indigenous Galician company, is a European leading firm in the fisheries sector (Almeida, Figueiredo and Rui Silva, 2011);
- the automotive sector, which is centred around the PSA Peugeot-Citroën plant in Vigo and several component producers (Almeida et al, 2011), and which accounts for about 12% of regional output, 26% of regional exports and 11% of industrial employment;
- the shipbuilding sector, which accounts for about 10% of industrial employment in the region, and about 45% of all shipyards in Spain;
- the textiles and clothing sector, which is centred around the Inditex group of companies in the region. Inditex companies incorporate the internationally renowned Zara brand, which was founded and remains headquartered in Galicia (Almeida et al, 2011);

- production of natural stone, including granite and slate. According to Xunta de Galicia (2014), the region is Europe’s second largest producer of granite, while it accounts for 70% of Spain’s production of slate (with Spain being a leading global producer);
- the timber sector, which accounts for about 10% of output in the region, and the energy sector, incorporating activities in both the non-renewable and renewable energy sectors.

Figure 9.2: Relative Specialisation Index for Economic Sectors in Galicia



Note: Where a value is greater than 1.0, this indicates that the sector is an area of specialisation for Galicia relative to the Spanish economy generally.

Source: Xunta de Galicia (2014)

In terms of the geographic location of economic activity, Eurostat estimates show that about 76% of economic output in Galicia derives from the provinces of A Coruña and Pontevedra, with the remaining 24% derived from the provinces of Lugo and Ourense (based on 2013 estimates). This is perhaps unsurprising, given that three-quarters of the region’s population, and most of its major centres of population, are found in A Coruña and Pontevedra (see Section 9.2.2). Furthermore, this geographic split of activity is consistent across most major sectoral groups with the exception of agriculture, forestry and fishing, in which Lugo and Ourense account for 38% of activity.

Finally, the vast majority of firms in Galicia are very small, with Eurostat estimates indicating that about 97% of nearly 210,000 active enterprises in the region have less than 10 employees (based on 2016 estimates). However, the equivalent share of small enterprises across all of Spain (96%) and the EU-15 (94%) is similarly high, so Galicia is not entirely unusual in this regard.

9.3 Innovation Performance – Galicia

9.3.1 Introduction

This section examines the innovation performance of Galicia, as measured by conventional measures for R&D and innovation at the regional scale, with a particular focus on how performance has changed over the two EU Structural Fund programming periods of 2000-06 and 2007-13, according to commonly used indicators for R&D and innovation. In this regard, the description of innovation performance provided here therefore draws on the analysis of innovation performance in lagging regions, provided in the earlier quantitative analysis (Chapter 6), while also giving some update on performance in more recent years (where available).

As a general introduction, however, it is notable that the description of Galicia as a lagging region has often also been mirrored in descriptions of its innovation capability (albeit these descriptions are again based solely on the commonly used indicators for socio-economic development, R&D and innovation, at a regional scale). So, for example, the region has been regularly classified as a “Moderate Innovator” in the EU’s Regional Innovation Scoreboard, or as a region that achieves between 50% and 90% of the EU average based on the Scoreboard’s “regional innovation index” (see European Commission, 2012b, 2014b, 2016, 2017b, 2019). Similarly, Galicia has been classified in other studies (see Appendix B) as follows:

- a “region with a weak economic and technological performance”, based on a typology of patterns of innovation prepared by Navarro et al (2008), i.e. a region that had per capita incomes, investment levels in R&D, levels of tertiary education and lifelong learning, levels of employment and human resources in science and technology that were generally lower than EU averages, and which also had a low population density and low accessibility, with low levels of industrial activity and a greater reliance on the agriculture and service sectors;

- a “disadvantaged region”, based on a study of innovation dimensions and profiles developed by Pinto (2009), i.e. a region that recorded a relatively low performance in terms of technological innovation (e.g. patent registration, private investment in R&D and employment in high/medium technology industries), economic structure (e.g. GDP and employment in services), labour market availability (e.g. levels of employment and rate of individuals with intermediate education levels) and human capital performance (e.g. education, training and public investment in R&D);
- a “low efficiency” region, based on a study of knowledge production and diffusion by Foddi and Usai (2013), which assessed how regions use internal and external inputs (i.e. investment in R&D, human capital and existing patent production) for the production of new knowledge and ideas (i.e. new patent applications).

Such classifications, admittedly, tend to be very R&D oriented in terms of how they convey innovation in regions, while the “statistical average” nature of such indicators at the regional scale also might not adequately reflect or capture the true spatial level at which R&D and innovation occurs, even within regions (e.g. taking account of urban and rural divides). However, there are nonetheless a limited number of indicators available to measure R&D and innovation at a regional scale, so on this basis, the rest of this section now examines regional trends across available R&D and innovation indicators, with a focus on the 2000-13 study period, including: R&D expenditure; R&D personnel; patent activity; employment in key innovating sectors (all sourced from Eurostat); and innovation trends in firms, as per results from the Companies in Innovation Survey, which is carried out in Spain by the Instituto Nacional de Estadística (Spain’s national statistics office).

9.3.2 Total R&D Expenditure

Investment in R&D in Galicia, measured in terms of R&D expenditure per capita (PPS), grew significantly over the 2000-13 study period. For example, Table 9.9 shows that average annual R&D expenditure per capita in Galicia grew by 110% between the 1994-99 and 2000-07 periods, thereafter growing by another 27% between the 2000-07 and 2008-12 periods.

Growth in the earlier part of the 2000s, therefore, was well above the equivalent growth in R&D expenditure for all of Spain and for the EU-15, which stood at roughly 60% and 20% respectively, while growth in expenditure thereafter was similar to overall Spanish levels (27%) and again above EU-15 levels (14%). The slowdown in expenditure growth when compared to the early 2000s, meanwhile, coincided with the impact of the global financial and economic crisis, which commenced in 2008, while R&D expenditure per capita over the more recent 2013-17 period (based on Eurostat data) has been at a similar level to the 2008-12 period, with little growth between periods.

Table 9.9: Total R&D Expenditure per Capita (PPS) in Galicia 1994-2012

	1994-99	**2000-07**	**2008-12**	**Growth 1994-99 v 2000-07 (%)**	**Growth 2000-07 v 2008-12 (%)**
Galicia	71.35	149.95	190.09	110.1%	26.8%
Spain	152.50	240.22	305.50	57.5%	27.2%
EU-15	390.67	470.95	536.74	20.5%	14.0%

Note: Derived from Eurostat data, using R&D expenditure estimates (dated 15-05-14, extracted 25-08-14) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.

Source: Author’s calculations based on Eurostat data

Despite expenditure growth, however, it is also clear from Table 9.9 that the base level of R&D investment in Galicia over the periods continued to lag both Spanish and EU-15 averages. The region’s average annual R&D expenditure per capita in the 2008-12 period, for example, was equivalent to about 62% of the Spanish average and about 35% of the EU-15 average for the same period. This point is further illustrated when R&D investment is expressed as a share of GDP, with Table 9.10 showing that Galicia again lagged Spanish and EU-15 averages. Moreover, more recent Eurostat data for the

2013-17 period shows that annual R&D expenditure per capita in Galicia was equivalent to between 61% and 70% of the Spanish average over that period.

Table 9.10: R&D Expenditure as a % of GDP in Galicia 2000-13

	2000	2007	2013
Galicia	0.63%	0.99%	0.87%
Spain	0.89%	1.23%	1.26%
EU-15	1.85%	1.86%	2.11%
Note: Based on Eurostat data. Estimates are dated 31-03-16 and extracted 16-06-16.			

Source: Eurostat

9.3.3 Business R&D Expenditure

Trends in business R&D expenditure are another indicator of the level of resources dedicated to the innovation process, and in particular the level of investment in innovation by firms. In this regard, growth in business R&D expenditure per capita in Galicia over the 2000-13 period (again expressed in PPS terms) was also substantial. For example, Table 9.11 shows that average annual business R&D expenditure per capita in Galicia grew by 220% between the 1994-99 and 2000-07 periods, and by another 40% between the 2000-07 and 2008-12 periods. Growth in the earlier part of the 2000s, therefore, was again well above the equivalent growth in business R&D expenditure for all of Spain (over 70%), while growth in business expenditure in the later period was also above overall Spanish levels (23%) and EU-15 levels (13%). Evidence for the more recent 2013-17 period, however, again suggests a similar level of expenditure to the 2008-12 period, with little growth between periods.

Table 9.11: Business R&D Expenditure per Capita (PPS) in Galicia 1994-2012

	1994-99	2000-07	2008-12	Growth 1994-99 v 2000-07 (%)	Growth 2000-07 v 2008-12 (%)
Galicia	19.38	62.03	88.22	220.0%	42.2%
Spain	75.57	130.70	160.96	72.9%	23.1%
EU-15	n/a	301.19	339.11	n/a	12.6%
Note: "n/a" = not available. Derived from Eurostat data, using R&D expenditure estimates (dated 15-05-14, extracted 17-09-14) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.					

Source: Author's calculations based on Eurostat data

Moreover, despite the evidence for growth, the business share of total R&D expenditure in Galicia remained below both Spanish and EU-15 averages. In the 2008-12 period, for example, the average business share of total R&D expenditure in Galicia was 46%, meaning that R&D investment in the region remained marginally more dependent on public sector investment, while the equivalent figure for all of Spain was 53% and the equivalent figure for the EU-15 was 63%.

Nonetheless, it should also be noted that the business share of total R&D expenditure in Galicia grew over time, from an average of 27% in the 1994-99 period up to the average of 46% in the 2008-12 period. More recent Eurostat data for the 2013-17 period, meanwhile, shows that annual business R&D expenditure per capita during that period was equivalent to between 45% and 50% of total R&D expenditure per capita in the region, whereas the equivalent Spanish average figure was between 53% and 55%.

9.3.4 Total R&D Personnel

Growth in R&D personnel in Galicia, measured in terms of R&D personnel per million population, has displayed a similar trend to growth in R&D expenditure, growing significantly over the past couple of decades. For example, Table 9.12 shows that average annual R&D personnel per million population in Galicia grew by just under 100% between the 1994-99 and 2000-07 periods, thereafter growing by another 33% between the 2000-07 and 2008-12 periods. Growth in the earlier part of the 2000s, therefore, was again well above the equivalent growth in R&D personnel for all of Spain, which stood at 64%, while growth in personnel thereafter was also higher than overall Spanish levels (26%) and EU-15 levels (15%). However, more recent Eurostat data for the 2013-17 period again shows a similar level of R&D personnel to the 2008-12 period, with little growth between periods.

Table 9.12: Total R&D Personnel per Million Population in Galicia 1994-2012

	1994-99	2000-07	2008-12	Growth 1994-99 v 2000-07 (%)	Growth 2000-07 v 2008-12 (%)
Galicia	1,372	2,719	3,621	98.2%	33.2%
Spain	2,253	3,705	4,669	64.4%	26.0%
EU-15	n/a	4,995	5,734	n/a	14.8%

Note: "n/a" = not available. Derived from Eurostat data, using R&D personnel estimates (dated 15-05-14, extracted 22-08-14) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.

Source: Author's calculations based on Eurostat data

Moreover, as with trends in R&D investment, it is again clear from Table 9.12 that the base level of R&D personnel in Galicia has lagged both Spanish and EU-15 averages, though to a lesser extent than in the case of R&D investment. The region's average annual R&D personnel per capita, for example, was equivalent to about 78% of the Spanish average and about 63% of the EU-15 average in the 2008-12 period. Furthermore, this point is also illustrated when R&D personnel are expressed as a share of active population, with Table 9.13 showing that Galicia has similarly lagged Spanish and EU-15 averages in this regard, while more recent Eurostat data for the 2013-17 period shows that annual R&D personnel per capita in Galicia was equivalent to between 76% and 82% of the Spanish average over that period.

Table 9.13: R&D Personnel as a % of Active Population in Galicia 2000-13

	2000	2007	2013
Galicia	0.48%	0.67%	0.73%
Spain	0.69%	0.90%	0.88%
EU-15	1.03%	1.12%	1.25%

Note: Based on Eurostat data. Estimates are dated 31-03-16 and extracted 17-06-16.

Source: Eurostat

9.3.5 *Business R&D Personnel*

Growth in business R&D personnel in Galicia in the 2000-13 period (expressed per million population) was also substantial. In this regard, Table 9.14 shows that average annual business R&D personnel per million population in Galicia grew by 240% between the 1994-99 and 2000-07 periods, and by another 50% between the 2000-07 and 2008-12 periods. Growth in the earlier part of the 2000s was again, therefore, well above the equivalent growth in business R&D personnel for all of Spain (about 100%), while growth in business personnel in the later period was also above overall Spanish levels (27%) and EU-15 levels (14%). In the more recent 2013-17 period, meanwhile, Eurostat data suggests that business R&D personnel per million population in Galicia has grown by a further 10% when compared to the 2008-12 period.

Table 9.14: Business R&D Personnel per Million Population in Galicia 1994-2012

	1994-99	2000-07	2008-12	Growth 1994-99 v 2000-07 (%)	Growth 2000-07 v 2008-12 (%)
Galicia	250	854	1,285	242.3%	50.4%
Spain	790	1,563	1,986	97.8%	27.1%
EU-15	n/a	2,723	3,114	n/a	14.3%

Note: "n/a" = not available. Derived from Eurostat data, using R&D personnel estimates (dated 15-05-14, extracted 05-06-14) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.

Source: Author's calculations based on Eurostat data

Nonetheless, despite this growth, and as in the case of R&D investment, the business share of total R&D personnel in Galicia has remained below both Spanish and EU-15 averages. In the 2008-12 period, for example, the average business share of R&D personnel in Galicia for the period was 35%, while the equivalent figure for all of Spain was 43% and the equivalent figure for the EU-15 was 54%. At the same time, it should also be noted that the business share of total R&D personnel in Galicia has increased over time, from an average of 18% in the 1994-99 period up to the average of 35% in the 2008-12 period. More recent Eurostat data for the 2013-17 period, meanwhile, shows that annual business R&D personnel per capita during that period was equivalent to between 38% and 45% of total R&D personnel per capita in the region, whereas the equivalent Spanish average figure was consistently equivalent to about 44% of total R&D personnel per capita during this time.

9.3.6 *Patent Activity*

The growth trends evident in R&D investment and R&D personnel activity in Galicia have also been evident in the region's growth in patent applications, a commonly recognised output of R&D and innovation activity. Table 9.15, for example, shows that the average annual number of patent applications in Galicia (expressed per million population) grew by nearly 180% between the 1994-99 and 2000-07 periods, and by a further 60% between the 2000-07 and 2008-11 periods[39].

Growth, therefore, was well above overall Spanish growth (96% and 23%) and EU-15 growth (40% and 4%) across the two periods.

Table 9.15: Total Patent Applications per Million Population in Galicia 1994-2011

	1994-99	**2000-07**	**2008-11**	**Growth 1994-99 v 2000-07 (%)**	**Growth 2000-07 v 2008-11 (%)**
Galicia	3.10	8.57	13.73	176.4%	60.3%
Spain	13.29	26.09	32.16	96.3%	23.3%
EU-15	96.41	134.52	140.39	39.5%	4.4%

Note: Derived from Eurostat data. Galicia and Spain estimates are derived using patent application estimates (dated 30-01-14 and 02-06-15, extracted 29-08-14 and 02-11-15) and population estimates (dated 13-10-14, extracted 17-10-14). EU-15 estimates are derived using patent application estimates (dated 26-01-16, extracted 09-05-16) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.

Source: Author's calculations based on Eurostat data

However, it is clear from Table 9.15 that the base level of patent activity in Galicia has continued to lag both Spanish and EU-15 averages, i.e. a trend that is similar to that evident for both R&D investment and R&D personnel in Galicia. For example, the region's average annual patent applications per million population in the 2008-11 period were equivalent to about 43% of the Spanish average for the period, but it was just 10% of the EU-15 average. This distance from EU averages for patents, when compared to the differences in R&D investment, has also been previously commented on by González-López, Dileo and Losurdo (2014)[40].

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[39] It should be noted that data on patent applications was only available up to 2011 at the time of the analysis, whereas data on R&D investment and R&D personnel was available up to 2012.

[40] An update on more recent data is not possible because, at the time of writing, Eurostat did not report data on patent applications at the regional level beyond 2012.

9.3.7 Employment in Key Sectors

At the sectoral level, regional data is available for a number of broad sectoral groups that Eurostat classifies as technology or knowledge-intensive sectors – these include high and medium-high technology manufacturing, knowledge intensive services and high technology sectors (a sub-set of the other two groups). In this regard, Table 9.16 shows that growth in average annual employment in these sectors was recorded in Galicia between the 1994-99 and 2000-07 periods. For example, growth in average annual employment in high and medium-high technology manufacturing in Galicia was nearly 38% between the 1994-99 and 2000-07 periods, higher than overall Spanish growth (24%) and EU-15 growth (less than 1%). Average annual employment in knowledge intensive services in Galicia grew by 43% between the same periods, again higher than the EU-15 average growth of 21%, but lower than the overall Spanish growth of 52%. Similarly, average annual employment in high technology sectors in Galicia grew by 48% between the 1994-99 and 2000-07 periods, also higher than the EU-15 average growth of 19%, but again lower than the overall Spanish growth of over 70%. Therefore, regional employment growth in these sectors did not out-perform either Spanish or EU-15 averages to the extent that was evident for R&D investment, R&D personnel or patent applications over the same periods, though growth was still positive.

Table 9.16: Employment in Key Innovating Sectors in Galicia 1994-2007

	1994-99	**2000-07**	**Growth 1994-99 v 2000-07 (%)**
High/Medium-High Tech Manufacturing			
Galicia	37,888	52,094	37.5%
Spain	708,700	875,700	23.6%
EU-15	11,679,000	11,740,000	0.5%
Knowledge Intensive Services			
Galicia	168,083	240,122	42.9%
Spain	3,071,400	4,668,900	52.0%
EU-15	46,918,000	56,536,000	20.5%
High Technology Sectors			
Galicia	13,305	19,681	47.9%
Spain	327,100	557,700	70.5%
EU-15	6,613,000	7,847,000	18.7%

Note: Data refers to annual averages for each of the two periods examined. EU-15 data for the first period, however, relates to 1995-99. Eurostat data for Galicia and Spain is dated 26-06-13, extracted 29-08-14. Eurostat data for EU-15 is dated 15-07-15, extracted 10-05-16.

Source: Author’s calculations based on Eurostat data

Since average annual employment in the 2000-07 period cannot be compared to average annual employment in the period from 2008 onwards, due to changes in the European NACE codes, Table 9.17 instead shows employment growth in the key sectoral groups between the years 2008 and 2012. The data suggest that there was no growth in employment in high and medium-high technology manufacturing in Galicia during the period, though EU-15 employment in the sector declined by 9% and total Spanish employment in the sector declined by 18% during the same time. Employment in knowledge intensive services in the region declined by 7% in the period, though it grew slightly in both an overall Spanish and EU-15 context, while employment growth in high technology sectors for the period stood at 14%, in contrast to an overall Spanish average decline of 5% and an EU-15 average decline of 1%. The data, however, also have to be viewed within the context of the global financial and economic crisis, which occurred over the period.

Table 9.17: Employment in Key Innovating Sectors in Galicia 2008-12

	2008	2012	Growth 2008-12 (%)
High/Medium-High Tech Manufacturing			
Galicia	43,000	43,000	0.0%
Spain	844,000	690,000	-18.2%
EU-15	10,408,000	9,505,000	-8.7%
Knowledge Intensive Services			
Galicia	354,000	330,000	-6.8%
Spain	6,308,000	6,397,000	1.4%
EU-15	69,623,000	71,553,000	2.8%
High Technology Sectors			
Galicia	21,000	24,000	14.3%
Spain	666,000	634,000	-4.8%
EU-15	7,028,000	6,979,000	-0.7%

Note: Eurostat data for Galicia and Spain is dated 06-10-15, extracted 02-11-15. Eurostat data for EU-15 is dated 22-12-15, extracted 10-05-16.

Source: Author’s calculations based on Eurostat data

The share of employment within these sectors in Galicia, in general, has also remained below national and EU averages. As a share of total employment, for example, employment in high and medium-high technology manufacturing in the region accounted for 3.7% of total employment in the region in 2013, which was slightly below the Spanish average share (3.9%) but further below the EU-15 average share

(5.5%). Employment in high technology sectors in the region, on the other hand, accounted for 2.7% of total employment in 2013, noticeably below both the Spanish average share (3.7%) and the EU-15 average share (4.1%), while employment in knowledge intensive services accounted for about 32% of total employment in Galicia in 2013, again below the Spanish average share (36%) and the EU-15 average share (42%). More recent data for 2018, meanwhile, shows that:

- employment in high and medium-high technology manufacturing in Galicia accounted for 3.8% of total employment in the region, compared to a Spanish average of 4.1% and an EU-15 average of 5.6%;
- employment in knowledge intensive services accounted for about 34% of total employment in the region, compared to a Spanish average of 36% and an EU-15 average of 43%;
- employment in high technology sectors accounted for 2.9% of total employment in the region, compared to a Spanish average of 3.6% and an EU-15 average of 4.2%.

9.3.8 Companies in Innovation Survey (Spain)

Another source of data on innovation performance in Galicia is the Companies in Innovation Survey, which is carried out in Spain by the Instituto Nacional de Estadística. This survey provides data regarding: the total number of innovative companies[41] by region; the number of product innovating companies by region; and the number of process innovating companies by region.

However, it should be noted that the survey only focuses on companies with at least 10 paid employees, which account for just 3% of firms in Galicia and 4% of firms in Spain more generally (as previously noted in Section 9.2.6). Also, being a survey, the possibility of survey bias or sample size issues should be allowed for[42].

[41] The definition of an "innovative company" used for the survey is in line with international standards for the definition of innovation in companies, i.e. the Oslo Manual. It thus includes technological innovation (technologically new products and services as well as significant technological improvements to them) and non-technological innovation (whereby a company is considered to be innovating when it carries out product, process, marketing or organisational innovations).

[42] The sample size for the survey, across the whole of Spain, is over 40,000 enterprises with 10 or more employees.

Table 9.18 provides data on the total number of innovative companies in Spain and in each lagging region, with data examined in three-year periods, from the 2003-05 period through to the 2011-13 period. It suggests that the number of innovative companies in Galicia has fluctuated over time, from a high of nearly 2,560 companies in the 2009-11 period down to a low of about 2,060 companies in the 2011-13 period. However, it is notable that Galicia's share of all innovative companies in Spain has either grown or been maintained in this time, rising from 4.6% in the 2003-05 period up to between 5.3% and 5.4% for most of the following periods. In this respect, therefore, Galicia appears to compare favourably with other lagging regions in Spain.

Table 9.18: Innovative Companies in Lagging Regions in Spain 2003-13 – All Innovation

	2003-05	**2005-07**	**2007-09**	**2009-11**	**2011-13**
Andalucía	6,135	5,754	4,828	6,365	4,399
	12.9%	*12.3%*	*12.4%*	*12.5%*	*11.5%*
Canarias	1,781	1,585	1,170	1,789	1,318
	3.7%	*3.4%*	*3.0%*	*3.5%*	*3.5%*
Cantabria	495	586	487	519	380
	1.0%	*1.3%*	*1.2%*	*1.0%*	*1.0%*
Castilla-la Mancha	1,510	1,793	1,245	1,773	1,120
	3.2%	*3.8%*	*3.2%*	*3.5%*	*2.9%*
Castilla y León	1,905	1,898	1,808	2,260	1,492
	4.0%	*4.0%*	*4.6%*	*4.4%*	*3.9%*
Comunidad Valenciana	5,721	4,971	4,400	5,755	4,296
	12.0%	*10.6%*	*11.3%*	*11.3%*	*11.3%*
Extremadura	613	625	465	610	552
	1.3%	*1.3%*	*1.2%*	*1.2%*	*1.4%*
Galicia	***2,189***	***2,502***	***2,082***	***2,557***	***2,064***
	4.6%	***5.3%***	***5.3%***	***5.0%***	***5.4%***
Principado de Asturias	768	821	686	917	631
	1.6%	*1.8%*	*1.8%*	*1.8%*	*1.7%*
Región de Murcia	1,414	1,575	1,091	1,465	1,092
	3.0%	*3.4%*	*2.8%*	*2.9%*	*2.9%*
SPAIN – TOTAL	47,529	46,877	39,043	50,982	38,092
	100.0%	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Note: Estimates refer only to companies with at least 10 paid employees.
Source: Instituto Nacional de Estadística

Moreover, the number of innovative companies in Galicia was, on average, equivalent to about 29% of all active enterprises in the region that had 10+ employees during the 2011-13 period (based on comparison with Eurostat data for total active enterprises with 10+ employees in Galicia). This was similar to the average for all of Spain in the same period, but slightly below the equivalent estimate for Galicia in the 2009-11 period (31%).

Table 9.19 looks at the number of innovative companies in both Spain and its lagging regions, when expressed on a per capita basis (per million population). In this regard, the table shows that the number of innovative companies in Galicia has generally been below the overall Spanish average, and this is common to most lagging regions. However, when compared to other lagging regions, Galicia nonetheless had the 3rd highest number of innovative companies in per capita terms in the 2011-13 period. Furthermore, its relative ranking among lagging regions has also grown over time.

Table 9.19: Innovative Companies Per Million Population in Lagging Regions in Spain 2003-13

	2003-05	2005-07	2007-09	2009-11	2011-13
Comunidad Valenciana	1,288	1,062	893	882	858
Región de Murcia	1,107	1,166	769	751	747
Galicia	***807***	***916***	***756***	***751***	***745***
Cantabria	903	1,044	844	828	641
Canarias	987	834	587	572	632
Castilla y León	771	761	711	710	588
Principado de Asturias	723	772	640	637	587
Castilla-la Mancha	824	935	613	597	532
Andalucía	808	732	595	583	525
Extremadura	576	581	427	423	500
SPAIN – TOTAL	1,117	1,065	855	840	814

Note: Estimates refer only to companies with at least 10 paid employees. Regions ranked according to their level in the 2011-13 period.
Source: Derived from Instituto Nacional de Estadística, using Eurostat population data

Table 9.20 provides data on the number of product innovating companies in Spain and its lagging regions. It suggests that the number of companies in Galicia engaging in product innovation has again fluctuated over time, from a high of over 1,640 companies in the 2009-11 period to a low of about 870 companies in the 2007-09 period. Galicia's share of product innovating companies in Spain has also fluctuated but increased, from a low of 4.8% in the 2005-07 period up to a more recent high of 5.9% to 6.0%. In this respect, therefore, Galicia again appears to compare favourably with other lagging regions in Spain.

Table 9.20: Innovative Companies in Lagging Regions in Spain 2003-13 – Product Innovation

	2003-05	**2005-07**	**2007-09**	**2009-11**	**2011-13**
Andalucía	3,294	3,301	1,866	2,909	1,791
	12.3%	*13.0%*	*10.6%*	*10.7%*	*9.2%*
Canarias	1,165	966	318	960	579
	4.3%	*3.8%*	*1.8%*	*3.5%*	*3.0%*
Cantabria	292	301	178	338	220
	1.1%	*1.2%*	*1.0%*	*1.2%*	*1.1%*
Castilla-la Mancha	894	937	472	978	546
	3.3%	*3.7%*	*2.7%*	*3.6%*	*2.8%*
Castilla y León	947	1,064	749	1,308	850
	3.5%	*4.2%*	*4.2%*	*4.8%*	*4.4%*
Comunidad Valenciana	2,932	2,463	2,178	2,876	2,302
	10.9%	*9.7%*	*12.3%*	*10.6%*	*11.9%*
Extremadura	382	280	194	354	255
	1.4%	*1.1%*	*1.1%*	*1.3%*	*1.3%*
Galicia	***1,411***	***1,225***	***870***	***1,643***	***1,136***
	5.3%	***4.8%***	***4.9%***	***6.0%***	***5.9%***
Principado de Asturias	381	489	299	504	381
	1.4%	*1.9%*	*1.7%*	*1.9%*	*1.8%*
Región de Murcia	910	908	456	797	515
	3.4%	*3.6%*	*2.6%*	*2.9%*	*2.7%*
SPAIN – TOTAL	26,866	25,353	17,644	27,203	19,370
	100.0%	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Note: Estimates refer only to companies with at least 10 paid employees.
Source: Instituto Nacional de Estadística

Finally, Table 9.21 provides data on the number of process innovating companies in Spain and its lagging regions. It suggests that the number of companies in Galicia engaging in process innovation fluctuated from a low of nearly 1,380 companies in the 2003-05 period to a high of nearly 1,890 companies in the 2009-11 period. Galicia's share of process innovating companies also fluctuated but increased, from a low of 3.9% in the 2003-05 period up to a high of 5.5% in the 2007-09 period.

Table 9.21: Innovative Companies in Lagging Regions in Spain 2003-13 – Process Innovation

	2003-05	2005-07	2007-09	2009-11	2011-13
Andalucía	4,480	3,865	3,953	5,115	3,653
	12.7%	*11.6%*	*12.1%*	*12.7%*	*12.2%*
Canarias	1,254	958	1,046	1,311	1,101
	3.6%	*2.9%*	*3.2%*	*3.3%*	*3.7%*
Cantabria	366	399	432	334	282
	1.0%	*1.2%*	*1.3%*	*0.8%*	*0.9%*
Castilla-la Mancha	1,013	1,217	1,071	1,404	898
	2.9%	*3.7%*	*3.3%*	*3.5%*	*3.0%*
Castilla y León	1,473	1,286	1,602	1,662	1,080
	4.2%	*3.9%*	*4.9%*	*4.1%*	*3.6%*
Comunidad Valenciana	4,634	3,718	3,701	4,601	3,330
	13.2%	*11.2%*	*11.3%*	*11.4%*	*11.2%*
Extremadura	385	455	395	426	408
	1.1%	*1.4%*	*1.2%*	*1.1%*	*1.4%*
Galicia	***1,376***	***1,787***	***1,814***	***1,857***	***1,520***
	3.9%	***5.4%***	***5.5%***	***4.6%***	***5.1%***
Principado de Asturias	592	537	563	700	459
	1.7%	*1.6%*	*1.7%*	*1.7%*	*1.5%*
Región de Murcia	981	1,010	948	1,181	861
	2.8%	*3.0%*	*2.9%*	*2.9%*	*2.9%*
SPAIN – TOTAL	35,166	33,193	32,735	40,191	29,840
	100.0%	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Note: Estimates refer only to companies with at least 10 paid employees.

Source: Instituto Nacional de Estadística

9.4 Regional Economic Structure and Performance – Puglia

9.4.1 Introduction

Puglia is a region situated in the south-east of Italy. It has a surface area of about 19,500 km^2, and Eurostat estimates (for 2018) show that the region has a population of over 4.0 mn people.

As is the case with Galicia, the region of Puglia was classified as a lagging region throughout the period between 1994 and 2013[43]. In particular:

- the region was designated as having Objective 1 status for Structural Fund purposes in the 1994-99 and 2000-06 programming periods, i.e. a region with a GDP per capita of less than 75% of the EU-15 average (based on 15 member states)[44];
- similarly, for the 2007-13 period, it was designated as a Convergence region, again being a region with a GDP per capita of less than 75% of the EU average (based on 25 member states)[45].

Like Galicia, therefore, Puglia was a region that was afforded high priority for EU Structural Fund assistance across the 1994-2013 period. Indeed, it continued to be classified as a lagging region for the 2014-20 Structural Fund programming period, with a GDP per capita below 75% of the EU-28 average, meaning that it has remained a priority region for Structural Fund purposes.

The rest of this section now examines recent trends in population density and growth, GDP, labour market, employment and unemployment, education and skills, and sectoral composition in Puglia. In general, data presented again relate to the 2000-13 period, alongside updated data for 2017 or 2018, with regional trends compared to both Italian and EU-15 averages.

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[43] Further discussion of lagging regions, and the definition of such regions that is adopted for this thesis, is again provided in Chapter 3.

[44] There were six other Italian regions that were designated with Objective 1 status during the 2000-06 period, including Campania, Basilicata, Calabria, Sicily, Sardinia and Molise. However, Molise only had Objective 1 status on a transitional and reduced basis.

[45] There were five other Italian regions that were designated as Convergence regions during the 2007-13 period, including Campania, Basilicata, Calabria, Sicily and Sardinia. However, Basilicata only had Convergence region status on a transitional and reduced basis.

9.4.2 *Population*

As noted in Section 9.4.1 above, Puglia has a population of over 4.0 mn people. Across the 2000-13 study period, however, population growth in the region was well below both Italian and EU-15 averages. Table 9.22, for example, shows that the Puglian population grew by less than 1% between 2000 and 2013, whereas EU-15 average growth was nearly 6% and Italian average growth was nearly 5%. Between 2013 and 2018, moreover, there was little change in the population in Puglia, whereas the Italian population grew by more than 1% and the EU-15 population grew by over 2%.

Table 9.22: Population Growth (%) in Puglia 2000-13 and 2013-18

	2000 (000s)	2007 (000s)	2013 (000s)	2018 (000s)	Growth 2000-13 (%)	Growth 2013-18 (%)
Puglia	4,035	4,032	4,051	4,048	0.4%	-0.1%
Italy	56,929	58,224	59,685	60,484	4.8%	1.3%
EU-15	377,597	391,489	400,035	408,416	5.9%	2.1%

Note: Based on Eurostat data. All estimates are dated 13-09-19 and extracted 20-12-19.
Source: Eurostat

Eurostat estimates also show that Puglia experienced negative net migration in nine of the 14 years between 2000 and 2013 (and in three of the four years up to 2017). Annual net migration has ranged from -0.5% up to 1.0% of the total regional population, while natural change in population has ranged from -0.3% up to 0.3% of population.

Table 9.23 shows that population density in Puglia, at about 210 persons per km^2, is slightly above the Italian average (203 persons per km^2) and well above the EU-15 average (123 persons per km^2). When compared to other regions that have been classified as “lagging” in Italy, population density is well above Basilicata, Sardinia, Molise and Calabria (at between 55 and 130 persons per km^2), similar to Sicily (at 196 persons per km^2), but significantly lower than in Campania (at 428 persons per km^2).

Table 9.23: Population Density (per Km²) in Puglia 2000, 2007, 2013 and 2017

	2000	2007	2013	2017
Puglia	209.9	210.3	208.3	210.2
Italy	193.0	198.0	199.4	203.3
EU-15	113.6	117.8	121.0	123.0
Note: Based on Eurostat data. All estimates are dated 13-09-19 and extracted 20-12-19.				

Source: Eurostat

According to Eurostat data, more than 30% of the population in Puglia is located in Bari province, which is also the largest metropolitan area in the region. Another 20% of the population is situated in Lecce province, with 15% in the province of Foggia, 14% in the province of Taranto, 10% in the province of Brindisi and 10% in the province of Barletta-Andria-Trani. Population density within the provinces ranges from a low of 90 persons per km^2 in Foggia up to a high of nearly 330 persons per km^2 in Bari, with the density in other provinces ranging between 210 persons per km^2 and 290 persons per km^2. Foggia, with 15% of the region's population but with more than 35% of the region's territory, is clearly the most rural province within the region.

Figure 9.3: Map of Puglia

Source: Rainer Lesniewski/Shutterstock.com

9.4.3 GDP

In economic terms, several authors (e.g., Muscio, 2011, Florio, Pellegrin and Sirtori, 2014, Grigolini, Pancotti, Sirtori and Vignetti, 2015) have noted a lack of progress in Puglia in converging towards either national or European levels of output over recent periods, culminating in the fact that the region, as noted in Section 9.4.1, continues to receive priority status for Structural Fund assistance within the EU.

Table 9.24, for example, shows that GDP per capita in Puglia, as measured in PPS terms, grew from 15,600 in 2000 up to 17,800 in 2007, representing a growth of 14%. This means that growth was slightly below growth in overall GDP per capita for Italy over the same period, which was about 18%, and it was well below growth in GDP per capita across the EU-15, which was 27%. However, GDP per capita in the region subsequently fell by 4% between 2007 and 2013 (from 17,800 down to 17,100) due to the impact of the financial and economic crisis, though it increased again to 18,700 in 2017 (a growth of more than 9%).

Table 9.24: Growth in GDP per Capita (PPS) in Puglia 2000-17

	2000	**2007**	**2013**	**2017**	**Growth 2000-13 (%)**	**Growth 2013-17 (%)**
Puglia	15,600	17,800	17,100	18,700	9.6%	9.4%
Italy	23,700	27,900	26,400	28,900	11.4%	9.4%
EU-15	23,030	29,170	29,280	32,410	27.1%	10.7%
Puglia as % of Italy	65.8%	63.8%	64.8%	64.7%	-	-
Puglia as % of EU-15	67.7%	61.0%	58.4%	57.7%	-	-

Note: Based on Eurostat data. Estimates are dated 06-09-19 and extracted 23-12-19.
Source: Eurostat

In relative terms, therefore, Puglia appears to have made little progress in bridging the gap towards either overall Italian or EU-15 averages. GDP per capita in the region, for example, has remained relatively static, at about 65% of the Italian average between 2000 and 2017, while it has fallen from 68% to 58% of the EU-15 average over the same period. Moreover, relative to other lagging regions in Italy, growth in GDP per capita in Puglia in the 2000-07 period was slightly behind all other regions, including Basilicata (16%), Campania (18%), Calabria (20%), Sicily (20%), Sardinia (21%) and Molise (22%). However, all but one of these regions (Sardinia) experienced a larger decline in GDP per capita, of between 4% and 7%, in the 2007-13 period, i.e. over the period during and after the 2008-09 global financial and economic crisis.

9.4.4 Labour Market

As regards labour market trends, Table 9.25 shows that the labour force participation rate in Puglia changed little during the 2000-13 study period. The labour force participation rate in 2013, for example (53%), was identical to 2000, while the rate remained at between 51% and 53% across the intervening period. Labour force participation rates in the region therefore failed to keep pace with growth in the Italian average over the period, which grew from 60% in 2000 up to more than 63% in 2013, while participation rates across the EU-15 grew from 69% to 73% in the same period. As of 2018, meanwhile, labour force participation in Puglia was also at 54%, again below both the Italian and EU-15 averages.

Table 9.25: Labour Market Trends in Puglia 2000, 2007, 2013 and 2018

	2000	**2007**	**2013**	**2018**
Labour Force Participation (%)				
Puglia	52.9%	52.5%	52.9%	54.4%
Italy	59.9%	62.4%	63.4%	65.6%
EU-15	69.0%	71.8%	73.1%	74.3%
Employment (%)				
Puglia	43.6%	46.6%	42.3%	45.5%
Italy	53.4%	58.6%	55.5%	58.5%
EU-15	63.2%	66.7%	64.9%	68.7%
Unemployment (%)				
Puglia	17.5%	11.2%	19.9%	16.2%
Italy	11.0%	6.2%	12.3%	10.8%
EU-15	8.5%	7.2%	11.3%	7.6%

Note: Estimates derive from Eurostat data. Estimates are dated 24-04-20 and extracted 04-06-20. Economic activity rates and employment rates are expressed as a percentage of the population (aged 15-64), while unemployment rates are expressed as a percentage of the economically active population (aged 15-64).

Source: Eurostat and author's calculations (based on Eurostat data)

The unemployment rate in Puglia experienced a noticeable decline between 2000 and 2007, falling from nearly 18% down to 11% in the period. Furthermore, this compared favourably with trends in unemployment across Italy (which fell from 11% to 6%) and the EU-15 (which fell from 8% to 7%). However, the unemployment rate in the region remained well above both Italian and EU-15 averages, and unemployment also grew strongly again up to 2013, rising to almost 20%. The influence of the global financial and economic crisis over the 2007-13 period should again be noted, given that unemployment in both Italy and the EU-15 also rose in the same period, but unemployment in Puglia nonetheless remained well above the Italian average (12%) and the EU-15 average (11%) in 2013. As of 2018, meanwhile, the rate of unemployment in Puglia stood at just over 16%, compared to an Italian average rate of nearly 11% and an EU-15 average rate of less than 8%.

Similarly, the employment rate in Puglia experienced some growth between 2000 and 2007, rising from close to 44% in 2000 up to nearly 47% in 2007. However, the employment rate in 2007 was again well below both the Italian average (59%) and the EU-15 average (68%), while the employment rate in the region had fallen back to about 42% by 2013, still remaining well below the Italian average (56%) and the EU-15 average (65%). As of 2018, meanwhile, the rate of employment in Puglia stood at about 46%, compared to an Italian average rate of about 59% and an EU-15 average rate of about 69%.

Labour market trends experienced in Puglia were also similar to those experienced in other lagging regions in Italy over the same period. Labour force participation rates in such regions, for example, saw little positive movement in the period (with the exception of Sardinia between 2000 and 2007). Unemployment rates in lagging regions all saw positive reductions between 2000 and 2007, followed by sharp rises between 2007 and 2013, while employment rates in such regions witnessed growth between 2000 and 2007, followed by decline between 2007 and 2013. Puglia was therefore no different to other similar regions in Italy across the period, even if it did not clearly out-perform these regions either.

9.4.5 Education

Table 9.26 shows the level of tertiary education attainment in Puglia, how it has progressed over time, and how it has compared to Italian and EU-15 averages between 2000 and 2018 for (a) the population aged 25-64 and (b) the population aged 30-34. In this regard, it shows that there was growth in the share of the Puglian population aged 25-64 that had completed higher education, rising from just under 9% in 2000 up to more than 13% in 2013 and nearly 15% in 2018. Despite this growth, however, higher education levels for this age cohort in Puglia still lagged both Italian and, in particular, EU-15 averages. In 2018, for example, the share of the overall Italian population with completed higher education was at over 19%, while its share of the overall EU-15 population stood at nearly 34%.

Moreover, a similar pattern is evident when looking at tertiary education attainment among the younger population cohort aged 30-34. In this regard, Table 9.26 again shows that there was growth in the share of the Puglian population that had completed higher education, rising strongly from over 9% in 2000 up to nearly 21% in 2013 and nearly 22% in 2018. Nonetheless, tertiary education attainment levels for the age cohort still lagged the Italian average of nearly 28% and the EU-15 average of more than 41% in 2018.

Table 9.26: Population with Tertiary Education Attainment in Puglia 2000-18 (%)

	2000	**2007**	**2013**	**2018**
Aged 25-64				
Puglia	8.6%	11.2%	13.2%	14.8%
Italy	9.7%	13.5%	16.4%	19.3%
EU-15	21.3%	25.2%	30.1%	33.7%
Aged 30-34				
Puglia	9.4%	13.9%	20.8%	21.8%
Italy	11.6%	18.6%	22.5%	27.8%
EU-15	24.6%	32.6%	38.3%	41.4%

Note: Based on Eurostat data. Estimates are dated 24-04-20 and extracted 04-06-20.

Source: Eurostat

Table 9.27, meanwhile, suggests that the prevalence of continuous education and training among Puglia’s adult population remained relatively unchanged across the same period. In particular, it shows that participation rates in continuous education and training changed little between 2000 and 2018, being slightly over or under 5%. In 2018, however, the Italian average for participation in continuous education and training was about 8%, while the EU-15 average was nearly 13%.

Table 9.27: Population Aged 25-64 Participating in Education and Training in Puglia 2000-18 (%)

	2000	2007	2013	2018
Puglia	4.7%	5.2%	4.8%	5.4%
Italy	4.8%	6.2%	6.2%	8.1%
EU-15	8.1%	10.8%	12.4%	12.7%

Note: Based on Eurostat data. The participation rate in education and training covers participation in formal and non-formal education and training, and is used by Eurostat as a measure of lifelong learning. The reference period for participation is four weeks prior to survey interview. All estimates are dated 24-04-20 and extracted 05-06-20.

Source: Eurostat

9.4.6 Key Sectors and Enterprise Base

Table 9.28 provides data on the broad sectoral share of employment in agriculture, industry and services in Puglia between 2000 and 2018. It shows that agriculture (including forestry and fishing) accounted for about 11% of employment in the Puglian economy in 2000, with industry accounting for another 27% of employment and services accounting for the remaining 62%. Employment in agriculture in the region, therefore, was larger than the Italian or EU-15 average at that time. By 2013, however, agriculture’s share of employment had fallen to about 9% of employment, while employment in industry dropped to about 23%, with employment in services rising to more than 68%. Puglia’s share of employment in agriculture therefore remained above Italian and EU-15 averages, while its share of industrial employment was below the Italian average (but was similar to the EU-15 average), and these sectoral patterns were still evident in 2018.

Table 9.28: Sectoral Shares of Total Employment in Puglia 2000, 2007, 2013 and 2018

	2000	2007	2013	2018
Agriculture				
Puglia	11.2%	8.9%	8.9%	8.3%
Italy	5.2%	4.0%	3.6%	3.8%
EU-15	4.3%	3.5%	2.9%	2.6%
Industry				
Puglia	26.9%	26.1%	22.8%	22.4%
Italy	31.8%	30.2%	27.0%	26.1%
EU-15	28.8%	26.1%	22.5%	22.0%
Services				
Puglia	61.8%	65.1%	68.4%	69.3%
Italy	63.0%	65.9%	69.4%	70.1%
EU-15	66.5%	69.8%	74.6%	75.4%

Note: Derived from Eurostat data. All estimates are dated 11-12-19 and extracted 20-12-19.

Source: Author's calculations based on Eurostat data

Table 9.29 shows a more detailed sectoral breakdown of economic activity in Puglia between 2000 and 2013, this time according to GVA. It shows a smaller share for agricultural output over the period, at between 4% and 6%, with an industry share of output, excluding construction, that was 13% in 2013 (down from 17% in 2000). Within the services sector, the largest shares of output were attributable to the combined wholesale/retail, transport and accommodation/food service sectors (between 20% and 22%) and public administration related sectors (between 22% and 24%).

Construction activity fell slightly between 2007 and 2013 (from 7% to 6%), though real estate activities grew from 10% to 14% of GVA. However, share of output in information and communications, financial and insurance activities and professional or scientific/technical activities remained relatively unchanged, at between 14% and 15%, between 2000 and 2013.

Table 9.29: Sectoral Shares of Gross Value Added in Puglia 2000, 2007, 2013 and 2018

	2000	2007	2013	2018
Agriculture, forestry, fishing	5.7%	3.8%	4.5%	n/a
Industry	16.5%	15.5%	12.9%	n/a
Construction	5.7%	6.8%	5.7%	n/a
Wholesale/retail, transport, accommodation/food services	21.8%	20.0%	20.6%	n/a
Information and communications	2.7%	2.4%	2.2%	n/a
Financial and insurance activities	3.6%	4.3%	4.2%	n/a
Real estate activities	10.1%	12.4%	14.4%	n/a
Professional, scientific/technical, administrative/support	7.8%	8.1%	7.8%	n/a
Public administration/defence, education and health	21.8%	22.9%	24.0%	n/a
Arts, entertainment, recreation and other service	4.3%	3.9%	3.6%	n/a

Note: Derived from Eurostat data. Estimates are dated 31-05-20 and extracted 05-06-20. “n/a” = not available.

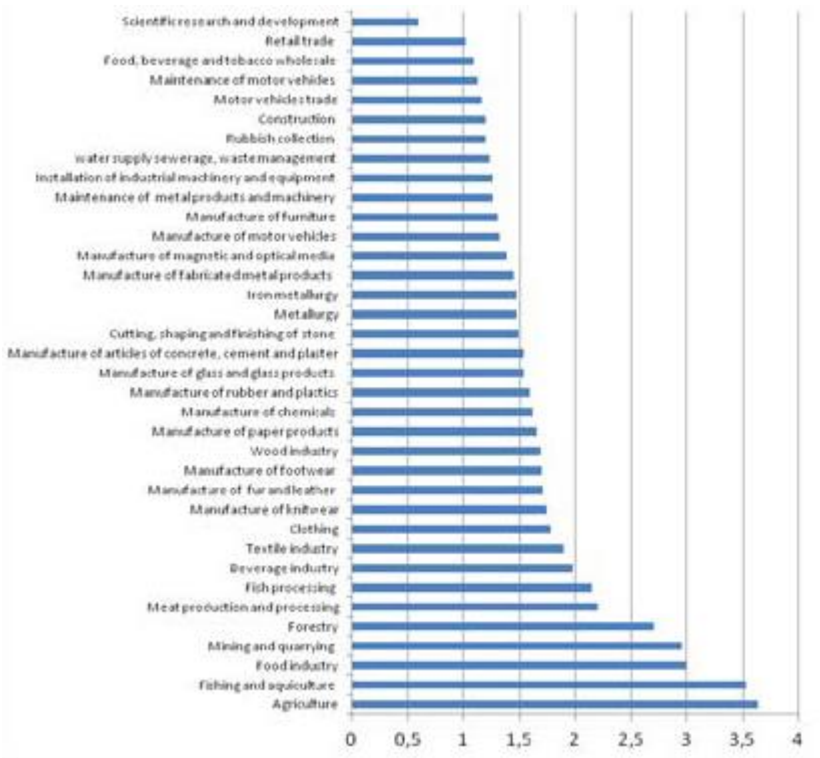
Source: Author’s calculations based on Eurostat data

Analysis carried out by González-López et al (2014), and presented in Figure 9.4, gives further insights on areas of specialisation within the Puglian economy, relative to the Italian economy. In particular, the analysis suggests that sectoral specialisation within the Puglian economy is as follows:

- sectors with an above-average representation in the region (relative to the Italian average) include agriculture (including forestry and fishing), the food industry and related sectors, the textile and footwear industries, and the manufacture of wood and related products;
- other sectors with above-average representation include metallurgy and related sectors, manufacture of motor vehicles and the furniture sector.

Agriculture, therefore, remains an important contributor to the Puglian economy, as has been noted by Muscio (2011) and Grigolini et al (2015). Muscio (2011), for example, asserts that Puglia has been an export leader for wheat, olive oil and tomatoes. However, the same author notes that manufacturing specialisations in the region, outside of larger companies, were generally concentrated in low technology, low added value industries. In this regard, the analysis presented by González-López et al (2014) also suggests that Puglia is not specialised in scientific research and development, while no high-tech economic activities show a specialisation index above 0.5.

Figure 9.4: Relative Specialisation Index for Economic Sectors in Puglia



Note: Where a value is greater than 1.0, this indicates that the sector is an area of specialisation for Puglia relative to the Italian economy generally.

Source: González-López et al (2014)

In terms of firm size, Grigolini et al (2015) have noted that the enterprise base in Puglia is typified by a preponderance of small firms and micro-enterprises in sectors like textiles, food and furniture, which operate alongside a smaller number of larger companies that drive "industrial districts" in sectors like the automotive, mechatronics and aerospace industries[46]. Indeed, like Galicia, the vast majority of firms in Puglia are very small, with Eurostat estimates indicating that about 97% of nearly 260,000 active enterprises in the region have less than 10 employees (based on 2016 estimates). At the same time, the equivalent share of small enterprises across all of Italy (96%) and the EU-15 (94%) is similarly high, so Puglia, like Galicia, is not unusual in this regard.

[46] Grigolini et al (2015) describe "industrial districts" as being SMEs with a coherent specialisation profile, and vertically or horizontally integrated among each other, that spontaneously cluster in specific areas, often centred on one or few large catalysing enterprises.

Lastly, in terms of the geographic location of economic activity, Eurostat estimates show that about 36% of economic output in Puglia derives from the province of Bari, with another 32% of output derived from the neighbouring provinces of Taranto, Brindisi and Barletta-Andria-Trani (based on 2013 estimates). The share of economic activity across these provinces is therefore similar to the share of population (previously described in Section 9.4.2). About 15% of output is derived from the northern province of Foggia, while 17% of output is derived from the southern province of Lecce. Moreover, the geographic split of activity is consistent across most major sectoral groups, with the exceptions of: agriculture, forestry and fishing, in which Foggia alone accounts for 28% of activity; and information and communications, in which Bari alone accounts for 64% of activity.

9.5 Innovation Performance – Puglia

9.5.1 Introduction

This section examines the innovation performance of Puglia, again with a particular focus on how performance has changed over the two EU Structural Fund programming periods of 2000-06 and 2007-13, according to commonly used indicators for R&D and innovation. In this regard, the description of innovation performance provided here, as with the analysis for Galicia, draws on the analysis of innovation performance in lagging regions, provided in the earlier quantitative analysis (Chapter 6).

In terms of broad innovation capability, Puglia's overall status is very similar to Galicia, based on previously published classifications of regional innovation capability. So, for example, the region has, like Galicia, been regularly classified as a Moderate Innovator in the EU's Regional Innovation Scoreboard (see European Commission, 2012b, 2014b, 2016, 2017b, 2019). Similarly, Puglia has also been classified in other studies (see Appendix B) as follows:

- a "region with a weak economic and technological performance", based on a typology of patterns of innovation prepared by Navarro et al (2008), i.e. a region that had per capita incomes, investment levels in R&D, levels of tertiary education and lifelong learning, levels of employment and human resources in science and technology that were generally lower than EU averages, and which also had a low population density and low accessibility, with low levels of industrial activity and a greater reliance on the agriculture and service sectors;

- a “disadvantaged region”, based on a study of innovation dimensions and profiles developed by Pinto (2009), i.e. a region that recorded a relatively low performance in terms of technological innovation (e.g. patent registration, private investment in R&D and employment in high/medium technology industries), economic structure (e.g. GDP and employment in services), labour market availability (e.g. levels of employment and rate of individuals with intermediate education levels) and human capital performance (e.g. education, training and public investment in R&D);
- a “low efficiency” region, based on a study of knowledge production and diffusion by Foddi and Usai (2013), which assessed how regions use internal and external inputs (i.e. investment in R&D, human capital and existing patent production) for the production of new knowledge and ideas (i.e. new patent applications).

As noted when describing R&D and innovation performance in Galicia, however, such classifications tend to be very R&D oriented in terms of how they convey innovation in regions, while the “statistical average” nature of such indicators at the regional scale also might not adequately reflect or capture the true spatial level at which R&D and innovation occurs, even within regions (e.g. taking account of urban and rural divides). Nevertheless, given that there are a limited number of indicators available to measure R&D and innovation at a regional scale, the rest of this section again examines regional trends across available R&D and innovation indicators, including: R&D expenditure; R&D personnel; patent activity; and employment in key innovating sectors.

9.5.2 Total R&D Expenditure

Investment in R&D in Puglia, again measured in terms of R&D expenditure per capita (PPS), has grown over the past couple of decades, though not to the same extent as witnessed in Galicia. For example, Table 9.30 shows that average annual R&D expenditure per capita in the region grew by nearly 50% between the 1994-99 and 2000-07 periods, thereafter growing by another 13% between the 2000-07 and 2008-12 periods.

Growth in the earlier part of the 2000s was therefore noticeably ahead of the equivalent growth in R&D expenditure for all of Italy and for the EU-15, which both stood at about 20%, while growth in expenditure thereafter was similar to EU-15 levels (14%), but slightly ahead of the Italian average (10%). Moreover, more recent Eurostat data for the 2013-17 period suggests an increase in R&D expenditure per capita when compared to the 2008-12 period, equivalent to growth of about 16%.

Table 9.30: Total R&D Expenditure per Capita (PPS) in Puglia 1994-2012

	1994-99	2000-07	2008-12	Growth 1994-99 v 2000-07 (%)	Growth 2000-07 v 2008-12 (%)
Puglia	68.56	101.48	114.96	48.0%	13.3%
Italy	217.08	263.36	290.71	21.3%	10.4%
EU-15	390.67	470.95	536.74	20.5%	14.0%

Note: Derived from Eurostat data, using R&D expenditure estimates (dated 15-05-14, extracted 25-08-14) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.

Source: Author's calculations based on Eurostat data

However, it is also clear from Table 9.30 that the base level of R&D investment in Puglia significantly lags both Italian and EU-15 averages. The region's average annual R&D expenditure per capita in the 2008-12 period, for example, was equivalent to about 40% of the Italian average and about 21% of the EU-15 average for the same period, and this point is further illustrated when R&D investment is expressed as a share of GDP, with Table 9.31 showing that Puglia again lags Italian and EU-15 averages in this respect. Moreover, more recent Eurostat data for the 2013-17 period shows that annual R&D expenditure per capita in Puglia was equivalent to between 36% and 48% of the Italian average over that period.

Table 9.31: R&D Expenditure as a % of GDP in Puglia 2000-13

	2000	2007	2013
Puglia	0.58%	0.76%	0.82%
Italy	1.01%	1.13%	1.31%
EU-15	1.85%	1.86%	2.11%

Note: Based on Eurostat data. Estimates are dated 31-03-16 and extracted 04-10-16.

Source: Eurostat

9.5.3 Business R&D Expenditure

In contrast to Galicia, growth in business R&D expenditure per capita in Puglia (again expressed in PPS terms) significantly under-performed growth in total R&D expenditure over the 2000-13 period. For example, Table 9.32 shows that average annual business R&D expenditure per capita in Puglia grew by 17% between the 1994-99 and 2000-07 periods, though growth increased to 24% between the 2000-07 and 2008-12 periods. At the same time, in relative terms, growth was similar to overall Italian averages over the periods (17% and 21% respectively), while being ahead of EU-15 levels (13%) between the 2000-07 and 2008-12 periods. Furthermore, more recent Eurostat data for the 2013-17 period again suggests a significant increase in business R&D expenditure per capita when compared to the 2008-12 period, equivalent to growth of about 50%.

Table 9.32: Business R&D Expenditure per Capita (PPS) in Puglia 1994-2012

	1994-99	2000-07	2008-12	Growth 1994-99 v 2000-07 (%)	Growth 2000-07 v 2008-12 (%)
Puglia	19.80	23.22	28.76	17.3%	23.8%
Italy	110.99	129.62	156.56	16.8%	20.8%
EU-15	n/a	301.19	339.11	n/a	12.6%

Note: “n/a” = not available. Derived from Eurostat data, using R&D expenditure estimates (dated 15-05-14, extracted 17-09-14) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.

Source: Author’s calculations based on Eurostat data

The business share of total R&D expenditure in Puglia, therefore, remained below Italian and EU-15 averages over the 2000-13 period. In the 2008-12 period, for example, the average business share of R&D expenditure in the region was 25%, while the equivalent figure for all of Italy was 54% and the equivalent figure for the EU-15 was 63%. Furthermore, the business share of total R&D expenditure in Puglia also decreased in relative terms, from an average of 29% in the 1994-99 period down to an average of 25% in the 2008-12 period. At the same time, however, more recent Eurostat data for the 2013-17 period shows that annual business R&D expenditure per capita during that period increased to between 27% and 40% of total R&D expenditure per capita in the region (compared to an Italian average of between 55% and 62%).

9.5.4 Total R&D Personnel

Growth in R&D personnel in Puglia, measured in terms of R&D personnel per million population, displayed a similar trend to growth in R&D expenditure across much of the 2000-13 period. For example, Table 9.33 shows that average annual R&D personnel per million population in the region grew by about 50% between the 1994-99 and 2000-07 periods, thereafter growing by 20% between the 2000-07 and 2008-12 periods.

Growth in the earlier part of the 2000s, therefore, was well above the equivalent growth in R&D personnel for all of Italy, which stood at 18%. Growth between the 2000-07 and 2008-12 periods was also above the EU-15 average (15%), though it was somewhat below the overall Italian average (29%). More recent Eurostat data for the 2013-17 period, meanwhile, suggests further growth in R&D personnel per million population, equivalent to growth of about 20% when compared to the 2008-12 period.

Table 9.33: Total R&D Personnel per Million Population in Puglia 1994-2012

	1994-99	**2000-07**	**2008-12**	**Growth 1994-99 v 2000-07 (%)**	**Growth 2000-07 v 2008-12 (%)**
Puglia	947	1,403	1,679	48.2%	19.7%
Italy	2,515	2,977	3,840	18.4%	29.0%
EU-15	n/a	4,995	5,734	n/a	14.8%

Note: “n/a” = not available. Derived from Eurostat data, using R&D personnel estimates (dated 15-05-14, extracted 22-08-14) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.

Source: Author’s calculations based on Eurostat data

As with trends in R&D expenditure, however, it is also clear from Table 9.33 that the base level of R&D personnel in Puglia remains well below both Italian and EU-15 averages. The region’s average annual R&D personnel per capita in the 2008-12 period, for example, was equivalent to about 44% of the Italian average and about 29% of the EU-15 average for the same period. Furthermore, this point is further illustrated when R&D personnel are expressed as a share of active population, with Table 9.34 showing that Puglia again lags Italian and EU-15 averages in this respect, while more recent Eurostat data for the 2013-17 period shows that annual R&D personnel per capita in Puglia remained at between 43% and 45% of the Italian average over that period.

Table 9.34: R&D Personnel as a % of Active Population in Puglia 2000-13

	2000	2007	2013
Puglia	0.30%	0.51%	0.50%
Italy	0.64%	0.85%	0.98%
EU-15	1.03%	1.12%	1.25%

Note: Based on Eurostat data. Estimates are dated 31-03-16 and extracted 04-10-16.
Source: Eurostat

9.5.5 *Business R&D Personnel*

Table 9.35 shows that the average annual business R&D personnel per million population in Puglia grew by 27% between the 1994-99 and 2000-07 periods, and by another 37% between the 2000-07 and 2008-12 periods. Growth in the earlier part of the 2000s was therefore higher than the equivalent growth in business R&D personnel for all of Italy (17%), though growth in the later period was below the Italian average (50%). At the same time, growth in business R&D personnel between the 2000-07 and 2008-12 periods was well ahead of the EU-15 average (14%), while more recent Eurostat data for the 2013-17 period suggests further significant growth in business R&D personnel per million population, equivalent to growth of about 80% when compared to the 2008-12 period.

Table 9.35: Business R&D Personnel per Million Population in Puglia 1994-2012

	1994-99	2000-07	2008-12	Growth 1994-99 v 2000-07 (%)	Growth 2000-07 v 2008-12 (%)
Puglia	219	277	379	26.6%	36.5%
Italy	1,074	1,260	1,884	17.3%	49.5%
EU-15	n/a	2,723	3,114	n/a	14.3%

Note: “n/a” = not available. Derived from Eurostat data, using R&D personnel estimates (dated 15-05-14, extracted 05-06-14) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.
Source: Author’s calculations based on Eurostat data

Nonetheless, as with business R&D expenditure, the business share of total R&D personnel in Puglia has generally remained below both Italian and EU-15 averages. In the 2008-12 period, for example, the average business share of R&D personnel in the region was 23%, while the equivalent figure for all of Italy was 49% and the equivalent figure for the EU-15 was 54%. Also, the business share of R&D personnel in Puglia was unchanged between the 1994-99 and 2008-12 periods, at 23%. At the same time, however, more recent Eurostat data for the 2013-17 period shows that annual business R&D personnel per capita during that period was equivalent to between 30% and 44% of total R&D personnel per capita in the region, whereas the equivalent Italian average figure was between 51% and 60% of total R&D personnel per capita during this time.

9.5.6 Patent Activity

In terms of innovation "outputs", Table 9.36 shows that the average annual number of patent applications in Puglia (expressed per million population) grew by nearly 120% between the 1994-99 and 2000-07 periods, but only by a further 20% between the 2000-07 and 2008-11 periods. Across both periods, however, growth was well above overall Italian patents growth (49% and -4%) and EU-15 patents growth (40% and 4%).

Table 9.36: Total Patent Applications per Million Population in Puglia 1994-2011

	1994-99	**2000-07**	**2008-11**	**Growth 1994-99 v 2000-07 (%)**	**Growth 2000-07 v 2008-11 (%)**
Puglia	5.36	11.64	14.10	117.0%	21.1%
Italy	52.48	78.40	75.40	49.4%	-3.8%
EU-15	96.41	134.52	140.39	39.5%	4.4%

Note: Derived from Eurostat data. Puglia and Italy estimates are derived using patent application estimates (dated 30-01-14 and 02-06-15, extracted 29-08-14 and 02-11-15) and population estimates (dated 13-10-14, extracted 17-10-14). EU-15 estimates are derived using patent application estimates (dated 26-01-16, extracted 09-05-16) and population estimates (dated 13-10-14, extracted 17-10-14). Data refers to annual averages for each of the three periods examined.

Source: Author's calculations based on Eurostat data

Again, however, it is clear from Table 9.36 that the base level of patent activity in Puglia still significantly lags both Italian and EU-15 averages, i.e. a trend that is similarly evident for both R&D investment and R&D personnel in the region. For example, the region's average annual patent applications per million population in the 2008-11 period was equivalent to just 19% of the Italian average for the same period, or just 10% of the EU-15 average, although the region's relative share of patent activity vis-á-vis Italian and EU-15 averages has increased over time[47].

[47] An update on more recent data is not possible because, at the time of writing, Eurostat did not report data on patent applications at the regional level beyond 2012.

9.5.7 Employment in Key Sectors

Table 9.37 shows that growth in average annual employment in high and medium-high technology manufacturing, knowledge intensive services and high technology sectors was recorded in Puglia between the 1994-99 and 2000-07 periods, though the level of growth was somewhat below that recorded in Galicia. Growth in employment in high and medium-high technology manufacturing in the region, however, was well above both Italian and EU-15 averages, while the region also out-performed average Italian and EU-15 growth for employment in high technology sectors.

For example, growth in average annual employment in high and medium-high technology manufacturing in Puglia was nearly 20% between the 1994-99 and 2000-07 periods, well above both overall Italian growth (9%) and EU-15 growth (less than 1%). Similarly, average annual employment in high technology sectors in Puglia grew by 30% between the 1994-99 and 2000-07 periods, higher than both the EU-15 average growth of 19% and the overall Italian growth of over 25%. Employment growth in knowledge intensive services in the region, at 19%, was similar to the EU-15 average of 21%, though below the Italian average of 26%.

Table 9.37: Employment in Key Innovating Sectors in Puglia 1994-2007

	1994-99	**2000-07**	**Growth 1994-99 v 2000-07 (%)**
High/Medium-High Tech Manufacturing			
Puglia	36,482	43,598	19.5%
Italy	1,526,800	1,659,300	8.7%
EU-15	11,679,000	11,740,000	0.5%
Knowledge Intensive Services			
Puglia	273,851	325,639	18.9%
Italy	5,044,900	6,370,400	26.3%
EU-15	46,918,000	56,536,000	20.5%
High Technology Sectors			
Puglia	22,865	29,765	30.2%
Italy	734,300	918,100	25.0%
EU-15	6,613,000	7,847,000	18.7%

Note: Data refers to annual averages for each of the two periods examined. EU-15 data for the first period, however, relates to 1995-99. Eurostat data for Puglia and Italy is dated 26-06-13, extracted 29-08-14. Eurostat data for EU-15 is dated 15-07-15, extracted 10-05-16.

Source: Author's calculations based on Eurostat data

Again, as with Galicia, average annual employment in the 2000-07 period cannot be compared to average annual employment in the period from 2008 onwards due to changes in the European NACE codes. Therefore, Table 9.38 shows employment growth in the key sectoral groups between the years 2008 and 2012. This data, which also has to be viewed within the context of the global financial and economic crisis that occurred over the period, suggests that annual employment in high and medium-high technology manufacturing in Puglia fell by about 3% between 2008 and 2012, which was similar to the Italian average (-4%) but somewhat better than the EU-15 average (-9%). Annual employment in knowledge intensive services in the region recorded a fall of 5%, thereby slightly under-performing both the Italian average (-1%) and the EU-15 average (3%). In contrast to this, annual employment in high technology sectors in Puglia showed a growth of more than 22% between 2008 and 2012, whereas there was a stagnation in employment in these sectors in both an Italian and EU-15 context for the same period.

Table 9.38: Employment in Key Innovating Sectors in Puglia 2008-12

	2008	**2012**	**Growth 2008-12 (%)**
High/Medium-High Tech Manufacturing			
Puglia	31,000	30,000	-3.2%
Italy	1,376,000	1,324,000	-3.8%
EU-15	10,408,000	9,505,000	-8.7%
Knowledge Intensive Services			
Puglia	434,000	413,000	-4.8%
Italy	7,731,000	7,638,000	-1.2%
EU-15	69,623,000	71,553,000	2.8%
High Technology Sectors			
Puglia	18,000	22,000	22.2%
Italy	763,000	759,000	-0.5%
EU-15	7,028,000	6,979,000	-0.7%

Note: Eurostat data for Puglia and Italy is dated 06-10-15, extracted 02-11-15. Eurostat data for EU-15 is dated 22-12-15, extracted 10-05-16.

Source: Author’s calculations based on Eurostat data

However, the share of employment within these sectors in Puglia has, like Galicia, again remained below national and EU averages. As a share of total employment, for example, employment in high and medium-high technology manufacturing in the region accounted for 2.4% of total employment in the region in 2013, which was well below the Italian average share (5.9%) and the EU-15 average share (5.5%). Employment in high technology sectors in the region accounted for 1.6% of total employment in 2013, below both the Italian average share (3.4%) and the EU-15 average share (4.1%), while employment in knowledge intensive services accounted for about 35% of total employment in Puglia in 2013, similar to the Italian average share (34%) but below the EU-15 average share (42%). More recent data for 2018, meanwhile, shows that:

- employment in high and medium-high technology manufacturing in Puglia accounted for 2.4% of total employment in the region, compared to an Italian average of 6.1% and an EU-15 average of 5.6%;
- employment in knowledge intensive services accounted for about 33% of total employment in the region, compared to an Italian average of 35% and an EU-15 average of 43%;
- employment in high technology sectors accounted for 1.4% of total employment in the region, compared to an Italian average of 3.5% and an EU-15 average of 4.2%.

9.6 Chapter Summary

- The purpose of this chapter has been to describe (a) the socio-economic context in Galicia and Puglia, as an input to understanding the regional socio-economic setting in each region, and (b) the innovation performance of the two case study regions, based on the earlier quantitative analysis (see Chapter 6), which shows how the performance of the two regions has differed under commonly used indicators for R&D and innovation activity.
- In terms of socio-economic structure, Galicia and Puglia are both regions that display a mix of urban and rural populations, but with significant concentrations of population in certain territories (e.g. Vigo and A Coruña in Galicia, Bari and its surrounding area in Puglia), and a recent history of low population growth and population emigration.
- Similarly, most economic activity in the two regions is concentrated around the main population centres, with important sectors in Galicia including the fisheries sector, the automotive sector, shipbuilding, textiles and clothing, and natural

resources (e.g. stone, timber), while key sectors in Puglia include the food industry and related sectors, textiles and footwear, manufacture of wood or related products, and (to a lesser extent) the metallurgy, automotive and furniture sectors. The vast majority of firms operating in both regions are small in size, though each region also has some larger indigenous and foreign-owned firms operating within the aforementioned sectors.

- Economic growth in Galicia, however, was noticeably stronger than in Puglia during the 2000-13 study period, and this was evident in trends in GDP, labour market participation, employment and unemployment, while Galicia also has a more highly educated population (based on levels of tertiary education attainment), which similarly grew more strongly over the period. At the same time, these growth trends somewhat mirrored the experiences of Spain and Italy generally over the period, while both regions experienced a substantial negative economic shock in the latter years of the study period, due to the impact of global financial and economic crisis.
- In terms of R&D and innovation, meanwhile, both Galicia (during the 2000-06 period) and Puglia (during the 2007-13 period) have been identified as relatively good absorbers of EU Structural Fund support for R&D and innovation (see European Commission, 2012b, 2014b). Yet, Galicia has achieved the more significant growth in its innovation performance since the mid-1990s, based on the trends in commonly used R&D and innovation indicators. In particular, growth in R&D expenditure, R&D personnel and patent applications generally out-paced both Spanish and EU-15 averages (on a per capita basis) over the 2000-13 period, while the relative share of R&D expenditure and personnel that was attributable to business sector activity also grew. Puglia, in contrast, similarly witnessed positive growth in R&D expenditure, R&D personnel and patent applications over the same period, with growth generally exceeding both Italian and EU-15 averages, but growth in the region was not as strong as in Galicia, while there was little change in the relative share of R&D expenditure and personnel that was attributable to business sector activity.
- At the same time, base levels of R&D and innovation activity in both regions remained well below national and EU-15 averages across most of these indicators, based on the evidence available, despite the growth in R&D and

innovation activity that occurred over the study period.

- Chapter 9, therefore, suggests that developments in R&D and innovation activity in both Galicia and Puglia have shown some progress in addressing issues related to the regional innovation paradox, such as the perceived need for increased investment in R&D and innovation, though the trend underlying this progress has varied over time. Moreover, the evidence in the chapter might also suggest that the earlier investment of "inputs" to R&D and innovation in Galicia, alongside its more buoyant economic growth and its well educated population, might have contributed to higher levels of "outputs" of R&D and innovation in that region, while still acknowledging a relatively low base of activity in both regions (and the perceived "low-tech" nature of many of the sectors that predominate in the regional economies).
- However, it is again important to remind the reader that Chapter 9 only tells us something about context, inputs, outputs and outcomes associated with the development of R&D and innovation in Galicia and Puglia over the 2000-13 period, based on commonly used indicators, without telling the whole story regarding the development of R&D and innovation in the two regions. Chapter 10, therefore, adds to the understanding of R&D and innovation development in both regions by looking at the structure of the regional innovation systems in the regions, while also describing the policies that have been in place to support R&D and innovation over the course of the study period.

CHAPTER 10 – CASE STUDIES: REGIONAL INNOVATION SYSTEMS AND POLICY DEVELOPMENTS

10.1 Introduction

This chapter describes the regional innovation systems in Galicia and Puglia, while it also describes the policies that have been in place to support R&D and innovation over the course of the study period.

As noted previously in Chapter 5 and Chapter 8, the analytical framework that underpins the case studies draws on Tödtling and Trippl (2005), and is illustrated again in Figure 10.1 below. The current chapter, therefore, contributes to this framework by describing the main elements of the regional innovation systems in Galicia and Puglia, with a focus on describing:

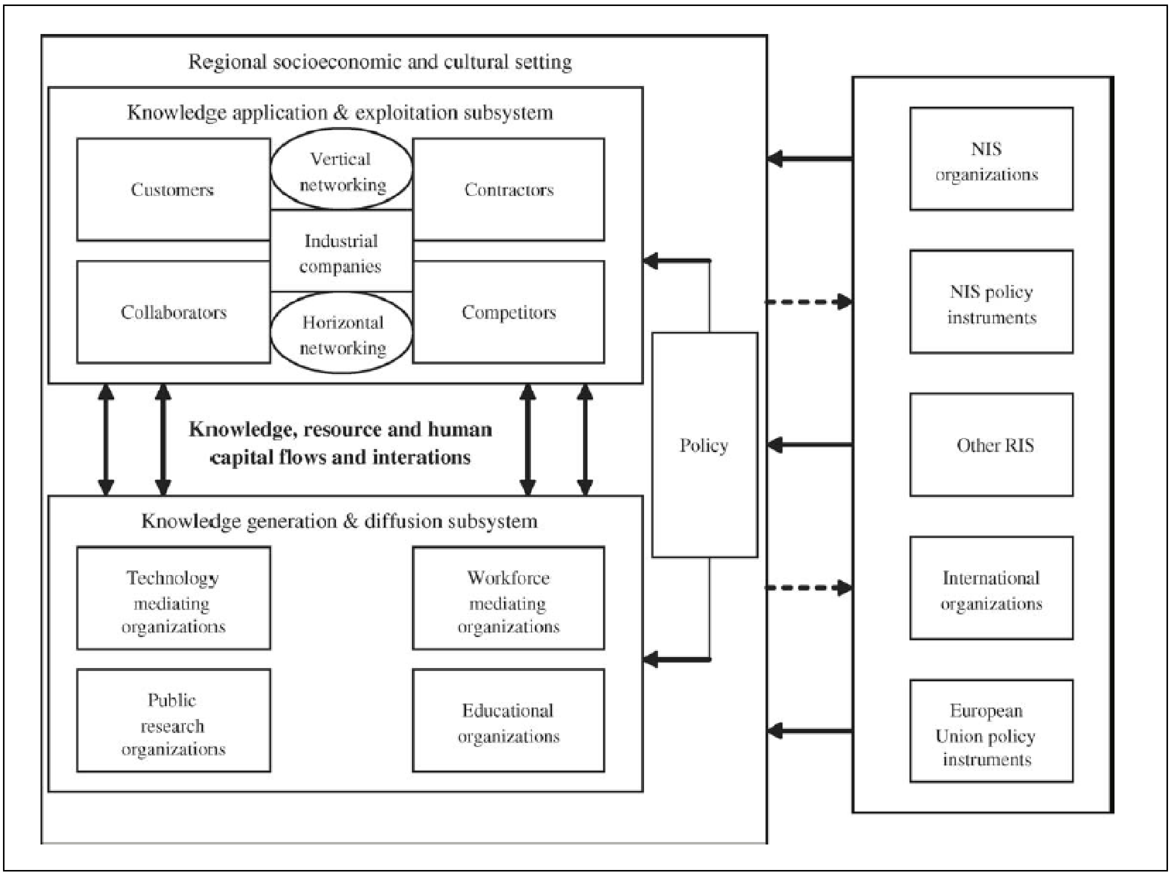
- the knowledge generation and diffusion sub-system, which (as noted in Chapter 8) includes educational institutions (e.g. universities, other higher education or vocational training institutions), public research institutions and technology mediating organisations (technology licensing offices, innovation centres);
- the knowledge application and exploitation sub-system, which consists of companies, their clients, suppliers, competitors and co-operation partners;
- the regional policy dimension, which includes (a) the regional policy "sub-system" of policy actors, which play a role in shaping regional innovation processes, and (b) the policies for innovation that have been developed in each region over the period.

However, it is again important to remind the reader at the outset that Chapter 10, like Chapter 9, only tells us something about context, inputs, outputs and outcomes associated with the development of R&D and innovation in Galicia and Puglia over the 2000-13 period, in this case by describing the main elements of each of the different sub-systems within the regional innovation systems in the two regions, and the policy developments. At the same time, the chapter tells us less about the processes, connections and other influencing factors underlying the development of R&D and innovation in the two regions, for example, both within the regional innovation systems or between the regional systems and the systems that exist at other spatial levels (e.g.

national, global). Further insights on these issues, therefore, are provided in the discussion of the research interviews in Chapter 11.

The regional innovation system in Galicia is described first, in Section 10.2, followed by the description of policy for R&D and innovation in Galicia over the period, in Section 10.3. Section 10.4 then describes the regional innovation system in Puglia, while Section 10.5 describes policy for R&D and innovation in the region over the period. Section 10.6 provides a summary of the chapter.

Figure 10.1: Analytical Framework for Analysis of Case Study Regions



Source: Tödtling and Trippl (2005)

10.2 Description of the Regional Innovation System in Galicia

10.2.1 Knowledge Generation and Diffusion Sub-system

The knowledge generation and diffusion sub-system in Galicia consists mainly of educational institutions, public research organisations and intermediate technological organisations.

Universities: There are three universities in the region – the University of Santiago de Compostela, the University of Vigo and the University of A Coruña. The University of Santiago de Compostela is a long-standing higher education institution in the region, with its establishment dating back to the late 1400s. However, both the University of Vigo and the University of A Coruña were only formally established as independent universities in 1990 (González López et al, 2014), both having originally been established as satellite campuses of the University of Santiago de Compostela in the early 1980s. Alongside their main campuses, the University of Santiago de Compostela now has a second campus in Lugo, the University of Vigo has other campuses in Ourense and Pontevedra, while the University of A Coruña has a second campus in Ferrol.

In relative terms, the University of Santiago de Compostela was ranked 14th for research out of 29 Spanish universities, according to the Times Higher Education World University Rankings for 2017, while the University of Vigo and University of A Coruña were ranked 22nd and 25th respectively. For wider comparison, the highest ranked university for research in Spain in the same year was Pompeu Fabra University in Catalonia, which was ranked 200th in global terms.

Table 10.1a and Table 10.1b provide an overview of the research institutes and research centres that have been formed within each of the three universities. In this regard, Table 10.1a shows that the University of Santiago de Compostela has the most extensive and varied range of research activity among the three universities, based on the number of institutes and centres, with González López et al (2014) pointing to its strengths in health sciences and classical disciplines. Health science specialisms include neurological sciences, industrial pharmacy, nutrition, molecular medicine, orthopaedics, biological chemistry and life sciences, while classical specialisms cover a range of activities in humanities, law, social sciences and business. Other research interests include aquaculture, mathematics and technological research.

González López et al (2014) have also contended that research specialisms in the University of Vigo and the University of A Coruña, in contrast, are more focused on technology and industrial engineering (Vigo) and architecture, civil engineering and computer studies (A Coruña) respectively. Again, Table 10.1b shows that research interests in Vigo include scientific and technological research, information and communication technologies, biomedical research, agri-food and marine science, while interests in A Coruña include construction and civil engineering, information and communication technologies, scientific research, technology research and biomedical research.

Table 10.1a: Research Institutes and Research Centres at Galician Universities

University	Research Institute or Centre
University of Santiago de Compostela	▪ Galician Language Institute (ILG) ▪ Aquaculture Institute ▪ Agricultural Biodiversity and Rural Development Institute (IBADER) ▪ Ceramics Institute ▪ Educational Science Institute (ICE) ▪ Pedro Barrié de la Maza Institute of Neurological Sciences ▪ Institute of Criminology ▪ Industrial Law Institute ▪ Galician Studies and Development Institute (IDEGA) ▪ Industrial Pharmacy Institute ▪ Nutritional Research and Analysis Institute ▪ Technological Research Institute ▪ Mathematics Institute ▪ Institute of Legal Medicine (INCIFOR) ▪ Orthopaedics Institute and Muscleskeletal Tissue Bank ▪ Galician Institute for High Energy Physics ▪ Biological Chemistry and Molecular Materials Research Centre ▪ Molecular Medicine and Chronic Diseases Research Centre ▪ Life Sciences and Technologies Research Centre ▪ Centre for Co-operative Studies (CECOOP) ▪ Centre for History Studies in the City ▪ Security Studies Centre (CESEG) ▪ Centre for Studies on Western Sahara (CESO) ▪ Centre for Tourism Studies and Research (CETUR) ▪ Centre for Film Studies (CEFILMUS) ▪ Research Centre for Emerging Cultural Processes and Practices (CIPPCE) ▪ Integral Centre of Analysis and Resolution of Conflict (CIARCUS) ▪ Gumersindo Busto Interdisciplinary Centre for American Studies ▪ Interdisciplinary Centre for Feminist Research and Gender Studies (CIFEX) ▪ Centre for Social Responsibility, Corporate Governance and Investor Protection

Source: Author’s own elaboration, derived from university websites

Table 10.1b: Research Institutes and Research Centres at Galician Universities

University	Research Institute or Centre
University of Vigo	▪ Scientific and Technological Research Assistance Centre (CACTI) ▪ Research Transfer and Innovation Centre (CITI) ▪ Technological Research Industrial Centre (MTI) ▪ Toralla Marine Science Station (ECIMAT) ▪ Biomedical Research Centre (CINBIO) ▪ Research Centre for Information and Communication Technologies (AtlantTIC) ▪ Agro-environmental and Food Research Centre (CIA) ▪ Strategic Consortium for Industry and Energy (INEX) ▪ Economics and Business Administration for Society (ECOBAS)
University of A Coruña	▪ Institute for Biomedical Research (INIBIC) ▪ University Institute in Environment ▪ University Institute in European Studies – Salvador de Madariaga ▪ University Institute in Geology – Isidro Parga Pondal ▪ University Institute in Health Sciences ▪ University Institute in Irish Studies – Amergin ▪ University Institute in Maritime Studies ▪ Centre for Advanced Scientific Research (CICA) ▪ Technology Research Centre (CIT)
Joint Centres	▪ Technological Institute for Industrial Mathematics (ITMATI)

Source: Author's own elaboration, derived from university websites

All three universities, moreover, co-operate in the Technological Institute for Industrial Mathematics (ITMATI), while both Vigo and A Coruña are associate partners in the University of Santiago de Compostela's development of Campus Vida, an "International Campus of Excellence" in life sciences, which has been developed under the Spanish national government's International Campus of Excellence Programme[48]. Similarly, both the University of Santiago de Compostela and the University of A Coruña have co-operated in the development of Campus do Mar, another International Campus of Excellence developed by the University of Vigo, which also involves the Spanish Council of Scientific Research and the Spanish Institute of Oceanography.

In addition, each of the universities has established Oficinas de Transferencia de Resultados de Investigación (OTRIs), or technology transfer offices (TTOs). In Galicia, all three universities have had such an office in place since the early 1990s (González López et al, 2014), with their establishment at the time being supported by Spain's

[48] The International Campus of Excellence Programme was established in Spain in 2009. Its objective was to promote aggregation between universities and between universities and other institutions around common projects and campuses (Seeber, 2017). It was hoped that this would, among other things, reduce fragmentation of structures and overlap of university offerings and improve both teaching and research specialisation within the university system.

National Plan for R&D 1988-91. According to Xunta de Galicia (2014), these offices were set up to provide an interface structure between universities and enterprises to maximise R&D capacities and outcomes in the wider productive economy and socio-economic environment. Thus, the main objectives of the OTRIs include:

- identifying university research outputs that are of potential commercial value[49];
- identifying demand for research outputs among companies, promoting potential opportunities to companies, and negotiating agreements with companies (e.g. licensing agreements for use of research outputs, or other deals with industry partners to develop new products, processes or services);
- promoting the development of new companies that are generated from university research results (i.e. spin-offs)[50];
- providing support to researchers in terms of marketing, contractual arrangements, patent processing, company set-up or other transfer support arrangements.

Technology Centres: Alongside the universities, more than 20 technology centres have been established in Galicia (Faiña et al, 2013, Xunta de Galicia, 2014) in order to more directly target R&D and innovation promotion and supports for enterprises and the productive sector, especially SMEs. Technology centres are therefore generally non-profit organisations, mostly private, that offer R&D and innovation support services to businesses, and their establishment has been commonplace in the development of regional innovation systems and policies across Spain. In Galicia, support from the ERDF has helped to increase the number of centres over the past 20 years, with the numbers increasing from less than 10 such centres in the late 1990s (Faiña et al, 2013).

[49] In this regard, data collated by the Spanish Universities' Knowledge Transfer Office Network, for the 2006-13 period, shows that the University of Santiago de Compostela made 176 patent applications in the period, or an average of 22 applications per year, ranging from 13 applications in 2007 up to 29 applications in 2010. In the same period, the University of Vigo made 125 patent applications, or an average of 16 applications per year, ranging from 11 applications in 2007 up to 20 applications in 2013. Data for the University of A Coruña, on the other hand, was only available for the 2011-13 period (with 12, 17 and 12 applications in each year).

[50] Again, data collated by the Spanish Universities' Knowledge Transfer Office Network, for the 2006-13 period, shows that the University of Santiago de Compostela created 24 spin-off companies in the period, while the University of Vigo created 21 spin-off companies. Data for the University of A Coruña, on the other hand, shows that it created another nine spin-off companies in the 2011-13 period.

Table 10.2, which provides an overview of the technology centres in Galicia, shows that there are a number of sectors that are served by several centres, including ICT, the aquaculture/fisheries/marine sectors, the food sector and construction. Other sectors with technology centre support include the automotive sector, shipbuilding, the timber sector, plastics and the energy sector, among others.

Table 10.2: Technology Centres in Galicia

Centre	Sector/Theme
Aquaculture, Fisheries and Marine	
Galician Aquaculture Technology Centre (CETGA)	Aquaculture
Technology Centre for the Preservation of Fishing Products (ANFACO)	Fisheries
Celeiro Fisheries Technology Centre (CETPEC)	Fisheries
Sea Technology Centre (CETMAR)	Marine
Naval Technology Centre of Galicia (CETENAGA)	Shipbuilding
Construction	
Technology Innovation Centre in Construction and Civil Engineering (CITEEC)	Construction
Granite Technology Centre (CTG)	Construction
Galician Slate Technology Centre (CTL)	Construction
Food	
Meat Technology Centre of Galicia (CTC)	Food
Milk Technology Centre	Food
Food Technology Centre in Lugo (CETAL)	Food
ICT and Technology	
Supercomputing Centre of Galicia (CESGA)	ICT
Information and Communication Technology Research Centre (CITIC)	ICT
Galician R&D Centre in Advanced Telecommunications (GRADIANT)	ICT
Software Technology Centre	ICT
Technological Research Centre (CIT)	Technology
Technology Institute of Galicia (ITG)	Technology
Other Sectors or Themes	
Automotive Technology Centre of Galicia (CTAG)	Automotive
Energy Saving and Energy Efficiency Technology Centre (Energylab)	Energy
Centre for Design and Technology (CIS-Galicia)	Innovation
Asociación de Investigación Metalúrgica del Noroeste (AIMEN)	Metallurgy
Official Metrology Laboratory of Galicia (LOMG)	Metrology
Galician Plastic Centre (CGAP)	Plastics
Centre for Innovation and Technological Services of Timber (CIS-Madiera)	Wood/Timber

Source: Author's elaboration

Public Research Organisations: Public research organisations (PROs) in Spain are national-level public research institutions, which form another core component of Spain's public system for scientific research and technological development, alongside universities. According to Xunta de Galicia (2014), these PROs carry out many programmed activities under Spanish national plans for scientific research, development and innovation, including the management of national and sectoral research programmes, training for researchers and provision of scientific and research advice.

There are eight different PROs in Spain. However, just two of these PROs operate within Galicia, where they have seven associated operations centres. These are:

- the State Agency of the Higher Council for Scientific Research (CSIC), which is the largest PRO in Spain, and which has five of its 130+ centres situated in the region;
- the Spanish Institute of Oceanography (IEO), which has two of its nine oceanographic centres in the region.

Research areas pursued by CSIC centres in Galicia include natural resources (the Institute of Marine Research), agricultural sciences (the Agrobiologic Research Institute of Galicia, the Biological Mission of Galicia) and humanities and social sciences (the Institute of Sciences of the Patrimony, the Padre Sarmiento Institute for Galician Studies). Research at the IEO oceanographic centres, which are situated in A Coruña and Vigo, focuses on aquaculture, fisheries, and the marine environment and environmental protection.

10.2.2 Knowledge Application and Exploitation Sub-system

The sub-system for knowledge application and exploitation in Galicia consists primarily of the region's enterprise base and its customers, collaborators, suppliers and competitors.

There has been some evidence, as outlined previously in Chapter 9, that activity within this sub-system in Galicia, i.e. business engagement in R&D and innovation activity, has increased in the period under review. For example:

- average annual business R&D expenditure in the region (when expressed on a per capita basis) grew by more than 350% between the 1994-99 and 2008-12 periods, with growth being well above both Spanish national and EU-15 averages. Moreover, growth in business R&D personnel also showed similar trends over the same periods;

- the Companies in Innovation Survey in Spain shows that Galicia's stock of innovative companies (with 10 or more employees) ranks highly when compared to other Spanish lagging regions, and this trend is common for the stock of companies engaging in both product and process innovation, when compared to similar regions.

At the same time, baseline levels of business R&D expenditure remained below both Spanish and EU-15 averages during the 2008-12 period, at an average of 46% of total regional R&D expenditure. Also, the overall stock of innovative companies in the region (as per the national Companies in Innovation Survey in Spain) fluctuated between 2,100 and 2,600 companies between 2003 and 2013. At about 2,100 companies in 2013, therefore, the stock of innovative companies represented about 1% of the estimated 210,000 firms in Galicia, which was similar to the overall share of innovative companies among Spanish firms.

The largest and best known firms operating in Galicia include several indigenous Galician companies alongside a smaller number of global multinational companies. These firms include, for example:

- PSA Peugeot-Citroën – the car manufacturer, which employs 5,700 people in Vigo, and which has been operating in Galicia since 1958;
- Inditex – an indigenous Galician firm that has established a multinational presence as a global fashion retailer, operating several major fashion brands (e.g. Zara), and which employs 175,000 people globally;
- Pescanova – another indigenous Galician firm that operates in the fishing, farming, processing and commercialisation of seafood products, with 11,000 employees globally;
- Repsol – the multinational producer of oil and natural gas, which operates a refinery in A Coruña that employs about 1,000 people;
- Coren – an indigenous Galician agri-food co-operative, which has over 4,700 co-operative partners and employs 3,200 people;
- Calvo – another indigenous Galician firm, which is one of the larger firms in Spain in the canned fish industry.

The promotion of “cluster” development in Galicia, as a means of improving competitiveness and innovation, has also been adopted as a policy initiative in the region during the period under review, through initiatives of the Instituto Galego de Promoción Económica, or the Galician Institute for Economic Promotion (IGAPE). This has led to the formation of 14 different cluster organisations in Galicia (listed in Table 10.3), and public funding for joint projects within these clusters, with cluster organisations being legal, non-profit entities that are intended to create joint strategies for innovative business groupings (“clusters”), promote collaboration between cluster partners, promote diversification and expanded market opportunities, and generate synergies between partners, among other things.

The cluster organisations listed in Table 10.3 span the aquaculture, audiovisual, automotive, biotechnology, food/seafood, granite, graphics, health, ICT, shipbuilding, textiles, tourism and wood/timber sectors, with clusters in the automotive, wood and shipbuilding sectors established during the 1990s, and most others being established between 2000 and 2011. Cluster organisations have between 10 and 300 members (mostly firms), depending on the cluster, and according to IGAPE (2014), the turnover of firms that are involved in the clusters is equivalent to about one-third of Galicia’s GDP.

Table 10.3: Cluster Organisations in Galicia

Name	**Sector**	**Members (Approximate)**
Cluster de la Acuicultura de Galicia	Aquaculture	15
CLAG	Audiovisual	40
CEAGA	Automotive	100
BIOGA	Biotechnology	65
CLUSAGA	Food	80
Cluster del Granito	Granite	50
Cluster Comunicación Gráfica	Graphics	70
Cluster Saúde de Galicia	Health	60
Cluster TIC Galicia	ICT	280
ANFACO-CECOPESCA	Seafood	250
ACLUNAGA	Shipbuilding	100
COINTEGA	Textiles	100
CTG	Tourism	65
CMD	Wood/Timber	50

Source: Author’s elaboration, derived from Clusters de Galicia and individual cluster websites

It is also notable that many of the cluster organisations in Galicia have links with the region's technology centres. Many technology centres, for example, are formally incorporated within cluster membership and structures, and some examples of this include:

- the Automotive Technology Centre of Galicia (CTAG), which is part of the CEAGA automotive cluster;
- the Galician Aquaculture Technology Centre (CETGA), which serves the Cluster of Aquaculture of Galicia;
- the Cluster TIC Galicia, which is supported by the Supercomputing Centre of Galicia (CESGA) and the Information and Communication Technology Research Centre (CITIC), among others;
- the Food Technology Centre in Lugo (CETAL), the Meat Technology Centre of Galicia (CTC) and the Technology Centre for the Preservation of Fishing Products (ANFACO), which are all members of the CLUSAGA food cluster;
- the ANFACO technology centre is also aligned to the ANFACO-CECOPESCA seafood cluster.

10.2.3 Regional Policy Sub-system

The regional policy sub-system consists of the relevant political institutions and regional development agencies in Galicia. These include relevant regional government departments, agencies that are tasked with the development of innovation in the region, or other agencies that have some influence on innovation in the region.

<u>*Regional Autonomy in Galicia*</u>: To provide context, it is important to recognise that a high degree of regional autonomy exists in Galicia, and this level of autonomy is common across Spanish regions in general. The establishment of strong regional competence in Spain can be traced back to the adoption of the current Spanish Constitution in 1978, which established the "Autonomous Communities", or autonomous regions. According to Sanz-Menéndez and Cruz-Castro (2005), therefore, the genesis for regional level development and implementation of innovation policy in Spain pre-dates its accession to the EU, which only occurred in 1986.

According to De Lucio, Mas-Verdu and Tortosa (2010), the constitutional changes adopted in the late 1970s set up autonomous regions as a core component of the political structure of the country, and the extent of regionalisation adopted, both in terms of its depth and pace, was without parallel among EU member states. In a similar vein, Moreno (2002) as cited by Sanz-Menéndez and Cruz-Castro (2005), described the political system in Spain as being "quasi-federal", such is the extent of regional power and autonomy, with the result that all autonomous regions have significant responsibilities for both defining and implementing policy at a regional level.

Furthermore, Faiña and López-Rodríguez (2010) noted that regional governments' competences in Spain include wide-ranging powers in education (including higher education), entrepreneurial and industrial policy, and research and innovation. Thus, in the realm of R&D and innovation, De Lucio et al (2010) have suggested that Spain's regional administrations have gained experience in designing and implementing innovation policies, and that the development of this experience has progressed over time. Faiña and López-Rodríguez (2010), in turn, have asserted that Spanish regional R&D and innovation plans have been generally intended to:

- define the sectoral and technological priorities of regional innovation systems, according to the technological needs and productive structure of the regional economy;
- deliver specifically adapted policy measures, with their own regional policy instruments, which are targeted at regional stakeholders, universities, research or technological centres, and firms;
- foment regional innovation systems by developing regional innovation networks between actors in the system and deploying programmes that are specifically adapted to the needs and capacities of innovation and business networks;
- encourage the generation of research projects and innovation activities in the business sector, by targeting firms that have the capacity to either undertake R&D and innovation projects or enter into partnership or collaborative projects with research and technological centres or other entities.

According to Del Castillo et al (2006) and Faiña and López-Rodríguez (2010), the majority of regions in Spain also established regional development agencies, with remits to promote innovation and entrepreneurial activities, including the implementation and delivery of regional innovation policies and plans. Moreover, in the specific context of Galicia, Sanz-Menéndez and Cruz-Castro (2005) pointed out that the region first established specific governance arrangements for R&D in the mid-1990s, having set up a Directorate General for Research, Development and Innovation in 1997. In this regard, therefore, they suggest that Galicia was different to several other Spanish regions at the time in bringing science policy and technology/innovation policy under a single policy domain, thereby being institutionally and administratively integrated at policy level.

Role of National Government: At the same time, the role that Spanish national government plays in developing research and innovation at the regional level needs to be considered. In this regard, for example, Sanz-Menéndez and Cruz-Castro (2005) pointed to "shared competencies" between the national and regional levels in science, technology, research and innovation policy, which required co-operation between national and regional governments. Faiña and López-Rodríguez (2010), meanwhile, asserted that National Research, Development and Innovation Plans for Spain, which have been developed at the national government level every four years since 1988, are the main planning instrument for innovation policy in the country, and that national government remains the key co-ordinator of innovation policy.

National plans for R&D and innovation therefore establish the actions to be undertaken by national government and its agencies, and these plans apply to the whole of Spain, while regional plans for R&D and innovation establish further region-specific actions but are also supposed to take account of national plan measures that are to be delivered in the regions (Faiña and López-Rodríguez, 2010). Co-operative frameworks have been put in place with an objective to facilitate innovation policy co-ordination between national and regional governments, with a General Council of Science and Technology having responsibility for co-ordination of national and regional R&D and innovation policies, and with national strategies and plans being formally approved by both national and regional governments. National policy measures are implemented in the regions by means of formal agreements made with regional governments, while funding of innovation policy measures in the regions have been mostly channelled through both national and regional operational programmes (OPs), which are co-financed the EU Structural Funds.

Regional Departments and Agencies in Galicia: At present, there are two main regional government departments that directly affect regional innovation policy in Galicia. The first of these is the Ministry of Economy, Employment and Industry, which has responsibility for developing innovation and entrepreneurship in the region. In the context of research and innovation, two important regional development agencies also fall within the remit of the Ministry of Economy, Employment and Industry – the Axencia Galega de Innovación, or Galician Agency for Innovation (GAIN), and IGAPE, the Galician Institute for Economic Promotion, which was referred to earlier.

GAIN is the main public agency with responsibility for promoting research and innovation in Galicia. It was relatively recently established by the regional government, in 2012, with a mission to "support and encourage growth and competitiveness in Galician enterprises, and promote and structure innovation policies in Galician public administrations" (Xunta de Galicia, 2014). Also, its key competences, as described by Xunta de Galicia (2014) include the following:

- drawing up and reviewing plans and programmes in matters of research, development and innovation, e.g. draft Galician Research, Development and Innovation Plans;
- planning, executing and supervising activities that are designed to promote innovation in productive sectors;
- co-ordination of research activities and programmes in the regional government departments and bodies;
- wider co-operation and collaboration activities to facilitate interaction among the different agents in the regional innovation system, including networking.

GAIN was therefore set up as a replacement for the Directorate General for Research, Development and Innovation in Galicia, primarily to further improve co-ordination and collaborative governance within the Galician regional innovation system (Xunta de Galicia, 2014), including the management of key stakeholders and budgets, and to take charge of the structure, planning, co-ordination, implementation and follow-up of actions related to R&D that are promoted by the regional government, as well as scientific and technical research promotion and co-ordination. Policy input to the agency is also facilitated from all regional government departments in Galicia, through the agency's Governing Council, which includes representatives from each government department as well as the three regional universities. Alongside this, a Galician Research and Innovation Advisory Council is intended to act as a channel for participation, co-ordination and contributions from all other agents in the Galician research and innovation system.

IGAPE, on the other hand, is the main public agency with responsibility for promoting wider economic development in Galicia. According to the agency's website, its mission is to "support all activities that contribute to improving the Galician production system, facilitating the processes of creation, consolidation and business growth", while its objectives are to:

- promote the creation of new companies and strongly encourage entrepreneurial spirit;
- increase the competitiveness of Galician companies through innovation and technological development;
- attract investment to Galicia and facilitate the internationalisation of Galician companies;
- support co-operation in and the development of collective projects by Galician companies.

In the context of research and innovation, therefore, it is mainly involved in running funding programmes that are targeted at developing research, innovation and technological development in Galician companies (Xunta de Galicia, 2014). However, IGAPE is also the lead agency promoting the development of cluster organisations in the region, as described in Section 10.2.2.

The other key department within the regional government in Galicia is the Department of Culture, Education and University Planning. Within this department, the General Secretariat of Universities has responsibility for university policy, including research in the universities, while the key agency operating on the department's behalf in this area is the Consortium Agency for the Quality of the University System (ACSUG).

According to the ACSUG website, the Department of Culture, Education and University Planning, in conjunction with the Department of Economy, Employment and Industry, approves funding programmes for the consolidation and structuring of internal research units in universities. It also, for example, provides programmes for postdoctoral researchers and "emerging researchers". Furthermore, ACSUG was established in 2001, as a consortium and co-ordinated agency of the Galician regional government and the three Galician universities, with an overall mission to improve the quality of the Galician university system. Part of its remit, therefore, involves the implementation of funding programmes for university research on behalf of its parent department.

10.3 Innovation Policy Developments in Galicia

10.3.1 Early Policy Initiatives – 1980s and 1990s

High levels of decentralisation, and associated political autonomy and financial capabilities, allowed several Spanish regional governments to take early initiatives to promote regional R&D and innovation policies, with some regions initiating such interventions before the emergence of EU policies, models or programmes (Sanz-Menéndez and Cruz-Castro, 2005). The regional government in Galicia was one such administration, and its efforts to engage in research and innovation policy development in the 1980s and 1990s included the following:

- the development of regional research plans or schemes during the 1980s to supplement national policy in the area, in line with the existing National Research, Development and Innovation Plan of the time (Sanz-Menéndez and Cruz-Castro, 2005);

- early identification of the need to prioritise the development of a stronger research system in Galicia as a policy priority, at about the same time that a new university development strategy stimulated the creation of two new public universities, i.e. Vigo and A Coruña (Sanz-Menéndez and Cruz-Castro, 2005);
- the establishment of OTRIs/TTOs within each of Galicia's three universities, on foot of national legislative and policy efforts to promote the general co-ordination of scientific and technical research and the transfer of knowledge and technology from universities to the productive system (González-López et al, 2014);
- the adoption within Galician regional law, in 1993, of the requirement to promote research and technological development by means of mandatory Galician Plans for Research and Development (Rodríguez Cuoto, 2007, González-López et al, 2014).

In the mid-1990s, the Galician regional government also received assistance under the EU's RIS Programme (as referred to in Chapter 7, Section 7.8) to develop an innovation strategy for the region. This project, known as ESTREIA, aspired to take the first steps to tackle perceived weaknesses in the Galician innovation system at that time, which included:

- duplication of science and technology services, and an absence of others, leading to a consequent lack of fit with the needs of the Galician productive sector;
- low levels of innovation in the business sector, due to a lack of suitable financial mechanisms to foster innovative projects and activities;
- lack of a regional scientific plan, absence of an integrated policy capable of fostering strategic direction and co-operation, and a lack of technological policy instruments for co-operation (Coruña University Foundation, 2004).

ESTREIA was a small-scale initiative, however, with a total budget of about €500,000 that was primarily targeted at providing an input to strategy and policy making. It therefore sought to establish guidelines for short- and medium-term technology policy actions, which would be achieved through consensus among the public, private and higher education sectors, to be facilitated through an informal innovation network of key actors and participative workshops (Coruña University Foundation, 2004). While the output of the ESTREIA project did not constitute a statutory or official plan for R&D and innovation in Galicia, therefore, Rodríguez Cuoto (2007) nonetheless suggested that it “paved the path” for subsequent R&D and innovation plans that were developed in the region over the following years.

10.3.2 Regional Plans for Research, Development and Innovation – 1999-2015

As noted in Section 10.3.1, by 1993, Galician regional law required that research and technological development in the region be promoted by means of mandatory Galician Plans for Research and Development. As a result, regional governments in Galicia had adopted four formal plans for research, development and innovation up to 2013, with the first plan commencing in 1999[51]. These plans were:

- the first Galician Plan for Research and Technological Development, which covered the period from 1999 to 2001;
- the second Galician Plan for Research, Development and Technological Innovation, which covered the period from 2002 to 2005;
- the third Galician Plan for Research and Technological Development and Innovation, which covered the period from 2006 to 2010;
- the fourth Galician Plan for Research, Innovation and Growth, which covered the period from 2011 to 2015.

Each of these plans, in turn, were part-funded by the EU Structural Funds, and their associated programmes. In particular, financial support for the regional plans was provided through both National Operational Programmes (NOPs), which were managed at the national government level, and Regional Operational Programmes (ROPs), which were managed at the regional government level. Measures in the 1999-01 and 2002-05 plans, for example, were part-funded by the Research, Development and Innovation NOP 2000-06 and by the Galicia ROP 2000-06. Funding for the 2006-10 and 2011-15 plans, on the other hand, included support from the Knowledge Economy NOP 2007-13, the Technological Fund NOP 2007-13 and the Galicia ROP 2007-13 (Faiña et al, 2013).

[51] According to González-López et al (2014), the delay between the 1993 adoption of the regional law and the subsequent 1999 launch of the first plan reflected “the difficulties to establish a coherent and integral strategy for R&D in the region”. The ESTREIA project, therefore, provided an input into this strategy making process.

Table 10.4 also gives a sense of how the volume of innovation-related Structural Fund investment in Galicia changed over time, based on a study of the main achievements of EU Cohesion Policy programmes and projects in the region, carried out by Faiña et al (2013). In particular, it shows that innovation's share of total Structural Fund investment in Galicia increased markedly between 1989 and 2013, but especially during the 2000-06 and 2007-13 Structural Fund programming periods. Between 1989 and 1993, for example, innovation projects in technological institutes and laboratories accounted for about €24 mn in investment during the 1989-93 programming period, or less than 2% of the €1.5 bn in total Structural Fund resources available to the region for the period, while innovation accounted for just €19 mn in support between 1994 and 1999, or less than 1% of the €3.6 bn in total Structural Fund resources available for that period. However, there was a significant increase in Structural Fund expenditure on R&D and innovation between 2000 and 2006, with over €520 mn in expenditure recorded, which was equivalent to 9% of the €5.9 bn in total Structural Fund resources available for the period, while initial Structural Fund allocations for R&D and innovation between 2007 and 2013 stood at more than €850 mn, which was equivalent to 22% of the €3.9 bn in total Structural Fund resource allocations for that period.

Table 10.4: EU Structural Fund Expenditure on Innovation in Galicia 1989-2013

Programming Period	**Expenditure on Innovation (€mn)**	**Total Structural Fund Expenditure (€mn)**	**Innovation as % of Total Structural Fund Expenditure**
1989-93	24.4	1,492.5	1.6%
1994-99	18.6	3,569.8	0.5%
2000-06	524.3	5,879.6	8.9%
2007-13	849.3	3,861.4	22.0%

Note: Expenditure estimates expressed in constant 2000 prices. Estimates for 2007-13 relate to allocations rather than actual recorded expenditures.

Source: Faiña et al (2013)

The regional plans for research, development and innovation, which were part-funded by this Structural Fund support, are described in more detail in the rest of this section.

Regional Plans 1999-2005: According to Rodríguez Cuoto (2007), the first Galician Plan for Research and Technological Development (1999 to 2001) was a largely experimental plan, which was designed to organise and guide the activities of the innovation system in Galicia and to co-ordinate public resources for research and innovation. Planned expenditure of over €130 mn was targeted under the plan (Xunta de Galicia, 2014), covering three main action lines, which were: training of human capital; creation of scientific and technical infrastructure; and implementation of research and innovation projects.

Some authors, however, have suggested that the second Galician Plan for Research, Development and Technological Innovation (2002 to 2005) was a further progression in the organisation of innovation policy in Galicia. According to Rodríguez Cuoto (2007), for example, this plan represented the first time that integrated R&D support actions in Galicia were truly organised in a single budget plan, which was guided by a "Galician innovation strategy" that had evolved over the course of previous actions (e.g. the RIS and first plan experiences). Similarly, Conde-Pumpido (2007), as cited in González-López et al (2014), also suggested that the 2002-05 plan was the first plan to clearly articulate a Galician innovation system and the relationship between universities and firms in the region.

Funding under the second Galician Plan for Research, Development and Technological Innovation amounted to about €285 mn (Xunta de Galicia, 2014), or more than double the funding allocated under the first plan. However, the stated goals of the second plan were, on paper, very broad-based and wide-ranging, while they also appeared to emphasise the development of R&D-oriented and technology-oriented innovation. These goals included:

- articulating, developing and strengthening the Galician innovation system, concentrating on weak points and optimising available resources;
- favouring development of economic and social sectors of interest to Galicia, and promoting an increase in R&D and technological innovation activities;
- promoting growth in key sectors, specifically those where a significant increase in financial resources for R&D and technological innovation would accelerate improvement;

- raising social awareness of the importance of R&D and technological innovation as the foundation for economic and social growth (Coruña University Foundation, 2004).

Planned sub-objectives or actions under this plan were also significantly more wide-ranging than under previous plans or initiatives, with the focus on R&D and technology again being evident. Table 10.5, for example, provides an overview of the main sub-objectives or actions outlined in the plan, grouped according to different themes. In summary, the main themes underlying these sub-objectives or actions included the following:

- development of research centres, through the creation of new technology centres and enhancement of existing centres, development of science and technology parks and creation of research groups;
- development of research and innovation in industry, through creation of R&D laboratories and departments in businesses, creation of spin-off technology-based companies, and promotion of R&D-centred business groups or clusters;
- development of better collaboration between and integration of key innovation actors, including improved co-operation between public research/innovation actors and the private sector, improved knowledge transfer and the expansion of TTO activities, and better inter- and intra-institutional co-ordination;
- development of training and human capital, by increasing the number of researchers and research technicians working in the region, providing more R&D and innovation training within the business sector, and promoting mobility of human capital between public and private research.

Table 10.5: Plan for Research, Development and Technological Innovation 2002-05 – Actions

Theme	Planned Actions
Research Centres	▪ Promote the creation of high quality research groups, capable of competing in the European Research Area ▪ Build up existing technology centres and promote closer links with businesses, universities and public research organisations ▪ Create new technology centres according to business needs ▪ Favour the provision of technological services that meet the needs of Galician companies ▪ Favour the development of scientific and technological parks
Industry	▪ Put programmes in place to identify and promote research projects in businesses ▪ Promote the creation of spin-off technology-based companies ▪ Favour creation of R&D laboratories and departments in businesses ▪ Promote the creation of R&D centres by business groups, e.g. associations or clusters
Collaboration	▪ Improve communication mechanisms between the public R&D system and businesses ▪ Improve co-operation between the public R&D system and businesses for business research projects ▪ Expand the activities of existing public system TTOs ▪ Expand transfer to the productive sector of technologies created in the public R&D system
Training and Human Capital	▪ Promote training that better meets technological needs in areas of socio-economic interest ▪ Increase the number of researchers and technicians, particularly in priority areas ▪ Bring prestige Galician researchers working outside the region back to Galicia ▪ Train personnel from businesses and other institutions in R&D and technological innovation management ▪ Promote mobility of human capital between universities and businesses to bring training in both areas closer together and build common areas of research interest
Integration	▪ Integrate the different system actors ▪ Integrate all functions, from training to basic research and innovation ▪ Promote inter- and intra-institutional co-ordination ▪ Create organisational structures that favour integration

Source: Authors' own elaboration, based on Coruña University Foundation (2004)

The language used to describe the plan's objectives and actions, moreover, included an emphasis on developing research and innovation activity in the private sector. Stated ambitions within the plan, in this regard, included the development of more in-house research activity within Galician businesses, development of closer links between technology centres and businesses, development of technology centres and technology services that better meet the needs of regional businesses, development of business clusters, improved collaboration between the public and private sectors, and better technology transfer, among others.

The overall programme structure for the second plan was sub-divided into a general research programme, sectoral programmes, cross-sectoral horizontal programmes and selected “strategic actions”. Sectoral programmes covered a variety of sectors, split broadly between natural resources (e.g. agriculture, marine, forestry, energy), innovation technologies (e.g. biotechnology, pharmaceuticals, food, health sciences, materials, environment) and “citizen services” (e.g. education, public health, tourism and leisure, economics and law, information society). Horizontal programmes focused on human resources, supports for business innovation, innovation promotion and international co-operation, while strategic actions focused on aquaculture and the information society in productive sectors.

Regional Plans 2006-2015: Thereafter, the 2002-05 plan was followed by the third Galician Plan for Research and Technological Development and Innovation (2006 to 2010). Funding under this plan amounted to about €800 mn (Xunta de Galicia, 2014), or nearly three times the funding allocated under the second plan. The broad mission of the third plan, as articulated by Rodríguez (2009), was “to foster the economic and social growth of Galicia through the improvement of its scientific and technological capacity, and in this way increase the participation of companies in the innovation process and the dissemination of the benefits of research in Galician society”, with science and technology investment and increased private sector innovation again apparent as priorities. Its ambitiously stated goal, moreover, was “to put Galicia in an advanced position in Europe regarding the research and innovation system” (Rodríguez, 2009).

In terms of broad structure, the plan again incorporated general programmes, sector-based programmes and horizontal programmes (Rodríguez, 2009). In this regard, therefore, it was somewhat similar to its 2002-05 predecessor. General programmes incorporated the promotion of basic research and the consolidation or creation of competitive research groups in the region. Sectoral programmes, on the other hand, sought to foster applied research and promote innovation and R&D in businesses, particularly in SMEs, covering a range of sectors including: rural environment; marine environment; energy and mining resources; natural environment and sustainable development; biomedicine and health sciences; food technology; materials and construction technologies; industrial design and production; information and communication technologies and information society; and culture and tourism. Horizontal programmes in the third plan included measures to enhance human capital for innovation and R&D in the region, communication and awareness raising measures, and measures to improve technology transfer and co-operation between key actors in the regional innovation system, e.g. creation of research and innovation centres, creation of scientific and technological parks, and support for interface structures between actors (Rodríguez, 2009).

Finally, the 2006-10 plan was followed by the fourth Galician Plan for Research, Innovation and Growth (2011 to 2015), which had targeted investment of nearly €200 mn in the first year alone. As a starting point, this plan pointed to progress made, through the previous plans, in fostering a system of research and innovation in Galicia, yet it also asserted that the Galician economy was still not sufficiently innovative to generate the productivity needed to foster economic and social growth (Xunta de Galicia, 2010). Its broad aim, therefore, was to focus on growing a knowledge economy based on research, information transfer, technological development and innovation, with stronger R&D and innovation activities within the enterprise sector, and with further improved co-ordination among agents of the research and innovation system more generally. In this regard, it thus sought to engender what it described as a “cultural change in favour of innovation” among companies, universities, research centres, technology centres and administrations (Xunta de Galicia, 2010).

The plan perceived that there were several key challenges that needed to be addressed in order to achieve its aims, and these challenges (as described by the plan) included:

- recruitment, formation, and retention of talent by providing incentives for positive mobility of persons of talent in Galicia, giving researchers and high capacity people more opportunities to display and use their competences;

- fostering competitive research by providing a better structure and more stable financial framework for the public research system, including better skills for research management and technology transfer within the university system;
- converting knowledge and value generated by universities and research centres into competitiveness within Galician businesses;
- the need to provide a strong foundation for innovation in SMEs and promote greater company internationalisation;
- the need for Galicia to generate financing for research and innovation from its own resources, as well as resources acquired by companies in a competitive manner, to a greater degree than in the past (Xunta de Galicia, 2010)[52].

To address these challenges, the fourth plan therefore set out a series of "strategic axes" or themes (i.e. sub-programmes of the plan), which are outlined in more detail in Table 10.6a and Table 10.6b. These themes included, inter alia:

- management of talent through strengthened relationships between universities, public research organisations and businesses, with a focus on addressing the perceived weakness of a lack of research personnel in the private sector;
- the consolidation of research groups, including structural and continued financing for "groups of competitive reference" (research groups that were regarded as competitive at a national or international level) as well as the further development of other research groups in the region to such a standard;
- a system of support for research that promotes effective and professional management structures and practices, and operational and financial efficiency;
- promoting knowledge by developing projects that involve an alliance of organisations beyond traditional technology transfer entities;
- harnessing innovation as an engine of growth by stimulating private investment in R&D and innovation and facilitating the development of innovation financing agents, which can enhance the critical mass of private investment supports available and complement to public supports;

[52] The need to generate own financing in future was considered important because Galicia was due to have a reduced priority status for receipt of EU Structural Funds in the 2014-20 Structural Fund programming period.

- internationalisation of knowledge and innovation processes, developing research and innovation projects with a global perspective by participating in international networks or alliances for innovation;
- development of sectoral programmes, with priority sectors being in: health; food, agriculture and fishing; biotechnology; information and communication technologies; nanoscience; nanotechnology; materials and new production technologies; energy; the environment (including climate change); transportation (including aeronautics, automotive, shipbuilding); socio-economic sciences and the humanities; and safety.

Table 10.6a: Plan for Research, Innovation and Growth 2011-15 – Actions

Theme	**Planned Actions**
Management of Talent	▪ Support for research careers ▪ Programme of support for consolidation of research personnel ▪ Programme of qualification and incorporation of support managers for research and technology ▪ Recruitment of researchers of international prestige ▪ Support for Galician researchers in making applications for programmes of excellence of the European Research Council ▪ Establishing mobility programmes for researchers ▪ Incorporating innovative talent into businesses ▪ Support for permanent labour contracting of technologists and PhDs ▪ Support for R&D&I visits to centres of knowledge (e.g. technology centres) for business personnel
Consolidation of Groups of Reference	▪ Support for consolidated research groups ▪ Support for research groups with high growth potential ▪ Co-operation among research groups ▪ Support for research projects
System of Support for Research	▪ Support mechanisms for R&D&I management ▪ Complementary support services ▪ R&D&I support infrastructures ▪ Support for viability studies for centres of knowledge ▪ Support for the creation and endowment of centres of knowledge ▪ Contracts programme to channel financial support for centres of knowledge ▪ Support for the development of technological platforms ▪ Promotion and consolidation of scientific and technological parks

Source: Xunta de Galicia (2010)

Table 10.6b: Plan for Research, Innovation and Growth 2011-15 – Actions

Theme	Planned Actions
Valuing of Knowledge (Transfer of Knowledge)	▪ Updated inventory of research capacities in Galicia ▪ Creation of mixed units (research groups and companies) ▪ Finance for development of the results of research projects ▪ Promotion of the creation of knowledge transfer agents ▪ Promotion of activities to protect intellectual property and generate patents ▪ Support for market studies for technologies within Galician companies ▪ Support for research groups in valuing projects
Innovation as an Engine for Growth	▪ Programmes promoting access to innovation (e.g. by stimulating a business culture of innovation, developing training in innovation management, identifying needs through business analyses, supporting R&D&I projects in SMEs) ▪ Developing collaborative models of innovation (e.g. by promoting projects based on “open innovation”, creating networks of agents to facilitate projects, supporting the participation of strategic Galician sectors in collaborative programmes) ▪ Promotion of growth in innovation (e.g. through facilitating access to financial instruments for innovation, creating seed capital programmes, generating risk capital funds, stimulating spin-offs and high impact innovation projects)
Internationalisation	▪ Creation of support networks for international projects ▪ Promotion of research projects among Galician centres and international centres of reference ▪ Support for international establishment of start-ups ▪ Promotion of leadership in international R&D&I projects
Sectoral Programmes	▪ Health ▪ Food, agriculture, fishing, and biotechnology ▪ Information and communication technologies ▪ Nanoscience, nanotechnology, materials and new production technologies ▪ Energy ▪ Environment ▪ Transportation ▪ Construction and civil engineering ▪ Tourism ▪ Socio-economic sciences and the humanities ▪ Safety

Source: Xunta de Galicia (2010)

10.3.3 R&D and Innovation Policy in Galicia – Reported Achievements

Reported achievements arising from R&D and innovation policy in Galicia, for the 2000-13 period, were obtained from indicators of progress made by Structural Fund-supported NOPs and ROPs during the period, which (as noted earlier in Section 10.3.2) funded many of the interventions planned under the region's formal plans for research, development and innovation.

In this regard, for example, Table 10.7 provides a summary of reported achievements in R&D and innovation policy under the Research, Development and Innovation NOP 2000-06, the Galicia ROP 2000-06 and the Galicia ROP 2007-13, as outlined in the study by Faiña et al (2013) of the main achievements of EU Cohesion Policy programmes and projects in the region[53]. In particular, it shows that reported achievements over the period included:

- investment in R&D and innovation infrastructures. Under the Research, Development and Innovation NOP 2000-06, this included the creation of nine new research centres in Galicia (including technology centres and university research centres) and upgrading of equipment and research capabilities in another 18 centres, while 30 centres received funding support under the programme. Under the Galicia ROP 2000-06, a further two new research centres were created and nearly 60 centres received funding support, while 25 research centres also received support under the subsequent Galicia ROP 2007-13;
- support for a large volume of R&D projects, including over 900 projects funded under the Research, Development and Innovation NOP 2000-06, nearly 2,600 projects funded under the Galicia ROP 2000-06 and nearly 3,000 projects supported under the Galicia ROP 2007-13;

[53] Reported achievements for the Knowledge Economy Fund NOP 2007-13 and the Technological Fund NOP 2007-13 in Galicia were not available.

- support for collaborative projects, including support for over 380 such projects under the Research, Development and Innovation NOP 2000-06, support for over 320 collaborative projects between firms and research centres under the Galicia ROP 2000-06[54] and support for nearly 1,200 co-operation projects between companies and research centres under the Galicia ROP 2007-13.

Table 10.7: EU Structural Fund Programme 2000-13 – Reported Achievements in Galicia

Indicator	**Achievement**
Research, Development and Innovation NOP 2000-06	
Number of R&D projects supported	915
Number of collaborative R&D projects financed	385
Number of projects financing R&D equipment	230
Number of research centres receiving grant support	30
Number of research centres “renewed” (technology centres, universities)	18
Number of research centres established (technology centres, universities)	9
Number of collaborative projects between companies and research centres	4
Galicia ROP 2000-06	
Number of researchers involved in supported projects	13,539
Number of R&D projects co-financed	2,584
Number of firms/SMEs participating in collaborative projects	535/438
Number of collaborative projects between firms and research centres	323
Number of knowledge diffusion workshops supported	194
Number of centres receiving grant support	57
Number of patents supported	12
Number of research centres created (technological centres, university centres etc)	2
Galicia ROP 2007-13	
Number of R&D projects supported	2,990
Number of co-operation projects between companies and research centres	1,193
Number of research centres supported	25

Note: Reported achievements for the NOPs in the 2007-13 period were not available. Achievements for the Galicia ROP 2007-13 are for the period up to 2011.

Source: Faiña et al (2013)

[54] According to Faiña et al (2013), the 320 projects supported under the Galicia ROP 2000-06 engaged more than 530 firms (and nearly 440 SMEs), which represented about 30% of all R&D active firms in the region with five or more employees.

10.4 Description of the Regional Innovation System in Puglia

10.4.1 Knowledge Generation and Diffusion Sub-system

The knowledge generation and diffusion sub-system in Puglia consists mainly of higher education institutions and public research organisations.

<u>*Universities*</u>: There are five universities in Puglia. As in Galicia, these universities incorporate both older and newer institutions, which include:

- the University of Bari, both the longest established and largest university in Puglia, which was founded in 1925;
- the University of Salento (formerly the University of Lecce), which was initially founded in 1955, but was formally recognised as a public university in 1967;
- the Polytechnic University of Bari, which was established in 1990 out of the former Faculties of Engineering and Architecture at the University of Bari;
- the University of Foggia, which was established in 1999;
- the Free Mediterranean University "Jean Monnet", a private but legally recognised university, which was founded in 1995.

In relative terms, the University of Bari was ranked 18th for research out of 40 Italian universities, according to the Times Higher Education World University Rankings for 2017, while the University of Salento was ranked 33rd. None of the region's other universities (Polytechnic University of Bari, University of Foggia, Free Mediterranean University "Jean Monnet") were featured in the rankings. The highest ranked university for research in Italy, meanwhile, was the Scuola Superiore Sant'Anna in the Tuscany region (Pisa), which was ranked 229th in global terms.

Table 10.8 provides an overview of key research areas that have been developed within each of these universities (with the exception of the Free Mediterranean University "Jean Monnet", which only has faculties in the areas of economics and law). In terms of specialisms, González-López et al (2014) suggest that the University of Bari possesses strong science-based specialisations in the health science, chemistry and physics areas as well as in other "classical" disciplines such as law, economics, philosophy and languages. Research activities in humanities or social science are also conducted in the university, including culture and tradition, gender studies, peace studies and performing arts.

Table 10.8: Key Research Areas in Puglian Universities

University	Research Area
University of Bari	▪ Biotechnology and life sciences ▪ Chemistry ▪ Physics/applied physics ▪ New materials ▪ ICT and computer science ▪ Pharmacology ▪ Food and vegetable genetics ▪ Health technologies ▪ Maritime zoology ▪ Veterinary medicine ▪ Environmental methodologies and technologies ▪ Cultural heritage and archaeology, tradition ▪ Gender studies ▪ Peace studies ▪ Performing arts studies
University of Salento	▪ Cultural heritage ▪ Materials ▪ Health science ▪ Mechatronics ▪ Nanotechnologies ▪ Avionics and aerospace engineering ▪ Automotive ▪ ICT and computer science ▪ Sustainable development and the environment ▪ Tourism ▪ Language and linguistics ▪ Philosophy
Politecnico di Bari	▪ Electronics ▪ Mechanics and mechatronics ▪ Health and water science ▪ ICT and computer science ▪ Transport engineering ▪ Agro-industry ▪ Civil engineering and environmental technologies
University of Foggia	▪ Food control techniques ▪ Alternative energy ▪ Breeding science and technology

Source: Author's own elaboration, derived from González-López et al (2014) and university websites

The University of Salento and the Polytechnic University of Bari, on the other hand, have more specialisations in areas such as mechanics, engineering and technology, though the University of Salento also has some research activity in humanities disciplines such as languages or philosophy. The University of Foggia specialises in agricultural sciences and health sciences, while overlap in specialisms between institutions, where they exist, more typically occur in the social sciences and humanities (González-López et al, 2014). Research co-operation activities between the universities include research centres dedicated to territorial analysis and the history of science (including all four public universities), while the University of Bari and the University of Salento are involved in co-operative research in epistemology, in conjunction with other universities outside of Puglia.

In addition, the development and promotion of TTOs as a means of fostering links between universities and industry has now become commonplace within universities in Puglia. At the same time, this is only a relatively recent phenomenon, and indeed the emergence of TTOs across Italian universities in general only occurred during the 2000s (González-López et al, 2014), with help from national and regional government funding. TTOs in Puglia are known as Industrial Liaison Offices (ILOs), and these offices received public support under the ILO initiative (between 2007 and 2008) and the follow-up ILO2 initiative (between 2009 and 2012) in order to develop resources and competencies to establish best practices in knowledge transfer and the valorisation of research results within Puglian universities[55]. However, for many years prior to this, the University of Bari had also run Tecnopolis, a science and technology park that hosts research and innovation activities, including incubation supports for new innovative companies or university spin-offs.

[55] For further details, see https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/ilo2-puglia. Data collated by the Network per la Valorizzazione della Ricerca Universitaria (Netval) also shows that the cumulative number of spin-off companies generated in Puglian universities grew from less than 20 in 2005 up to more than 80 in 2013, with Puglian universities' share of spin-offs created across all Italian public research institutions growing from 3.9% to 7.4% in the same period.

Public Research Organisations: Outside of the universities, Grigolini et al (2015) point out that more than 20 research institutes of the National Research Council of Italy (CNR) have facilities in Puglia, and Table 10.9 provides an overview of the CNR facilities in the region. CNR institutes that have headquarters in Puglia include the Institute of Biomembrane and Bioenergetics (Bari), the Institute of Plant Genetics (Bari), the Institute of Crystallography (Bari), the Institute of Nanotechnology (Lecce), the Institute of Sciences of Food Production (Bari) and the Institute of Intelligent Systems for Automation (Bari). About 20 other CNR institutes have research sites in the region, mainly in either Bari or Lecce, and these facilities cover research in domains such as chemistry, physics, medical sciences, nanotechnologies and nanoscience, environmental research, the marine sector and construction or industrial technologies.

Table 10.9: National Research Institutes in Puglia

Institute Headquarters	**Location**
▪ Institute of Biomembrane and Bioenergetics	Bari
▪ Institute of Plant Genetics	Bari
▪ Institute of Crystallography	Bari
▪ Institute of Sciences of Food Production	Bari
▪ Institute of Intelligent Systems for Automation	Bari
▪ Institute of Nanotechnology	Lecce
Institute Sections	**Location**
▪ Institute for Applied Mathematics	Bari
▪ Institute of Chemistry of Organometallic Compounds	Bari
▪ Institute of Nanotechnology	Bari
▪ Institute for Photonics and Nanotechnologies	Bari
▪ Institute for Chemical and Physical Processes	Bari
▪ Research Institute for Geohydrological Protection	Bari
▪ Water Research Institute	Bari
▪ Construction Technologies Institute	Bari
▪ Institute of Industrial Technologies and Automation	Bari
▪ Institute of Biomedical Technologies	Bari
▪ Institute for Sustainable Plant Protection	Bari
▪ Institute of Archaeological Heritage – Monuments and Sites	Lecce
▪ Institute of Clinical Physiology	Lecce
▪ Institute of Nanoscience	Lecce
▪ Institute for Microelectronics and Microsystems	Lecce
▪ Institute for Atmospheric Sciences and Climate	Lecce
▪ Institute of Cybernetics	Lecce
▪ National Institute of Optics	Lecce
▪ Marine Science Institute	Foggia
▪ Institute for Coastal Marine Environment	Taranto

Source: National Research Council of Italy

González-López et al (2014) also note that there are nearly 50 laboratories in Puglia that are recognised by the Italian Ministry of Instruction, University and Research (MIUR), including university laboratories and private facilities, while Muscio (2011) highlights the presence of the National Institute of Nuclear Physics (INFN) in the region, which has two divisions tied to university physics departments in Bari and Lecce. In addition, the region is home to a number of research centres that have been formed through public-private partnerships between universities and industry, and these include:

- Optel, which specialises in high-tech microelectronic and mechatronic solutions;
- the Technologies Design and Materials European Research Centre (CETMA), which carries out applied research and technology transfer in advanced materials, ICT and product development;
- Centro Laser, which is a public-private consortium company specialising in research and technology transfer in laser technologies.

10.4.2 Knowledge Application and Exploitation Sub-system

The sub-system for knowledge application and exploitation in Puglia consists primarily of the region's enterprise base and its customers, collaborators, suppliers and competitors.

Evidence for the period under review, as discussed in Chapter 9, shows that average annual R&D expenditure in the private sector in Puglia (when expressed on a per capita basis) grew by about 45% between the 1994-99 and 2008-12 periods, which was slightly above Italian national average growth across the same period. However, growth in business R&D expenditure in the region was below growth in total R&D expenditure, which grew by 68% between the 1994-99 and 2008-12 periods.

In contrast to this, average annual business R&D personnel in Puglia (when expressed per million population) grew by 73% between the 1994-99 and 2008-12 periods, which in this case was slightly below Italian national average growth in business R&D personnel across the same period. However, it was also only slightly below the region's overall growth in total R&D personnel across the same period.

Nonetheless, the private sector share of both total R&D expenditure and total R&D personnel in Puglia remains well below both Italian national and EU-15 averages. Over the 2008-12 period, for example, annual average R&D expenditure in the business sector in Puglia was equivalent to about 25% of total R&D expenditure in the region, whereas the equivalent figures for all of Italy and the EU-15 were 54% and 63% respectively. Business sector share of the region's total R&D personnel in the same period, on the other hand, was 23%, whereas the equivalent figures for all of Italy and the EU-15 were 49% and 54% respectively.

Sectors that are generating innovation activity in Puglia, however, include the mechatronics, automotive, aeronautics, software and food sectors. In terms of the firms involved, González-López et al (2014) have pointed to a number of multinational companies operating in the region, some of which are also carrying out research and innovation in the region, and these companies include:

- Leonardo, an Italian multinational aerospace company, which designs and manufactures both helicopters (formerly Agusta Westland) and military and civil aircraft (formerly Alenia Aermacchi), at sites in Brindisi and Foggia respectively;
- Sanofi, the French pharmaceuticals company, which operates a biotechnology research plant in Brindisi;
- Avio Aero, an Italian subsidiary of General Electric's aviation business, which manufactures aircraft engines in Brindisi;
- Fiat, the Italian car manufacturer, which operates a research centre at Valenzano, near Bari;
- Bosch, the German manufacturer of consumer goods, industrial technology, energy and building technology, and mobility solutions, which conducts R&D and innovation in the region through its vehicle components research centre in Bari (a former part of Fiat's research operations in the region);
- Eni, the Italian multinational energy company, which operates a petrochemical plant in Brindisi;
- Getrag, the German manufacturer of car transmissions and drive systems, which operates a manufacturing plant in Bari;

- IBM, the multinational software company, which operates a facility in Bari;
- Ilva, the Italian steel manufacturer, which operates a large steelworks in Taranto.

Alongside these larger firms, González-López et al (2014) have also cited local companies that are identified as carrying out research and innovation in their fields, and these include:

- Exprivia, an Italian software company operating from numerous sites both in Italy and abroad, which has its headquarters in Bari;
- companies such as Sincon, Insoft and Cle, which develop IT solutions and systems/services for public bodies and healthcare providers. Sincon is based in Taranto, while Insoft and Cle are based in Bari;
- Itel Telecomunicazioni, a medical devices and equipment company, specialising in diagnostic imaging, which is based in Bari;
- Mermec, a Puglian multinational provider of software solutions and equipment for the railway and steel industries, which is based in Bari;
- Masmec, another Puglian company based in Bari, which manufactures automated assembly and test machines for the automotive industry, as well as medical devices.

Some of these companies operate major private research centres within Puglia. For example, as noted above, Bosch established its "Centro Studi Componenti per Veicoli SpA" following Fiat's sale of its local "Centro Ricerche Fiat" to the German company (Grigolini et al, 2015). Avio Aero, meanwhile, established the "Apulia Development Center for Additive Repair", with the Polytechnic University of Bari, to develop repair procedures for aviation engine components using innovative technologies based on laser systems, and it collaborated with the polytechnic university to create "Energy Factory Bari", an integrated multidisciplinary laboratory to develop research activities and technologies in areas of common interest in the fields of aerospace and energy.

The promotion of so-called “technological districts” in Puglia, meanwhile, has also been adopted as a policy initiative in the region during the period under review. This policy initiative was initially launched in 2003, as a national research programme initiative, with public funding support (Florio et al, 2014), and its intention has been to foster firm’s innovation capabilities through collaboration with universities, research institutions and regional authorities, using the regional innovation systems or “triple helix” models (Florio et al, 2014, Bertamino, Bronzini, de Maggio and Revelli, 2017).

Technological districts, in the context of Puglian or Italian R&D and innovation policy, are therefore intended to incorporate aggregations of high-tech activities in geographically-defined areas, incorporating public research institutions, firms and local authorities, which are managed by legal entities, companies or consortiums for governance, integration and co-operation purposes (Bertamino et al, 2017)[56]. As of the end of 2011, about 30 such entities had been established across all Italian regions (Bertamino et al, 2017), while six districts were established in Puglia. The Puglian technological districts included:

- the High Technology Cluster (DHITECH), established in 2005;
- the Food Technological District (DARe), established in 2006;
- the Mechatronics District (MEDIS), established in 2007;
- the National Technological Cluster on Energy (DiTNE), established in 2008[57];
- the Aerospace District (DAP), established in 2008;
- the Technological Cluster on Human Health and Biotechnologies (H-BIO), established in 2012.

Table 10.10 gives an overview of the technological districts in Puglia, including the number of companies involved in each district, and some of the districts’ members. It shows that all the universities and the CNR participate in the districts, with the University of Bari, the University of Salento, the Polytechnic University of Bari and the CNR, in particular, being involved in all six districts. In addition, relevant local

[56] Further details on the policy rationale underlying the creation of these districts are provided in Section 10.5.
[57] According to Florio et al (2014), DiTNE was initially established as a regional technological district, but was thereafter conferred as a technological cluster of national interest, under the direct auspices of the Italian Ministry of Education, Universities and Research.

authorities as well as industry representative bodies (e.g. Confindustria Puglia, Confindustria Bari, Confindustria Lecce) are represented. Between 10 and 50 companies are involved in each district's activities, with some of the main private sector firms carrying out research and innovation activity in the region (e.g. Leonardo, Avio Aero, Mermec, Masmec, Itel Telecommunicazioni, Exprivia) being involved in multiple districts.

Table 10.10: Technological Districts in Puglia

District Name	Key Sectors	Number of Companies Involved	District Partners – Notable Members
DHITECH	ICT, Health	15	University of Bari, University of Salento, Polytechnic University of Bari, CNR, INFN, Confindustria Lecce, Leonardo, Avio Aero, Exprivia
DARe	Food	44	University of Bari, University of Salento, Polytechnic University of Bari, University of Foggia, Free Mediterranean University "Jean Monnet", CNR, Confindustria Puglia, Exprivia, Foggia Chamber of Commerce, Amminstrazione Provinciale di Foggia
MEDIS	Mechatronics	10	University of Bari, University of Salento, Polytechnic University of Bari, CNR, Centro Laser, Confindustria Bari, Bosch, Fiat, Getrag, Mermec, Masmec, Itel Telecommunicazioni
DiTNE	Energy	21	University of Bari, University of Salento, Polytechnic University of Bari, CNR, Avio Aero, Eni, Exprivia
DTA	Aerospace	51	University of Bari, University of Salento, Polytechnic University of Bari, CNR, Optel, CETMA, Centro Laser, Confindustria Puglia, Leonardo, Avio Aero, Mermec, Province of Brindisi
H-BIO	Health	21	University of Bari, University of Salento, Polytechnic University of Bari, University of Foggia, CNR, Confindustria Puglia, Sanofi, Masmec, Itel Telecommunicazioni, Exprivia

Source: Author's elaboration, derived from district websites

10.4.3 Regional Policy Sub-system

As in Galicia, the sub-system for regional innovation policy in Puglia consists of the relevant political institutions and regional development agencies. These again include relevant regional government departments and agencies that are tasked with the development of innovation in the region.

Regional Autonomy in Puglia: Puglia and the other Italian regions have regional government administrations, with legislative and policy making powers within their territories. In this regard, a development that occurred in 2001 was the reform of the Italian Constitution. According to Muscio (2011), this reform gave regional administrations a responsibility for policy making in the area of scientific and technological research, and support to innovation for industrial sectors, although in exercising these powers regions were required to observe some fundamental principles set out by national law. Prior to this change, however, regions were not free to create their own regional agencies for innovation, laboratories or research networks, or develop their own innovation strategies (Muscio, 2011).

Grigolini et al (2015) have therefore suggested that these constitutional reforms altered the balance of power between national and regional governments in the area of innovation policy, by delegating more powers to regional administrations and by establishing concurrent legislative powers for national and regional governments in a number of areas (including scientific and technological research and support to innovation). Muscio (2011) also noted that Italian regions started to reorganise regional institutions at this time, in order to carry out the new legislative tasks imposed by the 2001 reform, while Florio et al (2014) have similarly asserted that the reforms provided Italian regions with an initial motivation to develop institutions and mechanisms to promote innovation.

Role of National Government: At the same time, it is important to note that powers and competences in the areas of scientific/technological research and innovation remained to some degree concurrent or shared between national and regional governments (Ciffolilli, Naldini, Rossi and Wolleb, 2006, Florio et al, 2014, Grigolini et al, 2015) in the period under review, notwithstanding the constitutional changes adopted in 2001. For example, Ciffolilli et al (2006) suggest that national government concentrates mainly on co-ordinating RTDI policy and pre-competitive development of strategic sectors prioritised in national research programmes, while regional governments concentrate on supporting local production systems, providing innovation services at a regional level, and technology transfer. Muscio (2011) also notes that the national government retains exclusive legislative power in the area of university education (both public university funding and regulation) and academic research, while competences in the area of industrial research and innovation are shared between the regional and national level, mainly on the basis of investment size (with smaller investment programmes are carried out by regions).

Regional Departments and Agencies in Puglia: Primary responsibility for innovation policy within Regione Puglia (the Puglian regional government) lies with the Department for Economic Development, Innovation, Education, Training and Work. In the context of innovation policy, and according to the regional government's website, this department:

- governs policies for competitiveness and innovation in Puglian production systems;
- oversees regional policies for economic development, the implementation of programmes, and the development of knowledge and support for scientific research, technological innovation and the education and university system;
- facilitates and supports the internationalisation of production systems;
- guides the education system in Puglia and implements policies to develop the education system and support higher education.

There are also three regional agencies, operating under the remit of the Department for Economic Development, Innovation, Education, Training and Work, which support innovation policy activities in Puglia. These agencies include, the Agenzia Regionale per la Tecnologia e l'Innovazione (ARTI), InnovaPuglia and PugliaSviluppo.

ARTI was established by the regional government in 2004, becoming fully operational in the second half of 2005 (Fiore et al, 2011). According to the agency's website, its key strategic objective is to "promote the pervasive role of innovation in the various regional policies and to strengthen the protagonists of innovation in Puglia and the relations between them, through actions that promote technology transfer from research to industry and the qualification of human capital of the region”. Key activities of the agency, again as espoused on its website, include the following:

- supporting the regional administration in the implementation of policies for the “technological development of the productive fabric”, the diffusion of innovation in society and the socio-economic growth of the territory;
- promoting the economic and social exploitation of research results and the birth of innovative companies;
- supporting the internationalisation process in the Puglian research and innovation system;
- developing dissemination models that stimulate young people to acquire new skills and initiative, and stimulate society to adopt innovative approaches;
- monitoring and evaluating regional initiatives and measures.

According to Muscio (2011), the introduction of ARTI into the governance of Puglian innovation policy has been indicative of a more “bottom-up” approach to regional innovation strategy, as the agency assists regional government to develop long-term strategy and priorities, and seeks to foster collaboration and networking between public and private agents in the regional innovation system (including scientific institutions and regional firms). Similarly, Florio et al (2014) have highlighted ARTI’s role in supporting policy formulation and fostering linkages between the public and private sectors (in particular, by better matching the research outputs of universities and local research institutions with the technological application needs and demands of the private sector).

InnovaPuglia was established in 2008, following the merger of Tecnopolis Scrl, the science and technology park, and FinPuglia SpA, an existing regional finance agency, to provide technical support to the regional administration in the implementation of regional technological investment programmes and to act as the regional public agency for ICT (Muscio, 2011). Its role, according to its website, involves the “definition and implementation of the regional digital system” and “regional strategic planning in support of digital innovation”, which includes:

- management of databases and information systems with strategic regional value;
- design, development and implementation of the regional information system;
- design, implementation and management of public ICT infrastructures.

A core function within InnovaPuglia activities, therefore, involves the management of ICT across the Puglian regional administration. This includes: procurement, monitoring, auditing, evaluation and control of ICT suppliers of the regional administration; supervision and co-ordination of strategic ICT services for the public administration; and standardisation and quality assurance of digital services for enterprises, residents, councils and other public bodies (Muscio, 2011). However, separate to this, the agency also acts as an implementing body that provides financial supports for technology investment and innovation policy initiatives on behalf of regional government, thereby giving it a role in the governance and implementation of R&D and innovation policy.

Lastly, PugliaSviluppo, the other main agency supporting innovation in Puglia, was formed from the regional branch of Sviluppo Italia, a national agency for enterprise development and investment (Florio et al, 2014). According to the agency's website, its aim is "to contribute, in implementation of the plans (and) programmes … of the Puglia region, to the economic and social development of the territory on behalf and at the request of the region through the implementation of activities of general interest in support of the Puglia region". According to Grigolini et al (2015), the agency thus seeks to foster improved business competitiveness in Puglia, and deliver grant schemes and other financial instruments that are intended to support entrepreneurship, innovation and internationalisation among Puglian firms. It therefore operates with a wider enterprise development remit, though its activities that relate to research and innovation include provision of aid schemes for innovative small or newly established businesses and the management, promotion and development of business incubation centres in Bari and Lecce.

10.5 Innovation Policy Developments in Puglia

10.5.1 Early Policy Initiatives – 1990s

González-López et al (2014) have contended that the first steps towards an "organic programme for technological innovation" in Puglia emerged from within the region's OP for European Regional Policy for the 1994-99 Structural Fund programming period. Funding for R&D and innovation under this programme, according to the authors, had a general goal to develop R&D activities, and specific goals to create joint ventures both among companies and between companies and universities or other research institutions. Supported actions were described as providing technical assistance to SMEs in order to develop technology transfer, high-level training for human capital and linkages among existing research structures.

The level of public investment attributed to R&D and innovation in Puglia at this time was relatively small-scale, however. For example, according to Regione Puglia (2001), related investment in the 1994-99 OP came to about 90 bn lira (about €46 mn), supporting about 100 SMEs and 20 university departments, research centres or consortia.

During this time, Puglia was also, like Galicia, a participant in the EU-sponsored RIS Programme (see Chapter 7, Section 7.8). The Puglia INNOVA project[58], which was funded under the RIS Programme, aspired to take the first steps towards introducing this type of approach to the planning, programming and delivery of innovation in Puglia, with a view to optimising regional innovation infrastructure, matching innovation supply with innovation demand, and meeting SME innovation needs. As in Galicia, a total budget of about €500,000 was again provided for the initiative (with EU co-funding), primarily to provide an input to strategy and policy making.

[58] See also http://ec.europa.eu/regional_policy/archive/innovation/innovating/pdf/puglia_en.pdf.

The Puglia INNOVA project was thus intended to develop a strategy and action plan for innovation in Puglia that would ultimately produce programmes, policies and methods to plan, deliver and monitor innovation policies for the region, which could in turn be directly incorporated within the EU Structural Fund programmes for the 2000-06 programming period. A link between RIS goals and subsequent Structural Fund programmes, it was hoped, would lead to a continuity between strategy development and implementation for innovation in the region, with the strategy suggested by Puglia INNOVA based on the following suggested lines of action:

- enhancement of the regional innovation infrastructure through better involvement of business in innovation management and through increased private sector involvement in the region's research centres, science parks and local innovation agencies;
- an increased focus on industrial districts and specialised local manufacturing systems, through public support to local sectoral research centres;
- support to foster a better match of supply and demand for innovation in the region.

Also, it was intended that this strategy and action plan would be developed on a partnership basis, with the institutional and political involvement of both regional authorities and organisations responsible for innovation activities. In particular, it was hoped that broad participation of business and local actors in RIS activities would help to foster projects that would better respond to real and identified innovation needs in the region. Nominal partners to the project therefore included relevant public ministries and agencies, regional innovation organisations (e.g. research centres located in the region), industry associations and funders, all participating in a regional steering committee for the project.

10.5.2 Regional Innovation Policy in Puglia – 2000-06 Period

The 2000-06 period coincided with the reform of the Italian Constitution, which occurred in 2001 and which, as noted in Section 10.4.3, conferred additional policy responsibilities on regional administrations in the area of scientific and technological research. Furthermore, at the regional level, Ciffolilli et al (2006) also noted that Objective 1 regions were required to prepare regional innovation strategies during the 2000-06 programming period. This was because the approval of research and innovation measures in regional OPs was made conditional on the approval of regional innovation strategies at a national level, as per the requirements of the Community Support Framework (CSF)[59] for Italy for the 2000-06 programming period.

The Puglia regional government, therefore, published a Regional Strategy for Scientific Research and Technological Development in 2001 (Regione Puglia, 2001). This strategy proposed several objectives or lines of action, which are outlined in Table 10.11, and which included:

- incentives for companies and consortia of companies to develop R&D, innovation and technology transfer activities, either on their own or in collaboration with other firms or organisations – such as support for in-house industrial research in companies, support for research involving groups of companies and/or research institutions, and promotion of firms' participation in international research projects (e.g. through the EU Framework Programmes);
- incentives to improve capacity within universities and research organisations, in particular through support for investment in research infrastructure and equipment, and support for the recruitment of research capacity;
- support to improve the links between universities/research organisations and firms – such as assistance for firms to help them identify innovation needs and access external research or innovation support, and promotion of more knowledge and innovation transfer through science and technology parks, research centres, technological districts etc;

[59] Community Support Frameworks were agreements between the European Commission and member states regarding the priorities for the use of funding provided by the EU Structural Funds in the various programming periods.

- improvement of human capital across the regional innovation system – through support for postgraduate qualifications and research doctorates, provision of research scholarships, training for research staff within firms, exchange of personnel between companies and research institutions, direct recruitment of researchers by companies and promotion of spin-off companies from research centres.

Table 10.11: Regional Strategy for Scientific Research and Technological Development 2000-06

Action	Description
I	Promoting organisation and supporting demand for innovation
I.1	Incentives to companies and business consortia for research, development, innovation and technology transfer activities
II	Qualification of the research offer, development, technology transfer and services for innovation
II.1	Strengthening and establishment of centres of scientific excellence
II.2	Infrastructure enhancement
II.3	Strengthening of human resources and competences within the R&D system
II.4	Attraction of science and knowledge-based business settlements
II.5	Network infrastructure of the regional system of knowledge
III	Strengthening of the network for innovation and connections between the scientific system and the productive system
III.1	Scientific-technological audits for SMEs
III.2	Establishment and strengthening of services and facilities for the exploitation of scientific results and technology transfer
IV	Human resources development
IV.1	Qualification and strengthening of human capital in the application system for research and innovation
IV.2	Qualification and strengthening of human capital in the offer system for research and innovation
IV.3	Support for innovation in the regional system of higher education
IV.4	Staff training in the field of public and private services for the promotion of innovation and technological development
V	Permanent Observatory of Innovation
V.1	Permanent Observatory of Innovation

Source: Regione Puglia (2001)

Similar to Galicia, however, most research and innovation policy measures that affected Puglia at this time were implemented either through national or regional OPs, and funding for regional strategy actions was implemented through these OPs. In the ROP for Puglia 2000-06, for example, investment of about €370 mn in innovation and knowledge economy related initiatives was planned, with investment measures promoted under the OP (as per Table 10.12) including investment in research and development, human capital and ICT for innovation (Ciffolilli et al, 2006).

Table 10.12: Regional OP for Puglia 2000-06 – Innovation Measures

Priority	**Measure**
3. Human resources	3.07 Higher education 3.12 Human resource improvement in research and technological development 3.13 Research and technological development
6. Service networks and hubs	6.02 Promotion of the information society and promotion of internationalisation 6.03 Support for innovation of local authorities 6.04 Human resources and information society

Source: Ciffolilli et al (2006)

At the same time, Puglia and the other Objective 1 regions in Italy also received financial support under the NOP for Research 2000-06 and the NOP for Local Development 2000-06, which included a combined allocation, across all Objective 1 regions, of close to €1 bn for investment in innovation and the knowledge economy in these regions, most of which was provided by the NOP for Research (Ciffolilli et al, 2006). The measures provided for under these OPs, which are outlined in Table 10.13, included support for research and development, human capital and ICT, and funding for industrial research and strategic R&D projects, among others.

Table 10.13: National OPs (Research and Local Development) 2000-06 – Innovation Measures

OP	Priority	Measure
Research	▪ R&D in industry and strategic sectors	▪ Research projects of industrial interest ▪ Promotion of innovation and technological development ▪ R&D in strategic sectors
Research	▪ Reinforcing the scientific system	▪ Strengthening of the scientific system ▪ Information society for the scientific system ▪ Centres of technological competence
Research	▪ Human resources	▪ Improvement of human resources in the R&D sector ▪ Training of high professionalism ▪ Higher education and university training ▪ Adaptation of vocational education and training
Local Development	▪ Integrated aid packages	-

Source: Ciffolilli et al (2006)

According to Ciffolilli et al (2006), the national OPs were more focused on direct aid schemes for both public research and enterprise, including SMEs, and investment in higher education so as to increase the throughput of science and technology graduates in Italy and reverse the “brain drain” of graduates from the country. Through the NOP for Industry 2000-06, national instruments also provided support for “integrated packages for innovation”, which were integrated support schemes for industrial research, pre-competitive development and commercialisation. Regional OPs, on the other hand, were intended to promote more indirect support policies, such as developing technology transfer services, and national OP initiatives were intended to be complementary to these regional OP mechanisms.

At the same time, the 2000-06 period coincided with the emergence of national-regional policy co-ordination, and funding supports, to develop technological districts across Italy. According to Bertamino et al (2017), the technological districts initiative was first promoted under the Italian National Programme for Research 2002-04, and later refined under the National Programme for Research 2005-07, with the aim being to foster companies’ innovation capabilities and local competitiveness by creating synergies among firms, universities, research centres and public authorities, all situated within limited territorial boundaries. To do this, the district structure or model was intended to act as an instrument of governance, which would manage integrated objectives and co-ordination of activities among key actors (Bertamino et al, 2017). Both regional and national governments were involved in the implementation of technology districts policy, with the regional level typically proposing districts, and the national level approving and funding them (Florio et al, 2014, Bertamino et al, 2017).

10.5.3 Regional Innovation Policy in Puglia – 2007-13 Period

Regional strategy and priorities for research and innovation in Puglia over the 2007-13 period were espoused in the Regional Strategy for Research and Innovation 2009-13 (Regione Puglia, 2009). This strategy again envisaged several objectives or lines of action, which are outlined in Table 10.14, and which included:

- actions to promote innovation in regional enterprise. This included support to foster single or collaborative innovation in both larger companies and SMEs, either in traditional or high-tech sectors, through direct aid interventions that supported technological audits or surveys, industrial research and experimental development or integrated aid packages (e.g. support for infrastructure acquisition, research investment and innovation consulting services);
- actions to support the further development of capacity in the public research system. This included support to strengthen research facilities and develop core competencies and infrastructures in targeted thematic areas (aerospace and aviation, agribusiness, biotechnology, medical technologies and human health, energy and environment);
- support for actions that improved links between the public research system and companies, which included the continued promotion and development of public/private collaboration through technological districts and innovation clusters, promotion of networks of public-private laboratories in targeted thematic areas and continued development of ILOs;
- investment in human resources, including support to develop skills through postgraduate training linked to regional innovation priorities, provision of research scholarships and postgraduate research, or support to promote the mobility of researchers between (public) research centres and companies;

- actions to support non-technological innovation activities (e.g. organisational or market innovation, or innovation in the management or reorganisation of companies) and initiatives to promote entrepreneurship and business innovation within the secondary and tertiary education systems.

Table 10.14: Regional Strategy for Research and Innovation 2009-13

Action	Description
1	Support for the demand for innovation in the regional entrepreneurial fabric
1.1	Spreading the propensity for entrepreneurship and innovation
1.2	Support for industrial research
1.3	Integrated innovation projects
1.4	Integrated actions for sustainable development and dissemination of information society
2	Strengthening the technological offer of the regional public research system
2.1	Strengthening of strategic scientific technological value areas
2.2	Structural strengthening of scientific research centres
3	Improving the connection between research and innovation demand and offer systems
3.1	High-tech districts
3.2	Networks of public-private laboratories
3.3	Regional network of knowledge exchange offices (ILOs)
3.4	Innovation “poles”
3.5	Best practice initiatives (between North and South of Italy)
4	Improvement of human resources in the research sector and innovation
4.1	Improvement of human resources

Source: Regione Puglia (2009)

Also, as in the 2000-06 period, the two main funding instruments supporting regional innovation policy in Italy over the 2007-13 period were again NOPs and ROPs. Muscio (2011), for example, notes that the NOP for Research and Competitiveness 2007-13 sought to implement national innovation policy in four so-called “lagging” regions – Calabria, Campania, Puglia and Sicily – and contribute to co-ordinating national and regional objectives in innovation policy. In addition, it integrated activities that were implemented by the national Ministries of (a) Education and Research and (b) Economic Development within a single programme – previously, in the 2000-06 period, the activities of these ministries were separated into two distinct programmes, i.e. the NOP for Research 2000-06 and the NOP for Local Development 2000-06 (Ciffolilli, 2010).

Research and innovation related activities that were eligible for funding in the four regions under this programme[60], which are outlined in Table 10.15, included:

- structural development of the public research system, which sought to promote the development and growth of research structures and laboratories in universities and public research bodies;
- continued support for the consolidation and strengthening of existing technological districts and public-private laboratories, plus support for the creation of new technological districts and laboratories;
- support for industrial research within companies, including projects that incorporate the participation of universities, public research organisations or research organisations promoting the participation of SMEs;
- support for the implementation of high-tech research, development and innovation programmes within firms in various industrial sectors, which could again incorporate the involvement of universities or public research organisations;
- support for commercialisation of programmes of experimental R&D and competitive improvement within both SMEs and large enterprises.

Analysis of data available on the programme's website[61] suggests that more than €1 bn was made available in Puglia for investment under related activities, out of a total budget for related activities (across four regions) of about €3 bn, and a total OP budget of about €6 bn. Most of the research and innovation related investment in Puglia was committed to industrial research, structural development and technological districts.

[60] See http://www.ponrec.it/en/ and https://www.researchitaly.it/en/national-operative-programme-for-research-and-competitiveness-2007-2013/.
[61] See http://www.ponrec.it/en/open-data/projects/.

Table 10.15: Key Policy Instruments – National OP for Research and Competitiveness 2007-13

Measure	Description	NOP Contribution in Puglia (€mn)	No. of Beneficiaries Supported
Industrial Research	Funding for companies to develop projects with high scientific-technological content, including potential for joint participation with universities and public research bodies, in ICT, advanced materials, energy, human health and biotechnology, agri-food, aerospace and aeronautics, cultural heritage, transportation and advanced logistics, and environment and safety	434.1	660
Structural Development	Implementation of structural and infrastructural enhancement projects for universities and public research bodies concerning, for example, the creation of new laboratories, the purchase of scientific and technological equipment and instruments, building works and structural modernisation, and training	297.1	70
Districts and Laboratories	Support for strengthening and consolidation of existing technological districts and laboratories, and creation of new districts and aggregations, through project funding	293.9	215
Social Innovation	Funding for projects to develop technologically innovative ideas to address social needs (e.g. smart mobility, smart health, smart education)	11.5	18
Technological Innovation	Initiatives to increase the technological capacity through experimental development of new products or processes, proposed by companies and with participation of universities and public research bodies	50.6	159
Interventions for Innovative Start-ups	Funding to promote the creation of new innovative companies and new digital or technological content companies	10.2	75
Note: Excludes investment under Smart Cities and National Technological Clusters measures, which involved funding of cross-regional projects. NOP contribution to Smart Cities was €189.8 mn across eligible regions, while NOP contribution to National Technological Clusters was €34.4 mn across eligible regions.			

Source: Programme website (accessed 2019)

ROPs in regions that were classified as “lagging”, on the other hand, were intended to complement the national OP (Muscio, 2011). The other main funding mechanism used to implement innovation policy in Puglia, therefore, alongside the NOP for Research and Competitiveness 2007-13, was the ROP for Puglia 2007-13. According to Grigolini et al (2015), the promotion of research and innovation was a focus of this OP’s strategy, and its strategic objectives were aligned with the region’s objectives for developing the regional innovation system, supporting an ambition for regional structural change towards high value added production, and seeking to foster more research and innovation through collaboration between firms and research institutions.

Axis 1 of the ROP for Puglia 2007-13 – Promotion and Dissemination of Research and Innovation for Competitiveness – had an initial budget allocation of €580 mn, out of a total OP budget of over €5.2 bn, although some of this Axis 1 allocation was devoted to the enhancement of broadband infrastructures and other digital infrastructure within public administration. Actions funded under the programme, as described by the Vignetti (2015) and on the programme’s website[62], are outlined in Table 10.16a, Table 10.16b and Table 10.16c, and included the following:

- support for investment in research and innovation by SMEs, including industrial research and experimental development, in order to increase innovative activities and regional production in both traditional manufacturing and innovative sectors;
- support for industrial development and experimental development by large companies in association with SMEs, and support for SMEs to obtain specialist consulting services in order to strengthen technological development and innovation activities;
- support for the creation of new enterprises investing in R&D and strengthening of existing micro and small innovative enterprises, targeting sectoral specialisations in advanced materials, advanced logistics, advanced manufacturing, ICT, environment and energy, health and agri-food;
- instruments to better valorise research outputs through promotion activities (ARTI) and through the promotion of the regional network of ILOs;

[62] See http://fesr.regione.puglia.it/portal/pls/portal/FESR.DYN_HOME_FESR.show.

- support for creation of public-private partnerships in research and innovation through co-operation between enterprises/research centres, reinforcement of technological districts, regional networks for knowledge transfer and innovation partnerships;
- support for SMEs to promote access to and use of ICT, and adopt digital solutions, in their productive and management operations;
- support for the creation of a "Living Labs" concept, whereby researchers, enterprises and groups of citizens exchange ideas and knowledge, plan activities together and experiment with innovative technological solutions;
- support for the use of public procurement to stimulate innovation, supporting the purchase of services and research and experimentation that are needed in the public sector but not already available in the market;
- industrial investment or "integrated facility packages" to increase productive innovation by medium-sized enterprises, small enterprises or consortia of SMEs in specific sectors, incorporating purchase of fixed assets and consulting services.

Table 10.16a: Key Policy Instruments Promoting Innovation – Regional OP for Puglia 2007-13

Measure	**Description**	**Eligible Investment**	**Expenditure (€mn)**	**No. of Beneficiaries Supported**
Aid for Investment in Research by SMEs	Support for investment in research and innovation promoted by SMEs in order to increase innovative activities and regional production in traditional manufacturing sectors and in innovative sectors	Personnel, fixed assets, services, consulting, patents	44.9	139
Aid for Consulting Services for Technological Innovation of SMEs	Support to SMEs for the acquisition of specialised consulting services to strengthen their technological development and innovation activities	Services and consulting	11.2	246
Note: Expenditure commitments are up to the end of 2014.				

Source: Vignetti (2015)

Table 10.16b: Key Policy Instruments Promoting Innovation – Regional OP for Puglia 2007-13

Measure	**Description**	**Eligible Investment**	**Expenditure (€mn)**	**No. of Beneficiaries Supported**
Aid to New Innovative Enterprises to Invest in R&D	Support for creation of new enterprises investing in R&D, as well as strengthening micro and small innovative enterprises, in order to strengthen the regional innovation system in advanced materials, advanced logistics, advanced manufacturing, ICT, environment and energy saving, health and agro-food sectors	Building, machinery, equipment, technology transfer	30.0	32
Networks for Knowledge Transfer – ARTI	Support to better valorise the output of research activities through promotion activities carried out by ARTI	Patents, advice and consulting	5.1	56
Networks for Knowledge Transfer – ILOs	Support to better valorise the output of research activities through promotion of the regional network of ILOs	Consulting, advice, technical assistance	1.2	-
Regional Partnership for Innovation	Support to promote the creation of public-private partnerships for research and innovation	Personnel, equipment, research contracts, services, consulting, patents	26.0	153
Aid to SMEs for Access and Use of ICT in Productive and Management Operations	Support to increase innovation in all economic and productive sectors of the region, diffusion of ICT technologies in SMEs' networks and implementation of ICT solutions in enterprises	Equipment hardware, software licences, software development, consulting	10.8	183

Note: Expenditure commitments are up to the end of 2014.

Source: Vignetti (2015)

Table 10.16c: Key Policy Instruments Promoting Innovation – Regional OP for Puglia 2007-13

Measure	Description	Eligible Investment	Expenditure (€mn)	No. of Beneficiaries Supported
"Living Labs"	Supports to create "Living Labs", aiming to favour constant interaction between demand, technology development and supply, through experimentation projects where researchers, enterprises and groups of citizens exchange ideas and knowledge, plan together and experiment with innovative technological solutions	Personnel, equipment, services, software, patents	21.9	204
Public Procurement for Innovation	Support for public procurement to stimulate innovation, through purchase of services for research and experimentation needed to develop new solutions for the public sector, not already available on the market	-	2.3	-
Integrated Facility Packages – Medium Enterprises and Consortia of SMEs	Finance to realise investments to increase productive innovation in selected sectors through purchase of machinery, consulting services for innovation, marketing, trade events, certification etc	Fixed assets, advice and consulting, investment in R&D, investment in energy efficiency	94.1	52
Integrated Facility Packages – Aid to Small Enterprises	Support for the enlargement, development and innovation of SMEs, by financing industrial investment to increase the production of goods and services, integrated with investment for R&D and the purchase of services	Fixed assets, advice and consulting, investment in R&D	51.6	37
Note: Expenditure commitments are up to the end of 2014.				

Source: Vignetti (2015)

10.6 Chapter Summary

- The purpose of this chapter has been to describe the regional innovation systems in Galicia and Puglia, while also describing the policies that have been in place to support R&D and innovation over the course of the 2000-13 study period.
- In terms of the regional innovation system, the chapter has described the knowledge generation and diffusion sub-system in each region (e.g. universities, research centres), the knowledge application and exploitation sub-system (e.g. firms) and the regional policy sub-system (e.g. government and agencies).
- In both regions, the knowledge generation and diffusion sub-systems show a mix of older, “traditional” university institutions, which embrace a wide variety of research disciplines, and younger universities (established in the past 30-50 years), where research interests tend to be more explicitly science-, engineering- or technology-oriented. The establishment of TTOs within universities, as a means to foster better links between university research and enterprise and to promote more knowledge transfer between the two, is also now common in both regions, though it is a more recent development in Puglia. Galicia appears to differ from Puglia, however, through its focus on the establishment of technology centres, which are research centres that are intended to more directly target R&D and innovation promotion and supports for enterprise and the productive sector.
- The knowledge application and exploitation sub-systems in both regions, on the other hand, appear to consist mainly of a small pool of both SMEs and large firms, operating in sectors such as aquaculture, audiovisual, automotive, biotechnology, food/seafood, granite, graphics, health, ICT, shipbuilding, textiles, tourism or wood/timber (Galicia) or mechatronics, automotive, aeronautics, software and food (Puglia). Both regions, however, have attempted to promote the development of cluster-oriented activity as a means of fostering research and innovation in firms via the establishment of formal cluster-oriented organisations, targeted at specific sectors, and with links to research centres and universities in each region being encouraged.
- In the regional policy sub-systems, both Galicia and Puglia have regional autonomy, in the form of regional government administrations, and powers in

both regions include policy making competence in the area of R&D and innovation. Regional competence in R&D and innovation is a more recent development in Puglia, however, where it was introduced in the early 2000s, whereas Galicia introduced regional laws to mandate formal planning for R&D and innovation during the 1990s. At the same time, competence for R&D and innovation in both regions still appears to be to some degree shared or concurrent between regional government and national government, with national governments still holding responsibility for overall co-ordination of R&D and innovation policy, or for university research policy, for example.

- From a policy perspective, allocation of funding for innovation activities also appears to have increased over time. Regional innovation policy in Galicia has been articulated through a series of multi-annual regional plans for research and development, the first of which was launched in 1999, while the development of regional innovation strategies was required as a pre-condition for funding of R&D and innovation measures in Puglia, through EU Structural Funds, during the 2000-06 and 2007-13 periods. In general, the description of policies in both regions over the 2000-13 period implied a focus on R&D and technology oriented innovation (though with some shift away from this in later years), alongside policies emphasising a need to improve capacity in both universities/research institutions/research centres and firms, develop greater collaboration between universities/research institutions/research centres and firms, and build human capital in R&D and innovation.
- Chapter 10, therefore, suggests that policy to develop regional innovation systems in both Galicia and Puglia has certainly sought to address perceived weaknesses in "lagging" regions, which are related to the regional innovation paradox, such as low levels of public assistance for innovation, lack of scientific/technological infrastructure, lack of innovative capacity in firms, lack of critical mass/clustering and weak co-operation links between public and private sectors (see Table 8.1), but with Galicia again being the more "early adopter" of policies to promote R&D and innovation.
- However, it is again important to remind the reader that Chapter 10, like Chapter 9, tells us less about processes, connections and other influencing factors underlying the development of R&D and innovation in the two regions, which

influence the success or otherwise of policy for regional innovation, both within the regional innovation systems or between the regional systems and the systems that exist at other spatial levels (e.g. national, global). Chapter 11 therefore seeks to aid the interpretation of the earlier evidence by considering the opinions and insights of a sample of informed interviewees in each region regarding the development of R&D and innovation performance and regional innovation systems over time. In addition, Chapter 11 gauges the extent to which such opinions either support or contradict the evidence provided in Chapter 9 and Chapter 10, and what this contributes to the understanding of the development of R&D and innovation in Galicia and Puglia.

CHAPTER 11 – CASE STUDIES: INTERVIEW PERSPECTIVES AND INTERPRETATION

11.1 Introduction

11.1.1 Purpose of the Chapter

As noted in the introduction to this thesis (Chapter 1) and in the methodology chapter (Chapter 5), the purpose of the research has been to explore "how public policy towards and public investment in regional innovation systems have contributed to R&D and innovation performance in lagging regional economies". Also, research objectives underlying this purpose have been to:

- examine how investment in R&D and innovation in lagging regions, and outputs attributed to R&D and innovation in such regions, have changed over time;
- explore public policy and public investment interventions that have been used to promote the development of regional innovation systems in lagging regions;
- understand the elements that constitute regional innovation systems in lagging regions, and the extent to which such systems have developed over time;
- examine how lagging regions address their region-specific characteristics when developing policies to promote regional innovation systems;
- examine how interaction with other spatial levels (e.g. national, EU) influences the development of policies to promote regional innovation systems in lagging regions.

Moreover, the research has addressed these aims and objectives within the context of the regional innovation paradox, and the assertion by proponents of the paradox (e.g. Oughton et al, 2002) that its main cause lies in the nature of regional innovation systems. The research has thus sought to meet its aims and objectives by means of an analytical framework that examined the regional innovation systems in Galicia and Puglia (and the connections within the systems), while also considering the connections that these regional systems have with other outside systems.

In this regard, Chapter 9 described the socio-economic context within both Galicia and Puglia, based on the type of indicators and data that the EU typically uses when describing the regions that it classifies as "lagging" regions. Alongside this, Chapter 9 also described the R&D and innovation performance of Galicia and Puglia between 2000 and 2013 (i.e. the period of study for this thesis), again based on commonly used indicators for R&D and innovation performance, including inputs (R&D expenditure, R&D personnel) and outputs (patents, employment in “innovating” sectors). Chapter 10, on the other hand, described the main elements of the regional innovation system in both Galicia and Puglia, with a particular focus on (a) the knowledge generation and diffusion sub-system, (b) the knowledge application and exploitation sub-system and (c) the regional policy sub-system, as per the analytical framework outlined in Chapter 5 and Chapter 8. In addition, related to the regional policy sub-system, Chapter 10 has also described the development of policy for R&D and innovation within the two regions up to 2013, with a particular focus on the 2000-06 and 2007-13 EU Structural Fund programming periods.

As noted in the introduction to the case studies, therefore, Chapter 9 and Chapter 10 tell us something about the inputs, outputs and outcomes associated with the development of R&D and innovation in Galicia and Puglia over the 2000-13 period. However, the chapters tell us less about the processes, connections or other influencing factors that might link inputs to outputs and outcomes. To address this, Chapter 11 aids the interpretation of the evidence provided in Chapter 9 and Chapter 10 by discussing the findings arising from a series of interviews that were carried out in both Galicia and Puglia. In this regard, the chapter (via the interviews) thus seeks to understand the opinions of a sample of informed actors in each region regarding the development of R&D and innovation performance and regional innovation systems over time, including their views on the processes, connections or influencing factors that are underlying investment/performance and regional innovation systems, which in turn provides the research with a deeper understanding of the issues underlying most of the research objectives (e.g. perceived input of different actors in the regional innovation systems, perceived appropriateness of policy prescriptions, perceived influence of links to national or other extra-regional levels, perceived influence of structural economic factors etc). Related to this, however, the chapter also tries to gauge the extent to which such opinions either support or contradict the evidence provided in Chapter 9 and Chapter 10, and what this contributes to the understanding of the development of R&D and innovation in Galicia and Puglia.

11.1.2 *Interview Sample*

In identifying candidates for interview, the researcher used a purposive sample of interviewees, with interviewees chosen based on their likely experience and knowledge of the regional innovation systems in Galicia and Puglia over a prolonged period of time, and with a particular focus on interviewees that were familiar with the regional innovation systems and the development of R&D and innovation policy over the 2000-13 period. Selection criteria that were used to identify potential interviewees, therefore, included:

a) selection of interview candidates that possessed experience related to R&D and innovation and regional innovation systems, which at least covered the 2000-06 and 2007-13 Structural Fund programming periods;
b) selection of interview candidates that were, as best as possible, representative of the different sub-systems of actors that are involved in regional innovation systems (e.g. policy makers, policy implementers, universities/research institutions, firm/industry representative bodies).

Candidates for interview were identified through desk-based research (e.g. literature searches, Internet searches) and through regional contacts in Galicia and Puglia. As noted previously in Chapter 5, there were nine (9) face-to-face interviews carried out during April-May 2017 across the two regions – four (4) in Galicia and five (5) in Puglia[63] – with interviews being carried out in English. Interviews also included a mix of experienced public sector, university sector and private sector interviewees in each region, as is again outlined in Table 11.1.

[63] As noted previously in Chapter 5, there were seven (7) potential candidates invited to be interviewed in each region across the categories referred to above (i.e. policy makers, policy implementers, research institutions, industry representative bodies). In both regions, there were five (5) candidates that agreed to be interviewed, though one potential interview in Galicia unfortunately had to be postponed and could not be subsequently re-arranged.

The sample of interviews conducted across the two regions is therefore small. This partly reflects (a) the decision to carry out the interviews on a face-to-face basis (which was considered to be the best means to carry out English language interviews with non-native English speaking interviewees) and (b) the resources available to carry out face-to-face interviews in each region. In addition, it reflects the nature of the discussions, which sought to cover a variety of topics and which, in most cases, involved interviews of between 90-120 minutes in duration. Moreover, while the sample of interviews conducted was small, it is nonetheless felt that the views of such a targeted, purposive sample of experienced interviewees might be reasonably expected to reflect wider opinions regarding R&D and innovation performance and the development of R&D and innovation policy within the region.

Table 11.1: List of Interviews

Interview	**Region**	**Sector**	**Role**
G1	Galicia	Public	Senior official in R&D and innovation planning and strategic co-ordination, regional government agency
G2	Galicia	University	Senior executive in knowledge transfer and collaboration in the university sector
G3	Galicia	University	Senior academic with expertise in R&D and innovation policy and the regional innovation system in Galicia
G4	Galicia	Private	Senior executive in a private intermediary organisation specialising in the R&D and innovation space
P1	Puglia	Public	Senior official with expertise in R&D and innovation, regional government agency
P2	Puglia	University	Senior academic with expertise in R&D and innovation policy and the regional innovation system in Puglia
P3	Puglia	Public	Senior official with expertise in R&D and innovation, regional government agency
P4	Puglia	Private	Senior executive with expertise in R&D and innovation, regional business representative body
P5	Puglia	Public	Senior official in R&D and innovation policy, regional government department

Source: Author

In terms of topics, the interviews were conducted in a semi-structured format, using a standard checklist of interview questions. The main topics that were addressed during the interviews included the following:

- interviewees' perceptions on the R&D and innovation performance of each region during the study period;
- interviewees' perceptions on the role of different actors within the regional innovation system, and how these roles have progressed over time, but with particular focus on the following:
  - universities and other research institutions;
  - firms, including both large enterprises and SMEs;
  - government and policy makers, including regional government, national government and the EU;
- interviewees' perceptions on the development of policies to foster R&D, science and technology and innovation in industry and enterprise in each region over the study period, and opinions on how such policies evolved over time.

A copy of the checklist of interview questions that was used to guide the semi-structured interviews is provided in Appendix C.

11.1.3 Chapter Structure

The rest of this chapter informs the research objectives by comparing the evidence from Chapter 9 and Chapter 10 with regional actors' perspectives on the following themes:

- the emergence of investment in R&D and innovation in Galicia and Puglia, and the development of policy for R&D and innovation in the regions, between 2000 and 2013 (see Section 11.2);
- what policy and investment in R&D and innovation in the regions achieved between 2000 and 2013, including development of the regional innovation systems (see Section 11.3);
- how governance and institutional arrangements have affected the development of R&D and innovation in the regions between 2000 and 2013 (see Section 11.4);

- other factors affecting the development of R&D and innovation in the regions, or lessons learned from the experience of developing R&D and innovation in the regions, between 2000 and 2013 (see Section 11.5).

Following the presentation of data and findings pertaining to these themes, Section 11.6 concludes the chapter by providing a summary of its main findings.

11.2 The Emergence of Investment and Policy for R&D and Innovation

11.2.1 Interpretation of Secondary Data

In Chapter 10, the description of policy development in Galicia and Puglia between 2000 and 2013, as outlined in Section 10.3 (for Galicia) and in Section 10.5 (for Puglia), would suggest that both regional governments and national governments placed an increased emphasis on developing and implementing policy to promote R&D and innovation over the period, with this policy emphasis in turn being supported by increased levels of public/EU investment in R&D and innovation.

In Galicia, for example, Section 10.3 presents evidence of an increased policy focus from the beginning of the 2000-13 period, with four statutory regional plans for R&D and innovation being developed and/or implemented over this time, and with public commitments for investment also increasing with each of these plans. Furthermore, EU co-financed support for the plans was also expanded during the period, with an increased share of total Structural Fund investment in the region being allocated to R&D and innovation policies and programmes during both the 2000-06 and 2007-13 periods, either through regionally-run ROPs or nationally-run NOPs. In Puglia, on the other hand, Section 10.5 presents evidence for a policy shift towards R&D and innovation that was most prevalent in the 2007-13 period, but with evidence nonetheless again pointing to an increase in Structural Fund resources for investment in R&D and innovation during this period, with this support also provided either through regionally-run ROPs or nationally-run NOPs.

The evidence presented in Chapter 10, therefore, suggests that national and regional governance in both regions took steps to address low levels of public assistance for innovation between 2000 and 2013, which has been one of the perceived weaknesses attributed to the innovation systems in regions that are perceived to be "lagging", as outlined in Chapter 8 (Table 8.1). In the context of the regional innovation paradox, moreover, it further suggests that national and regional governments in both regions have demonstrated a capability to invest in R&D and innovation during the period (though without providing evidence as to the effectiveness of that investment), and that the support provided via the EU, through the Structural Funds, has facilitated this.

Finally, the evidence in Chapter 10 regarding the nature of the policy interventions funded through increased public investment also suggests that policy drew inspiration from ideas espoused in the regional innovation systems approach. In this regard, for example, stated policy priorities that were common across the two regions between 2000 and 2013 included:

- the development of formal strategies for regional R&D and innovation;
- development of research infrastructures (e.g. research centres);
- development of human capital for R&D and innovation (researchers);
- increased engagement of the private sector in R&D and innovation (including SMEs);
- increased collaboration in R&D and innovation between the public and private sectors;
- provision of mechanisms to facilitate the transfer of knowledge within a regional innovation system (e.g. clusters).

Interpretation of the evidence of secondary data, therefore, might suggest that the public sector has clearly sought to tackle issues related to the regional innovation paradox in both regions by means of clear policy changes in favour of developing R&D and innovation, using a regional innovation systems approach, underpinned by increased public/EU financial support for investment in R&D and innovation.

Interview perspectives on this topic, and how they compare with evidence from the secondary data, are presented in Section 11.2.2.

11.2.2 Interview Perspectives

In general, interview perspectives appear to endorse the evidence of the secondary data in suggesting that there was a clear policy change in favour of developing R&D and innovation in both Galicia and Puglia between 2000 and 2013, and that regional and national governments have shown capability to target public/EU investment for R&D and innovation, with this increased focus on R&D and innovation first becoming evident in Galicia, before thereafter emerging in Puglia. Moreover, the interview perspectives also appear to support the evidence of secondary data by suggesting that a regional innovation systems approach was reflected in the nature of R&D and innovation policies adopted during this period, including the development and promotion of policies to better engage the private sector in R&D and innovation and to promote collaboration and knowledge transfer between regional actors.

The rest of this section now discusses interview perspectives on policy development in both Galicia and Puglia, while also discussing interviewees' opinions on the influence of EU Structural Fund investment within R&D and innovation policy in the two regions between 2000 and 2013.

Interview Perspectives – Galicia: Interview perspectives regarding R&D and innovation policy in Galicia over the 2000-13 period highlighted a variety of policy features that were commonly cited as being new policy initiatives in the region over this time, including:

- focus on investment in research infrastructures, not only research centres in universities but also technology centres that were oriented to the needs of the private sector and SMEs (G3, G4);
- promotion of new policy tools to promote wider adoption of R&D and innovation, e.g. using public procurement to stimulate innovation by encouraging R&D and innovation that develops new solutions for public sector needs (G2, G4);
- more emphasis on fostering collaboration between research institutions and industry, collaboration in researcher-to-researcher or company-to-company contexts, and promoting mechanisms for technology transfer and promotion of clusters (G1, G2, G3, G4);

- attempts to promote innovation finance for companies through venture capital (G2, G4);
- investment in improving human capital in R&D and innovation, but with a particular reference to the 2005-09 period (G3).

Perceptions of an increased policy emphasis on trying to foster knowledge transfer and collaboration, in particular, were strongly conveyed in the interviews. For example, G1 asserted that changes in policy over this period introduced *"more emphasis [on] really supporting technology transfer ... more emphasis on triggering collaboration between [research institutions] and industry"*, while also asserting that these changes in policy represented a *"change in the paradigm [for supporting R&D and innovation] ... for the first time, there were projects in collaboration between researchers and companies"*. In a similar vein, G2 highlighted the *"development of new instruments, like for example the [instruments] supporting co-operation between big companies and technology centres or universities"*, while G4 highlighted *"new tools ... like grants for companies that work together with technological centres and universities"* and the wider emergence of a *"portfolio of [policy] tools available [that was] richer (i.e. more varied) than it was 10 years ago or 20 years ago"*. G3, meanwhile, suggested that the 2005-09 period, in particular, witnessed a *"framework for R&D and innovation policy [that] was clearly systemic, [with] a strategy to support R&D in each institution, public and private sector, but with a clear effort to promote co-operation between any side and create new structures like technology platforms and technology centres that were devoted to the needs of a sector, not only to support individual activities"*.

<u>*Interview Perspectives – Puglia*</u>: Interview perspectives in Puglia, meanwhile, similarly support the perception of an increased policy focus on R&D and innovation over the 2000-13 period. P1, for example, asserted that *"innovation entered the regional [policy] agenda [in Puglia] ... in the last two programming periods (i.e. 2000-06 and 2007-13)"*, while P2 considered that *"Puglia is interesting because [government] made a choice in the last 12-15 years to invest more heavily in innovation"*.

However, interviewees also made a clear distinction between the 2000-06 and 2007-13 periods, with interview perspectives highlighting the latter period as witnessing real policy shift towards fostering R&D and innovation[64]. In this regard:

- P1 asserted that *"the policy portfolio in [Puglia] diversified a lot [in the 2007-13 period]. So a lot of new ideas were taken by the policymakers and transformed into new policies, for example, innovation in provision of public procurement, support to start-up companies developed a lot in the [2007-13] period"*;
- P1 also suggested that *"the creation of intermediary structures or the promotion of supports like technology districts or productive districts or clusters, all this was new"*, while also highlighting *"more focus on training and human capital, on services for the companies, for example support for market analysis, support for patenting, support for prototyping, support for many phases that run before R&D and after R&D"*;
- P4 asserted that the 2007-13 period devoted *"more attention towards small and medium enterprise and better dissemination of innovation. ... The 2007-13 period was mainly characterised by the decision to select champions in local small and medium enterprise, and to help these champions to grow"*;
- P5 suggested that policy in the period witnessed *"big change in the [policy] design phase because [government] used, in a practical and real way, the paradigm of quadruple helix (i.e. interaction to foster innovation between universities, industry, government and civil society)"*.

Moreover, as in Galicia, perceptions of an increased policy emphasis on trying to foster knowledge transfer and collaboration was also clearly conveyed in the interviews. P1, for example, cited policy in this period as *"trying to promote the aggregation of companies, with policy oriented to industrial districts or clusters and technological districts"*, while P3 regarded the period as witnessing *"a progressive [policy] situation of open innovation"* whereby *"all the regional programmes [for innovation were to] be oriented to promote co-operation and collaboration between industries and research*

[64] Insights from interviewees regarding the 2007-13 period, therefore, appear to reflect to a degree the opinions of other commentators, such as (a) Florio et al (2014), who contended that the policy adopted in Puglia at this time employed a more integrated, long-term approach that prioritised innovation as a tool for long-term economic development and (b) Muscio (2011), who has asserted that the strategy for innovation over this period was the first to set clear objectives for stakeholders to develop innovation activity in Puglia.

centres". In a similar vein, P5 also highlighted support for *"collaborative research"* in the 2007-13 period, *"[where] it was necessary to have the same level [of participation] of research centres and enterprises"*.

Interview Perspectives – Structural Funds: In both Galicia and Puglia, therefore, interview perspectives point to an evolution in R&D and innovation policy over the 2000-13 period, which contrasts with interview perceptions of policies prior to 2000, which were described as being more university-focused (G3, G4, P4), more fragmented (G3, P1, P4) and more driven by a linear model of innovation whereby both basic research[65] and applied research[66] were carried out in isolation (G3, P5), with little co-operation or collaboration.

Moreover, interview perspectives also support the evidence of secondary data to suggest that EU funding facilitated increased public investment in R&D and innovation during the 2000-13 period, while at the same time influencing the nature of the R&D and innovation policy initiatives that were adopted in the regions. In regard to funding, for example, all interviewees in both Galicia and Puglia cited the EU as an important provider of funding to develop R&D and innovation initiatives in the regions, with:

- G2 describing the EU as being *"a very important influence"* because *"[it is] easy to move people with the money, and it is more difficult if you don't have money to give"*;
- G4 similarly asserting that *"one of the clues [behind the evolution of R&D and innovation in Galicia] has been ERDF and the Structural Funds. Galicia has been a great recipient of Structural Funds, and in every period, it has invested a good quantity in research and development"*;
- P1 contending that *"in the last 15-20 years, the amount of money that has been available to [Puglia] from the Structural Funds, with the obligation to also orientate these funds to innovation and competitiveness and companies, has grown a lot"*.

[65] As noted in the literature review, basic research is research to improve scientific theories and understanding rather than research to develop technologies.
[66] As noted in the literature review, applied research is the use of scientific theory and understanding to develop technologies or techniques.

Furthermore, in terms of policy influence, G1 suggested that *"[EU strategy] has helped [the regional government in Galicia] to really go and think all together about our economy and the needs in innovation"*, while G2 contended that the EU's influence has helped to *"force [regions] to define what you want to do with the money, and to ask for results, to ask for indicators, to evaluate the policies"*. G4, in turn, asserted that the EU influence was instrumental in encouraging Spanish regions, including Galicia, to begin to use a more varied suite of policy tools to promote R&D and innovation, as *"the European Commission, when for instance it gives Structural Funds to a region like Galicia, it was always [emphasising] that you have a make more venture capital, you have to make more public procurement of innovation, you have to work on technology transfer"*. Similarly, in the context of Puglia:

- P3 suggested that "*the regional government has been able to plan innovation policy that is able to support SMEs, … following the European Commission approach to open innovation in SMEs"* and thereby draw "*policy inspiration"* from the EU, not just financial resources;
- P5 asserted that the EU *"has performed a crucial role"* in providing direction, monitoring and best practice to support policy formulation, and that *"the European Structural Funds are an important tool for learning, learning for better policy"*.

At the same time, however, it should be noted that Structural Fund investment and the influence of the EU did not necessarily "introduce" R&D and innovation policy to these regions, as the evidence in Chapter 10 has suggested that the genesis for an expanded R&D and innovation policy in both regions (but especially in Galicia) actually pre-dated the receipt of increased Structural Fund investment, e.g. through the transfer of increased competence for R&D and innovation policy from the national government level to the regional government level. Also, not all interview perspectives regarding the EU's influence on regional R&D and innovation policies were positive, with the appropriateness of some policy interventions in Galician and Puglian contexts being questioned in some cases. These issues are therefore further discussed in more detail in Section 11.4 (in the context of governance and institutional arrangements) and Section 11.5 (regarding other factors affecting the development of the regional innovation systems).

11.2.3 Secondary Data v Interview Perspectives

- The evidence from the case study research, including both the secondary data and the interview perspectives, suggests that both Galicia and Puglia placed an increased emphasis on developing and implementing policy to promote R&D and innovation between 2000 and 2013, with this emphasis being evident in Galicia from the beginning of the 2000-06 Structural Fund period, while it principally emerged in Puglia during the 2007-13 period.
- Moreover, the research also suggests that increased financial support from the EU Structural Funds facilitated the implementation of these more expansive policies for R&D and innovation, and increased public investment in R&D and innovation, in both Galicia (starting in the 2000-06 period) and Puglia (principally in the 2007-13 period), while the nature of policy in both regions over the period appears to have drawn inspiration from EU policy tools and practices with respect to R&D and innovation, and the ideas espoused in the regional innovation systems approach, as is evident in the nature of the policy initiatives that were pursued in each region.
- In the context of this study's research objectives and the regional innovation paradox, therefore, the research suggests that national and regional governments in both regions demonstrated a capability to invest in R&D and innovation during the 2000-13 period, with the help of EU Structural Fund support, and thereby take steps to address perceived low levels of public assistance for innovation. In this regard, public policy developments (and the EU financial support that was associated with these developments) would thus appear to have had a positive effect in generating increased public investment in R&D and innovation during the period, thereby suggesting that regions that are perceived to be "lagging" can indeed direct funds towards investment in R&D and innovation, when they are made available. However, this still tells us less about the appropriateness or effectiveness of this investment in the context, for example, of regional needs or capabilities.

11.3 The Achievements of Investment and Policy for R&D and Innovation

11.3.1 Interpretation of Secondary Data

In Chapter 10, the description of regional innovation systems, policy for R&D and innovation and stated policy achievements between 2000 and 2013, as outlined in Section 10.2 and Section 10.3 (for Galicia) and in Section 10.4 and Section 10.5 (for Puglia), suggest that governments in both regions have made some progress in implementing policies to foster R&D and innovation and improve innovation systems.

In Galicia, for example, the evidence from secondary data suggests that policies to promote R&D and innovation, and the public/EU investment that has supported these policies between 2000 and 2013, has contributed to the creation of new university research centres and the upgrading of equipment and facilities in existing research centres, while it has also delivered support for a large volume of R&D projects, including a large number of collaborative projects between firms and research centres (e.g. see Chapter 10, Section 10.3.3). In addition, the evidence suggests that the number of technology centres in the region was doubled over the period, with the purpose to directly target R&D and innovation activity that is oriented to the needs of the productive sector, while also pointing to efforts to promote clusters of economic activity, including clusters of R&D and innovation, by means of funding to establish cluster organisations.

Such activity, in turn, would suggest that successive governments in Galicia have sought to build on the steps taken prior to 2000 to promote R&D and innovation, such as the establishment of new, more technologically-oriented universities (Vigo, A Coruña), the establishment of TTOs to promote knowledge transfer from the universities to the private sector, and the development of technology centres.

The evidence from secondary data for Puglia, meanwhile, alludes to similar supports being provided and outputs delivered as per Galicia, though activity was more concentrated around the 2007-13 period (see Chapter 10, Section 10.5.3). This includes R&D and innovation infrastructure enhancements in universities and public research centres, funding for R&D projects in companies (plus funding for companies to access specialist R&D and innovation services), funding for collaborative projects between firms and universities, support for the establishment of TTOs within universities, and the promotion of clusters, by means of technological districts, alongside funding for projects developed within these districts.

The evidence presented in Chapter 10 thus alludes to further efforts in both Galicia and Puglia to address other perceived weaknesses attributed to the innovation systems of regions that have been regarded as “lagging”, as outlined in Chapter 8 (Table 8.1). These include:

- efforts to address the perceived lower quality or quantity of scientific and technological infrastructure (e.g. through investment in university research centres in both regions, or through investment in technology centres in Galicia);
- attempts to provide intermediaries capable of identifying demand for R&D and innovation and matching it with sources of R&D and innovation (e.g. through the establishment of TTOs in universities in Puglia[67], or through investment in technology centres in Galicia);
- efforts to build more dynamic, strongly developed clusters or critical mass of R&D and innovation activity (e.g. through the establishment of cluster organisations in Galicia or through funding to establish technological districts in Puglia, alongside further funding for projects that were initiated within these clusters/districts);
- attempts to address weak co-operation links between the public and private sectors, and a lack of networks/social capital (e.g. through funding for projects or initiatives that promote collaboration between firms and universities/research centres in both regions, through funding to develop clusters/technological districts, or through investment in technology centres in Galicia);
- efforts to encourage latent demand for innovation within firms and to address a lack of capacity in firms to identify their needs for innovation (e.g. through funding for R&D and innovation projects in firms and through funding, in the latter part of the 2000-13 period, to stimulate a culture of innovation in firms, identify potential needs through business analysis or acquire specialised consulting services to strengthen R&D and innovation activities).

[67] As outlined in Section 11.2 and Section 11.3, it should be noted that TTOs had already been established in universities in Galicia during the 1990s, i.e. prior to the main period of focus for this study.

Interpretation of the evidence of secondary data, therefore, points to some policy achievements in developing the regional innovation systems in both Galicia and Puglia. However, evident achievements as presented in Chapter 10 are mainly outputs, which tell us less about the results or impacts of policy, while the evident growth that occurred in both regions under commonly used indicators for R&D and innovation activity (as outlined in Chapter 9) also showed that base levels of R&D and innovation activity mostly remained below both national and EU-15 averages.

In order to provide further insights on achievements, interview perspectives on this topic (and how they compare with evidence from the secondary data) are presented in Section 11.3.2.

11.3.2 Interview Perspectives

Despite the secondary evidence for progress and policy achievements in developing regional innovation systems in Galicia and Puglia, interview perspectives would still nonetheless suggest that the development of the systems in both regions, including the connections between the sub-systems and the main elements in each part of the system, is a work-in-progress, displaying both positives and negatives. In this regard, the rest of this section now discusses interview perspectives on the regional innovation systems in the two regions, with the discussion focused on perceptions of (a) the knowledge generation and diffusion sub-system, (b) the knowledge application and exploitation sub-system and (c) collaboration within and between the sub-systems.

Interview Perspectives – Knowledge Generation and Diffusion: Interview perspectives on the development of the knowledge generation and diffusion sub-systems in Galicia and Puglia provide some contrasting insights, with interviewees in Galicia reflecting a greater sense of achievements within this sub-system than their counterparts in Puglia. For example, interview perspectives in Galicia have alluded to progress having been made in the development of R&D and innovation infrastructure within universities and research centres, and in fostering increased engagement of universities in R&D and innovation activity, with the views of G1, G3 and G4 all reflecting a perception of increased focus on R&D and innovation within universities in Galicia, and with interviewees citing evidence of this through:

- the emergence of technology transfer and spin-off activity (G1);
- the reinforcement of research departments and the creation of new R&D and innovation centres (G3);
- investment in human resources for R&D and innovation (G3);
- increased research specialisation within the university sector (G4), including research specialisations related to important sectors of the Galician economy, e.g. the automotive sector, the marine sector.

In this regard, G1 has thus asserted that *"the infrastructure for innovation has grown, there is more innovation, more research centres … there is a bigger focus on research in universities, I would say. Universities have established technology transfer, different instruments to really support innovation, not only doing research itself … but also adding instruments which facilitate the uptake or transfer of innovation resources by companies, and also the emergence of spin-offs"*. As a result, G1 has also contended that *"[while] universities were classrooms in the past, now there is a stronger component [of university activity] on research"*. G3, moreover, citing the 2005-09 period, asserted that Galicia *"experienced an important improvement in the public R&D sector around universities, which reinforced research departments and created new R&D centres in the universities, and new programmes [for] human resources in R&D"*, while G4 contended that university focus on R&D and innovation has evolved from having a single university in the 1980s, with *"few, few researchers, only in 2-3 topics"*, to having *"three universities, with [several] campuses, with researchers in a large number of topics, and probably this has been developed in the 1990s and the first [part] of this century"*.

Moreover, interview perspectives in Galicia further allude to a strongly positive perception of the contribution of technology centres to the region's innovation system, and the role of R&D and innovation policy in establishing these centres, with interviewees especially highlighting the role that these centres have performed in connecting with firms in the region and in trying to foster R&D and innovation activities that are aligned with industry needs. G2, for example, contended that *"the evolution of the technological centres has been outstanding because [Galicia has] now an automotive technological centre [with] a very strong relationship with Citroën and all the automotive industry. In information technology, we have [the centre] in Vigo. In* *the agro-seafood sector, we have another big technological centre in Vigo too, and [another] in the metal and mechanical industry"*. G2, therefore, asserted that technology centres have been a "*very important key to understand the progress of innovation [in Galicia]"* based on their relationships and links to important sectors and clusters in the region, and that the centres thereby provide *"an agent in the middle … which [is] collaborating with industry and collaborating with companies"*.

Similarly, G4 cited the "*really, really important role of the regional government … from 2003 to 2010 more or less … [to] make a great effort in the creation of technological centres"* because *"[technological centres] don't make usually basic research, but they are [working with] companies that are [not already] in the market"* [68]. G3, meanwhile, suggested that the policy to develop technology centres represented a *"clear effort [by government] to create new centres, clearly oriented to the needs of the private sector for innovation, not only for R&D, mainly focusing on the needs of the SMEs in the different sectors"*. Moreover, G3 also suggested that "*the best things that were made in the past and are now preserved are the role of some of the technology centres. Some of the technology centres have been set up and have been clearly reinforced in the period, and now they have the capacity to continue to maintain an influence. I think that was the most clear progress preserved"*.

Interview perspectives in Galicia, therefore, provide some further evidence to suggest that R&D and innovation policy, and its associated public investment, has made achievements in reinforcing the research infrastructure of the region (i.e. university research centres and technology centres) in order to contribute to wider economic and productive sector growth. Interview perspectives regarding the knowledge generation and diffusion sub-system in Puglia, however, seem to offer a less positive perspective on achievements, which points to a disconnect between universities and firms.

[68] Such comments would appear to align with the views of Faiña et al (2013), who previously suggested that technology centre competences in Galicia fit well with key productive sectors in the region, while they also echo the views of Almeida et al (2011), which point to collaborative links being developed through a number of the region's technology centres, including CETMAR (marine sector), CTAG (automotive sector) and CIS (design sector).

In this regard, both P1 and P4 commented favourably on the R&D and innovation effort of the Polytechnic University of Bari, with P1 suggesting that it *"is able to set up some laboratories that are more oriented to the final phase of product demonstration, and you probably need some [more] technical support centres that provide this kind of service [in Puglia]"*, while P4 contended that *"in the three [universities], the polytechnic university is probably the best, it is trying to do something [regarding R&D and innovation]"*. More generally, however, P1 asserted that *"[universities have been] more oriented to their main mission of research and education. This has changed, but slowly, so sometimes companies have a demand for innovation, but they don't find answers [in the universities]. They sometimes find answers that, in order to become concrete industrial innovations need too much time, because universities provide basic research, research that is good for publishing papers, but not for improving the performance of a product or for improving the performance of a process. ... So this has been a factor that has slowed down the process [of developing R&D and innovation] a bit, not having excellence in industrial research in the region"*.

Similarly, P4 also contended that *"the impact [of universities] on small and medium enterprise is very [limited], they don't understand [SMEs]"* and that *"universities don't understand innovation, very often they don't understand that innovation is mainly technology transfer. The performance of universities is based on the number of articles [published]"*. Meanwhile, according to P5, universities in Puglia *"still have to develop a way to work with the companies. ... I think that universities need to understand the third mission (e.g. collaboration with industry, and better linking of activities to socio-economic contexts) in a clear way"*[69].

This less positive perception of universities in Puglia might, of course, reflect the fact that increased public investment in R&D and innovation in the region is a more recent phenomenon than was the case in Galicia, and it can take time for the impacts of such investment to become evident. Moreover, both P1 and P2 suggested that the recent performance of universities within the regional innovation system in Puglia needs to be put in some context, on the basis that their role had been weakened by national-level

[69] In this regard, González-López et al (2014) have similarly highlighted different institutional cultures and behaviours that exist between universities and firms in Puglia, citing in particular industry perceptions that universities focus solely on basic research, teaching, and internal scientific and departmental specialisations.

funding cuts in the university sector, which coincided with the period of increased Structural Fund investment in R&D and innovation in Puglia. In this regard, for example, P1 noted that *"[you have to consider] the scarcity of funds that the universities have for hiring new researchers or trying to capitalise on investment [in existing researchers] ... . The region [government] cannot substitute [national funding], this is just a bridge for a short period of time"*. Likewise, P2 asserted that *"the role of universities in this region is weaker and weaker because of national policies. ... At the same time you are making Structural Fund expenditure to increase R&D, you are cutting [expenditure] in universities"*. Further discussion of this issue is returned to in Section 11.4 and in Section 11.5.

<u>*Interview Perspectives – Knowledge Application and Exploitation*</u>: As noted in Section 11.3.1, the evidence from the secondary data points to policy and investment outputs targeting firms in both Galicia and Puglia, e.g. in the form of funding for R&D and innovation projects in firms or funding to promote clusters or critical mass of R&D and innovation activity. However, the perspectives of interviewees might suggest that the results or impacts arising from these outputs would appear mixed, with interview perspectives displaying both positives and negatives.

On the plus side, for example, in the context of Galicia, G1 suggested that *"companies are now more aware of the necessity to really innovate, depending on the sectors, of course"*, with the automotive and seafood sectors being especially highlighted. Similarly, with regard to indigenous Galician firms, G3 pointed to Pescanova, which operates in the seafood sector, as *"one of the pillars of R&D activity in Galicia ... [and] clearly an important actor in the Galician [innovation] system"*, while also highlighting the Coren co-operative, in the agri-food sector, as being *"important in innovation in this area"*.

Nonetheless, G3 still contended that *"the largest companies [that Galicia] has are Inditex-Zara, Citroën, Repsol ... . [But] the regional involvement of these companies in R&D and innovation is very poor ... Inditex is not in a sector that is R&D intensive, but [for] the other companies the centres of decision-making and centres of R&D are outside Galicia"*. In summary, G3 thus asserted that *"[while some] large [Galician-owned] companies have some importance in the R&D and innovation system, ... foreign* *companies are less important"*. Similarly, both G2 and G4 contended that larger companies often look outside Galicia for R&D and innovation, while G4 considered that *"Galicia needs to attract really, really big companies that make R&D"*. In this regard, however, G4 also cautioned that *"[attracting big companies is] not easy because at the present moment ... in terms of R&D for big companies ... all the regions [in Spain] are competing for that. All the regions want to attract big companies ... to make R&D with companies in [their] region, with research centres, with technological centres. So there's a kind of competition, so if you are a less developed region than others, it's a difficult competition"*.

Such perspectives, therefore, might suggest that policy and investment has struggled to increase the number of large firms engaging in R&D and innovation in Galicia or to improve the R&D and innovation links of such firms with the local economy, i.e. another of the perceived weaknesses attributed to the innovation systems of regions that have been regarded as "lagging", as outlined in Chapter 8 (Table 8.1). Furthermore, the level of R&D and innovation activity among small firms in Galicia is similarly perceived by interviewees to be limited. G3, for example, asserted that *"in general, the small companies [in Galicia] are very poor in these activities [R&D and innovation]. [Galicia] has a small pool of high-tech companies that are spin-offs, these are small companies with a high profile in R&D linked to the university research groups or research institutes in universities. ... But the evolution of these companies and their real relevance in the [region] is too modest"*, i.e. too small to create a major impact. In a similar vein, moreover, G4 contended that *"in Galicia, you have, more or less, 200,000 companies. ... But you don't have more than 1,000 companies that make R&D. ... So it has been an evolution [in R&D and innovation in Galicia], but an evolution that, how can I say, only impacts in a little part of the population of companies"*.

In the context of Puglia, meanwhile, interview perspectives similarly do not give any sense that there has been a step-change in the engagement of firms in developing R&D and innovation activity in the region, with interviewee opinions on firms' engagement in R&D and innovation in the region tending to highlight instances of high-tech activity and research excellence, but only in certain sectors. For example:

- P1 highlighted *"some points of excellence in Puglia"*, e.g. firms in the microelectronics and pharmaceutical sectors;
- P2 highlighted *"some firms in more high-tech activities, ... a couple of pharmaceutical firms, ... firms in automotive and components, ... and some interesting firms in automation and software"*;
- P3 highlighted *"a number of big companies [in Puglia] in mechatronics, for example, in automotive"*.

However, Interview P1 nonetheless asserted that *"innovation is still not widespread [among firms] in the region"*, while Interview P3 contended that *"[innovation processes] are clearly not detectable in all sectors, and the successes are clearly more evident in high-tech sectors"*. Furthermore, both P1 and P2 alluded to a lack of change in the stock of firms engaging in R&D and innovation in Puglia over time. In this regard, P1 suggested that *"you can see that the enterprises that participate in innovative regional projects are always the same enterprises"*, while P2 asserted that *"the main limits of the policies in these years [the study period] was that they were not able to increase this small group of firms [in R&D and innovation]"*. Somewhat related to this, in turn, is P4's suggestion that a lot of firms in Puglia are *"[outside] the process of innovation. If you talk about e-commerce, nobody is really using e-commerce, so we [Puglia] have a lot of small companies involved in trade and services that have not been touched by innovation"*.

Lastly, in relation to firm activity, Section 11.3.1 points to the evidence from secondary data, as presented in Chapter 10, which highlights policy and investment efforts to promote clusters of firm-level R&D and innovation activity within the knowledge application and exploitation sub-systems, e.g. by means of funding to establish cluster organisations in Galicia or technological districts in Puglia. Interview perspectives on the formation of such cluster activity, in turn, have alluded to policy achievements, with G1, for example, asserting that *"clusters are really playing a role to promote R&D in their companies [in Galicia]… a quite leading role"*, especially in the automotive and seafood processing sectors. G3 and G4 similarly highlighted the importance of co-operation in the automotive and seafood sectors in Galicia, with G3 in particular pointing to the cluster of R&D and innovation activity that has developed around the presence of Citroën[70], while P3 and P5 alluded to the importance of technological districts in Puglia in promoting aggregation and collaboration for R&D and innovation in the 2007-13 period. In Galicia, moreover, the importance of links between clusters and technology centres was also emphasised by both G1 and G2, with G2 contending that if *"you have a strong cluster, and you have a very important technology centre, supported by [regional government], then you have a very strong agent"*.

Still, some interview perspectives nonetheless pointed to a lack of development of clusters as a perceived weakness in the region, i.e. as per the weaknesses attributed to "lagging" regions in Chapter 8 (Table 8.1). G4, for example, stated that *"one of the problems [in Galicia], with the exception of the automotive sector, is that the clusters in [the region] are so weak"*, while G2 contended that clusters in Galicia *"are recent creations, and they have to grow, they have to organise ... to get more experience"* and that *"the capacity of the cluster has a strong relationship with the capacity of the companies which form the cluster"*. Related to this, it is therefore notable that the technology centres in Galicia that are perceived by interviewees to be most successful (e.g. the automotive and seafood centres) are aligned to clusters or sectors that have developed or been established in the region over a long period of time.

Interview Perspectives – Collaboration: As noted in Section 11.3.1, the evidence from the secondary data also points to policy and investment efforts to address weak co-operation links between the public and private sectors in R&D and innovation, and subsequent projects involving collaborative activity between the public and private sectors. In particular, this was evident through funding provided for large volumes of projects or initiatives that promoted collaboration between firms and universities/research centres in both regions, or through the efforts to develop technology centres, TTOs or clusters and technological districts, as previously discussed. However, interview perspectives on collaboration, while acknowledging increased activity in this regard, still nonetheless allude to mixed achievements, which again highlight both positives and negatives.

[70] The perceived importance of this cluster of R&D and innovation activity is interesting, given G3's assertion that Citroën itself does not engage in substantial R&D and innovation activity in Galicia.

On the plus side, when commenting on developments in Galicia, G2 asserted that a more positive attitude towards collaboration has developed within universities, suggesting that *"[technology-oriented] companies now see the universities and technology centres as natural providers of research, providing technology innovation"*, while G3 similarly contended that *"[Galicia] has made clear progress [in terms of collaboration] in the last decades"*. At the same time, however, G3 also asserted that *"[the region] needs to make much more effort in that direction (collaboration)"* because *"the main important collaborations of the university groups are not with Galician companies but with foreign companies"*. As a result, G3 suggested that *"collaboration between research groups/institutes of research in the universities and Galician companies is still too narrow [apart from] some specific areas"*, and that the region still needed "*to connect the strongest capacity in the universities in Galicia with the sectors in Galicia"*. Likewise, G4 contended that universities are still *"quite disconnected from the companies"* in Galicia, outside of some co-operation generated within clusters, while suggesting that there are *"really good researchers in some topics in Galicia, for example in health or in the food sector ... [but] this research is not related to the needs of the companies. It is one of the problems [in Galicia], in my opinion, that you have really good researchers, but they are not working on the challenges that the economic sectors have"*.

Regarding firms, meanwhile, G2 has alluded to improved levels of collaboration among large companies and small companies in the region, while at the same time suggesting that some of this engagement might have been *"perhaps forced by the structure of the support programmes of the government, which forced collaboration in order to get funding for projects"*. G1, however, suggested that firms in Galicia are still suspicious of collaboration with universities, that *"the level of trust [of universities] by industry is not so high"*, with some exceptions, and that industry's perceived need for *"quick answers"* clashes with university researchers' ambitions to *"build your own CV"*, with the result that *"when it comes to working with companies, sometimes you feel that [universities and companies] are both going in different ways"*[71]. More generally, Interview G4 also believed that there is still *"less culture of collaboration between companies and between companies and research centres"*, akin to what is found in

[71] This echoes similar comments made by P1 in the context of Puglia.

some other Spanish regions, such as the Basque Country. As a result, G4 cited the issue of firm collaboration activity as being *"a topic that hasn't been well resolved in Galicia, and the regional government hasn't had success in this area. ... This is, in my opinion, one of the failures of the evolution of the R&D system in Galicia"*.

In Puglia, interview perspectives (P1 and P4) suggested a perception that the inclination of universities in the region remains slow to collaborate with companies, and that activity has been driven principally by the opportunity to access funding for R&D and innovation activities. P1, for example, contended that *"you have to consider the culture of the local universities. Okay it has changed over time, but their starting point was ... that all of them were not so co-operative, not so interested in co-operating with companies"*. In addition, P1 asserted that *"universities and research centres [in Puglia] in some way have been pushed by policy and by reality to go after companies in some way, and the companies have been pushed by the regional policies to look at the effect of research because it was a way to find money"*. In a similar vein, moreover, P4 also suggested that *"[collaboration by universities] is very low ... they have an opportunistic approach, when they have to get money from the region, because some bid is pushing them together with companies ... just an opportunity to leverage [money]"*.

Regarding firms, on the other hand, a prevailing culture of competition rather than collaboration among Puglian firms was alluded to by both P1 and P2. For example, P1 contended that *"the attitude that local entrepreneurs have [is] to run alone in some way. [Firms in Puglia] don't have a big culture of collaboration, of aggregating or creating alliances. [They] prefer to compete"*. Thus, P1 considered firms in Puglia to be different to firms in other parts of Italy, suggesting that *"[in] central Italy, there is more tradition of co-operatives"*, while P2 similarly stated that *"[Puglia] is not Lombardy"* in terms of the nature of firms in the region[72].

At the same time, access to funding at a time of funding scarcity (e.g. in the aftermath of global financial and economic crises) was also cited by P1, as with universities, as being a possible driver of collaboration by firms over the study period. In this respect, P1 suggested that *"[to access funding], companies were requested to start some innovation*

[72] Tendencies towards competition rather than collaboration among firms in Puglia, moreover, have also previously been cited by both Muscio (2011) and Florio et al (2014).

oriented activities in collaboration with universities or research centres. ... [So] some companies that never before accessed these type of funds were pushed to doing it. In some cases, it was instrumental or opportunistic to take some money to survive. But in other cases, this push was in any case capable of producing some benefits for the companies in the more long-term because they were able to innovate products, look at processes or maybe find some new markets".

11.3.3 Secondary Data v Interview Perspectives

- The evidence of the secondary data would suggest that governments in both Galicia and Puglia have made some progress in fostering R&D and innovation and in implementing policies to improve their regional innovation systems. In particular, the evidence alludes to further efforts in the regions to address perceived weaknesses attributed to the innovation systems of regions that have been regarded as "lagging", such as: efforts to address the perceived lower quality or quantity of scientific and technological infrastructure; attempts to provide intermediaries capable of identifying demand for R&D and innovation and matching it with sources of R&D and innovation; efforts to build more dynamic, strongly developed clusters or critical mass of R&D and innovation activity; attempts to address weak co-operation links between the public and private sectors; and efforts to encourage latent demand for innovation within firms and to address a lack of capacity in firms to identify their needs for innovation.
- Interpretation of the evidence of secondary data, therefore, points to some policy achievements, in terms of outputs, in developing the regional innovation systems in both Galicia and Puglia. However, the evidence tells us less about the results or impacts of policy, and in this regard, interview perspectives would still suggest that the development of the systems in both regions, including the connections between the sub-systems and the main elements in each part of the system, is a work-in-progress, displaying both positives and negatives.
- At the same time, interview perspectives would suggest that policy in Galicia, as the more "early adopter" of R&D and innovation policy and of Structural Fund

investment for R&D and innovation, appears to have achieved more than in Puglia over the 2000-13 period. Perspectives on the development of the regions' knowledge generation and diffusion sub-systems, for example, provide some contrasting insights, with perspectives in Galicia alluding to progress in: developing R&D and innovation infrastructures within universities and research centres; fostering increased engagement of universities in R&D and innovation activity; and developing technology centres that connect with firms and try to foster R&D and innovation activities that are aligned with industry needs. Perspectives regarding knowledge generation and diffusion in Puglia, on the other hand, seem to offer a less positive perspective on achievements, though this has to be viewed within the context of the region being a more "late adopter" of R&D and innovation policy (i.e. during the 2007-13 period) at a time that also coincided with severe global financial and economic crisis.

- In the context of the knowledge application and exploitation sub-system, however, the perspectives of interviewees in both regions might suggest that the results or impacts arising from policy outputs would appear mixed. In Galicia, for example, interview perspectives highlight perceived successes in developing R&D and innovation "clusters" within a small number of sectors, while also suggesting that policy and investment has struggled to increase the number of large firms engaging in R&D and innovation in Galicia, or to improve the R&D and innovation links of such firms with the local economy. Furthermore, the level of R&D and innovation activity among small firms in Galicia is similarly perceived by interviewees to be limited. Similarly, interview perspectives in Puglia do not give any sense that there has been a step-change in the engagement of firms in developing R&D and innovation activity in the region, with interviewee opinions on firms' engagement tending to highlight instances of high-tech activity and research excellence, and activity within a small number of "technological districts", but only in certain sectors. At the same time, interviewees did not regard innovation as being widespread among firms, also pointing to a lack of change in the stock of firms engaging in R&D and innovation over time.
- Finally, interview perspectives on collaboration, while pointing to some increased activity in this regard, still nonetheless allude to mixed achievements

in both regions, which again highlight both positives and negatives. For example, interview perspectives in Galicia suggest that universities in the region have become more engaged in collaborative R&D and innovation activity over the study period, but these perspectives also imply that the main university collaborations are not with companies operating in the region, and that research is less related to the needs of companies in the region. In Puglia, on the other hand, interview perspectives allude to the university sector continuing to be slow to collaborate with companies, while interviewees in both regions also point to a perceived lack of a culture of collaboration among firms, or any natural inclination to collaborate, despite publicly supported increases in such activity.

- In the context of this study's research objectives and the regional innovation paradox, therefore, the research might raise some questions regarding the effectiveness or appropriateness of policy interventions in the 2000-13 period, despite improvements in commonly used indicators for R&D and innovation activity, while also pointing to the (negative) impact of external forces, arising from global financial and economic crisis during the 2007-13 period.

11.4 Governance and Institutional Issues in Fostering R&D and Innovation

11.4.1 Interpretation of Secondary Data

As noted in Section 11.2.2, the evidence from the secondary data presented in Chapter 10 suggests that Structural Fund investment and the influence of the EU did not necessarily "introduce" R&D and innovation policy to Galicia and Puglia, as the genesis for an expanded policy in both regions (but especially in Galicia) appears to have pre-dated the receipt of increased Structural Fund investment, e.g. through the transfer of increased competence for R&D and innovation policy from the national government level to the regional government level.

In this regard, for example, Chapter 10 suggests that regional autonomy has played an important role in shaping R&D and innovation policy in both regions. Regional governments in Galicia, in particular, had statutory competence for R&D and innovation policy since the 1980s, following the establishment of the system of autonomous regional governments in Spain. Moreover, regional government in Galicia also used these powers to initiate statutory planning for R&D and innovation policy from the early 1990s (in advance of increased public investment over the 2000-06 period). Regional government in Puglia, on the other hand, received increased powers with respect to R&D and innovation policy in the early 2000s, and likewise took steps to develop policy in this area prior to the receipt of significantly increased public/EU investment over the 2007-13 period (e.g. through the establishment of new agencies to promote R&D and innovation, like ARTI).

Regional governments in Galicia were therefore conferred with competences in R&D and innovation policy at an earlier stage than regional governments in Puglia, and the evidence in Chapter 10 suggests that regional governments in the region actively tried to make use of these powers. This may, in turn, have possibly contributed to or facilitated Galicia's better R&D and innovation performance over the 2000-13 period, when examined against the commonly used indicators for R&D and innovation performance.

At the same time, however, the evidence from the secondary data in Chapter 10 still nonetheless points to a national government role in shaping R&D and innovation policy and investment in both Galicia and Puglia. For example, as noted previously, Faiña and López-Rodríguez (2010) pointed to the importance of national plans for R&D and innovation in Spain, which were developed on a statutory basis every four years, and which incorporated measures that were to be implemented in regions and taken account of in regional R&D and innovation plans. National legislative and policy efforts, meanwhile, appear to have been a driver of initiatives such as the establishment of TTOs within Spanish universities, including the universities in Galicia (e.g. see González-López et al, 2014). Similarly, the evidence in Chapter 10 points to national government powers and competences with respect to university education and research in Puglia (e.g. see Muscio, 2011), while alluding to the role of national policy in promoting initiatives like technological districts. Also, it is clear from Chapter 10 that public/EU investment for R&D and innovation in both Galicia and Puglia was channelled through both regional and national sources over the 2000-13 period, with EU co-financed support, in particular, being allocated through both regionally-run ROPs and nationally-run NOPs during the 2000-06 and 2007-13 Structural Fund programming periods.

Interpretation of the evidence of secondary data thus points to a perception that both regional and national autonomy, and regional and national policies for R&D and innovation, influence R&D and innovation investment and performance in Galicia and Puglia. However, while acknowledging the existence of frameworks and mechanisms that are intended to facilitate co-operation and co-ordination between the regional and national levels, the evidence of the secondary data tells us little about the interactions and synergies (or lack of) between these regional and national policies, and how this influences R&D and innovation investment and performance. In order to provide further insights on these governance and institutional issues, therefore, interview perspectives on this topic are presented in Section 11.4.2.

11.4.2 Interview Perspectives

The discussion of regional autonomy and regional governance as applied to R&D and innovation policy in Galicia and Puglia, and the respective roles of regional governments and national governments in each region, was also a theme that emerged from the research interviews. In particular, this included comment on (a) the role of regional governments and (b) the role of national governments, and the interplay between the two.

Role of Regional Government: In broad terms, the evidence from the research interviews would appear to endorse the evidence from the secondary data that points to possible advantages of regional autonomy, and the ability of autonomous regional governments to actively participate in a regional innovation system and promote R&D and innovation policy within their regions. In this regard, for example, in reference to the broader issue of regional autonomy in Galicia, G3 has asserted that "*clearly, decentralisation was very positive in order to improve the regional innovation capacity [of Galicia]*", while G4 has similarly highlighted a long-established interest among Galician regional governments in fostering R&D and innovation, going back to the establishment of autonomous regional governments in Spain in the mid-1980s[73]. G1, in turn, suggested that the concept of *"innovation as the basis to increase competitiveness is [now] present in all messages and discourses by politicians, but also in the structure*

[73] Such comments also echo the observations of Sanz-Menéndez and Cruz-Castro (2005), who pointed to the early establishment of a regional Directorate General for Research, Development and Innovation in Galicia (in 1997), which brought science policy and technology/innovation policy under a single policy domain, thereby being institutionally and administratively integrated at policy level (see Chapter 10).

of every ministry and department, [and] the presence of specific teams for innovation [has been introduced within ministries and departments]", while G2 commended regional government in Galicia for *"trying to complete the value chain of innovation from basic research to the market"* and for *"filling the blanks and ... trying to define a very structured model ... and define and clarify responsibilities"*.

Regarding the role of regional government in Puglia, meanwhile, comments likewise suggest that regional government has become increasingly committed to participating in the regional innovation system and progressing R&D and innovation policy in the region. All research interviews, for example, acknowledged a growing importance of regional government within the system, with several interviews (P1, P2, P4, P5) especially alluding to the increasing prominence of this role during the 2007-13 Structural Fund programming period. In this regard, for example, P1, asserted that *"at the level of R&D innovation, I think [Puglia] did a lot, we have a very, very good regional policy. It is appreciated also at national level, [and] we have been recognised as one region that is really innovative in policy that it is able to make available for companies and research centres"*. In addition, P2 contended that *"Puglia is interesting because [regional government] made a choice in the last 12-15 years to invest more heavily in innovation"*, while P5 suggested that *"strong [political] commitment ... has been one of the most important causes or elements in [Puglia's] change"*. Moreover, P5 contended that *"if the [importance of] innovation policies aren't in the mind of the 'boss', it is impossible to perform in a way [that follows] an innovation paradigm. ... Strong political commitment is necessary to perform innovation policy ... to perform a cultural transformation"*.

Related to this, several interviews (e.g. G1 in Galicia, or P3, P4 and P5 in Puglia) also cited the development of new agencies for R&D and innovation as being a positive manifestation of regional government's increased commitment to and role in developing the regional innovation systems during the study period. G1, in particular, described the establishment of GAIN in Galicia as being a *"result of the policy to increase innovation ... [whereby] innovation was made very specific, very visible"*, while also providing the region with *"an agency to give more visibility [to R&D and innovation] and to give more flexibility in implementing programmes"*. In the context of Puglia, meanwhile, both P3 and P4 alluded that ARTI has played a positive role in trying to build connections between actors in the regional innovation system through *"assessment of universities and research centres in terms of availability to co-operate with SMEs"* (P3), *"[improving] entrepreneurial discovery in universities through start-ups, spin-offs"* (P3) or establishing *"connections to the university system"* (P4). Similarly, P5 contended that *"the mission of ARTI is to create not only an innovation culture but also the regional innovation system because one of the most important weaknesses of [innovation in] our region is the fragmentation of the system"*. In the opinion of P5, therefore, ARTI provides *"the capacity of the regional authority to understand the assets of the region, the gaps"* because *"ARTI is in the territory, is near the start-ups, the research centres, the industrial associations"*[74].

A slight caveat to the interview perspectives on regional institutions, however, is that not all comment on the governance arrangements for R&D and innovation in Puglia were positive, with some interviewees pointing to a lack of clarity regarding respective agencies' roles. For example:

- P2 alluded to a lack of clarity in the core role of InnovaPuglia (which implements support programmes to foster R&D and innovation in universities and firms, but which also manages the ICT needs of the wider Puglian regional administration), while suggesting that ARTI could be given a more substantial role in shaping and implementing R&D and innovation policy in the region;
- P4, in a similar vein, cited overlap between agencies as being a problem, with a lack of clarity on responsibilities and a lack of a systematic approach across agencies.

[74] Such comments, therefore, appear to support the views of other commentators regarding ARTI, which have similarly highlighted a contribution by the agency in trying to: better align university research and industrial innovation and develop technology transfer mechanisms across the university sector through the ILOs (Florio et al, 2014, González-López et al, 2014, Grigolini et al, 2015); better incorporate local knowledge and context into specific interventions or measures, so as to better fit with enterprise needs (Florio et al, 2014); and support technological districts that stimulate dialogue between stakeholders and beneficiaries, co-ordinate partnership between stakeholders in the districts, and foster their ongoing involvement in the management of districts (Grigolini et al, 2015).

Furthermore, another interesting caveat to emerge from the interviews was the varying extent to which the nature of different regional governments, or changes in regional government, have been perceived to shape regional R&D and innovation policy. In the context of Galicia, for example, G3 contended that *"the evolution of each region [in Spain] depends on the capacity of its own government to design a clear strategy to develop the region and the regional innovation and R&D system"*, with the likes of the Basque Country, Navarre and Catalonia being cited as good examples. In this regard, however, G3 also expressed an opinion that *"elections [in Galicia] favour conservative governments, with an idea to not valorise the autonomy … they don't appreciate, don't defend or make the most of the autonomy capacity [with regard to R&D and innovation]"*. To illustrate this, G3 also made a clear distinction between the regional government that was in office in Galicia between 2005 and 2009, and the regional governments that both preceded and followed it. According to G3, therefore, regional governments from the 1980s up to 2005 were quite conservative and traditional, they were *"too modest in ambition"* and there was no *"strategic agenda to modernise sectors, to push new sectors, to push new agents, to push new companies"*. In contrast to this, the government that took office between 2005 and 2009 was perceived by G3 to be more proactive in trying to foster R&D and innovation, by adopting *"a clear focus on the renewal of the productive system and on putting R&D policy and innovation policy at the core of its strategy"*, whereas a further change of regional government in 2009 was perceived as reverting to a more *"traditional position about industrial policy, innovation policy and R&D policy, to reduce the role [of R&D and innovation policy]"*.

Similar opinions, moreover, were also reflected in the comments of P4 in the context of Puglia, which asserted that *"to [explain] the framework or political scenario, the big change [that occurred] was [the coming to power of] the new left-wing government … the political change from right-wing to left-wing in 2005. … This change was probably the big change in terms of change of [R&D and innovation] strategy [in Puglia]"*. At the same time, however, G4 also points to an alternative perspective on this issue, suggesting that regional government *"stability"* in Galicia, arising from the electoral dominance of one party, helped to sustain an impetus to promote policies that foster R&D and innovation *"because you are making decisions for the mid-term, for the long-term"*.

Role of National Government: The evidence from secondary data, as outlined in Chapter 10, would appear to point to an R&D and innovation policy landscape that requires co-operation and co-ordination between the regional and national government levels in both Galicia and Puglia. Interview perspectives regarding the role of national government in the regions, however, suggest a perceived tension or disconnect between the regional and national levels rather than an effective co-operation or co-ordination between the two.

In this regard, for example, G1 described the national government role in fostering R&D and innovation in Galicia as being *"very limited, not visible, and as far as I've seen so far not very positive"*, while also suggesting that national government *"shapes policies and programmes, which don't really suit the needs of the region or the type of companies [in the region] more exactly"*. G3, in turn, similarly questioned the appropriateness of national policy in a Galician context, asserting that the region *"has not had special support or clear strategy from the central government that could benefit Galician industry ... because the strategy of the central government was mainly focused on activities and territories around the capital (Madrid) and the sectors linked to the industrial structure of Madrid"*, while G4 argued that the national government perception of Galicia was that it *"wasn't an R&D region"*, and that large-scale R&D and innovation investments were more typically targeted at regions such as Madrid or Catalonia.

Furthermore, interview perspectives have similarly alluded to a perceived lack of coherence and collaboration between regional government and national government in determining R&D and innovation policy for Galicia. G1, for instance, asserted that there is *"ongoing struggle between Galicia and the central government"* because *"[Galicia's] economy is very different to the rest of Spain ... and that is always a conflict"*, while also contending that *"[regional government] wants to co-ordinate much more, but [national government] doesn't want to co-ordinate so much"*. Similarly, G3 suggested that *"in general, the co-operation between the central government and the regions is weak because there is not a culture [of co-operation], a clear will in general from the central government to negotiate and to make a co-operative approach with regions"*, with national government instead being described as preferring to *"decide and to make its own programmes, and to try to implement that within the regions, or ask the regions to adhere to the central plan"*[75].

Moreover, interview opinions on the role of national government in Puglia elicited similar views regarding the national role in fostering R&D and innovation in the region, with some interviews again pointing to a disconnect between national policies and regional needs. P1, for example, highlighted the allocation of Structural Fund investment in Puglia between regional programmes and national programmes, and contended that *"basic choices are made [for national programmes] at national level, sometimes not taking into consideration the real needs of the regions in the south"*. Similarly, P4 didn't have *"any perception of national policy [taking account of Puglia]"*, while suggesting that "*on the national level, the policies are only [focused] on universities because the universities are managed by central policies*". In addition, perceived lack of coherence and collaboration between regional government and national government in determining R&D and innovation policy for the region was again highlighted, with P1 asserting that *"there is a continuous fight between the central level and the regional level, and not always is there integration"* and P4 suggesting that *"a systematic approach ... [whereby] national strategy would dedicate efforts on universities, education and large companies, and regions would dedicate their efforts on small and medium enterprise ... is not defined"*. P5, meanwhile, similarly pointed to a lack of synergy between national policy and regional policy, citing changes in national policy regarding technological districts as an example[76].

[75] Such comments, moreover, appear to support previous observations made regarding the national government role in Galicia and other Spanish lagging regions. These include: the observations of Faiña et al (2013), which noted the significant funding role played by national programmes in Galicia, alongside the local regional programmes, but also the potential room for improvement in terms of coherence between R&D and innovation measures in both national and regional programmes; and the views of Faiña and López-Rodríguez (2010), which contended that national Structural Fund programmes in Spain, while mainly targeted at less favoured or lagging regions, allocated a large concentration of support for ambitious and high profile projects promoting business R&D, even though much of the entrepreneurial fabric in such regions still required measures to stimulate demand for such projects.

[76] In this regard, both Muscio (2011) and Ciffolilli (2010) have suggested that separation of R&D and innovation competences between national and regional authorities in Italy can be blurred, which can lead to duplication and sub-optimal co-ordination, while Interview P1 similarly suggested that division of competences between national and regional governments might be more clear *"on paper"* than in practice.

11.4.3 Secondary Data v Interview Perspectives

- As noted in Section 11.2, the evidence from the secondary data suggests that Structural Fund investment and the influence of the EU did not necessarily "introduce" R&D and innovation policy to Galicia and Puglia, as the genesis for an expanded policy in both regions, but especially in Galicia, appears to have pre-dated the receipt of increased Structural Fund investment, e.g. through the transfer of increased competence for R&D and innovation policy from the national government level to the regional government level. In this regard, therefore, the evidence suggests that regional autonomy has played an important role in shaping R&D and innovation policy in both regions.
- At the same time, however, the evidence from the secondary data also nonetheless points to a national government role in shaping R&D and innovation policy and investment in both Galicia and Puglia, and this was evident during the study period through the application of national plans for R&D and innovation within regions, through the importance of initiatives that were initiated by national legislative or policy efforts, through national government powers and competences with respect to university education and research, and through public funding channels that combined both regional and national sources over the 2000-13 period.
- Interpretation of the evidence of secondary data thus points to a perception that both regional and national autonomy, and regional and national policies for R&D and innovation, influenced R&D and innovation investment and performance in Galicia and Puglia over the 2000-13 period, while telling us less about the interactions and synergies (or lack of) between these regional and national policies, and how this might influence R&D and innovation investment and performance.
- In this regard, therefore, evidence from the research interviews would appear to endorse the evidence from the secondary data in pointing to the importance of regional autonomy, and the ability of autonomous regional governments to actively participate in a regional innovation system and promote R&D and innovation policy within their regions, while also alluding to the varying extent

to which the nature of different regional governments, or changes in regional government, have been perceived to shape regional R&D and innovation policy.

- Interview perspectives regarding the role of national government in the regions, however, suggest a perceived tension or disconnect between the regional and national levels rather than an effective co-operation or co-ordination between the two, and a perceived lack of coherence and collaboration between regional government and national government in determining R&D and innovation policy, alongside some disconnect between national policies and regional needs, e.g. the formulation and implementation of policies that may not have taken full account of the R&D and innovation needs of the regions.
- In the context of the research objectives and the regional innovation paradox, therefore, this again raises questions about the nature of regions' exposure to outside influences, in the governance and institutional sense, and how these influences can shape policy and performance.

11.5 Other Factors Affecting Development of R&D and Innovation

11.5.1 Interpretation of Secondary Data

Finally, alongside the perceived weaknesses that have already been highlighted earlier, Chapter 8 (Table 8.1) points to further perceived weaknesses attributed to the innovation systems of regions that have been regarded as "lagging", such as:

- specialisation in "traditional" sectors, with little inclination for innovation;
- predominance of small firms with weak links to international markets;
- lack of an entrepreneurial culture prone to inter-firm co-operation.

In this regard, Chapter 9 (Section 9.2.6 and Section 9.4.6) has previously provided an overview of the key sectors and enterprise base in Galicia and Puglia, with the discussion in both cases highlighting (a) sectoral specialisation in sectors like agriculture, the automotive sector, fisheries, natural resources, shipbuilding and textiles and (b) the relatively small size of the average firm in each region, in terms of numbers employed.

In Galicia, for example, the evidence suggests that the sectoral share of agriculture in the region, though declining, remains above Spanish and EU-15 averages, while the region also has a higher than average level of activity (relative to all of Spain) in the automotive, fisheries, shipbuilding, textiles and timber sectors, among others. Similarly, the sectoral share of agriculture in Puglia remains higher than the Italian and EU-15 averages, despite a fall in share over time, while other sectors that account for higher than average levels of activity in the region (relative to all of Italy) include the automotive, food, furniture, metallurgy and textiles sectors. In addition, the evidence of the secondary data has shown that about 97% of enterprises in Galicia have less than 10 employees, whereas the equivalent figure for all of Spain is 96%, and for the EU-15 it is 94% (based on 2016 estimates). In Puglia, meanwhile, the evidence also shows that 97% of enterprises in the region have less than 10 employees, whereas the equivalent figure for all of Italy is 96%.

Moreover, the evidence for innovation performance in Galicia and Puglia, when assessed against commonly used indicators for R&D and innovation (as per Chapter 9), still suggests that the performance of both regions has continued to lag national and EU-15 averages, despite the growth recorded over the 2000-13 period. Underlying this, of course, was the low base level of R&D and innovation activity that was evident in both regions prior to the increases in investment and activity recorded over the 2000-13 period, based on the indicators used.

Interpretation of the secondary data, therefore, might suggest that the nature of sectoral specialisation in Galicia and Puglia, and the preponderance of small firms, are indeed to some extent limiting factors in both regions' ability to foster R&D and innovation activities. At the same time, however, the evidence also points to the likely negative impact of the global financial and economic crisis on R&D and innovation performance, as the reduced R&D and innovation growth trends over the 2007-13 period coincided with the onset of that crisis, which occurred in 2008-09. In particular, increases in EU Structural Fund investment in R&D and innovation in both Galicia and Puglia coincided with these negative external developments in each region's wider socio-economic and cultural setting, which is likely to have affected the impact of this public investment over the period.

In order to provide further insights on these issues, interview perspectives on this topic are presented in Section 11.5.2.

11.5.2 Interview Perspectives

The discussion of these factors was also a theme that emerged from the research interviews, and in broad terms, interview perspectives would appear to endorse a view that structural factors such as firm size, the nature of firms' productive specialisation and the impact of wider socio-economic developments are to some extent limiting factors in developing R&D and innovation in both Galicia and Puglia. At the same time, however, interview perspectives do not discount the potential to at least partially overcome such barriers or obstacles, and this is reflected in interview perspectives that allude to potential policy lessons learned from the experience of the 2000-13 period.

Structural Factors: Interview perspectives on the nature of firm size, for instance, convey a perception among some interviewees (e.g. G2, G4, P1, P2) that firm size hinders the development of R&D and innovation, due to factors such as a lack of human resources or financial resources, while interviewees at the same time suggested that firm size is an issue for many Spanish or Italian regions, not just Galicia or Puglia.

In the context of Puglia, therefore, P1 suggested that *"there are also some structural problems like undercapitalisation, too small dimension (i.e. size of firms). ... a situation that is common in Italy and in [Puglia]"*, while P2 implied that diffusion of technological innovation in SMEs was evident in some firms with 50-100 employees, but that diffusion of innovation was still challenging, even for firms of that size[77].

In the context of Galicia, meanwhile, G2 contended that *"[Galicia] has a common problem, which it shares with the rest of Spain, which is the [small] size of the companies. A challenge [for Galicia] is how we can engage the little companies in innovation"*. Similarly, G4 asserted that *"a big problem is the really, really small size of*

[77] Such views, in turn, echo views expressed in other studies, reports and strategies, which have highlighted weaknesses attributable to such firms, and challenges to their ability to develop innovation activity, such as: existence of only a small technological base, with little capacity for absorbing and exploiting knowledge, and thereby little capacity for fostering innovation (Faiña et al, 2013, Xunta de Galicia, 2014); and limited financial resources and inability to dedicate specialised budgets or specialised resources for knowledge absorption or exploitation, which hinders ability to conduct research or to foster technological product and process innovations (Florio et al, 2014, Xunta de Galicia, 2014).

the companies [in Galicia]. In Galicia, most of the companies are not small companies, they are micro companies, with one person, two people, three people, no more than that".

However, another perceived "structural" issue regarding enterprise's engagement in R&D and innovation, which was highlighted in the interviews, was the culture of firms in Galicia and Puglia more generally, with the dependence on "traditional", mature sectors in some way being associated with a traditional culture for doing business in each region.

In particular, several interviewees pointed to companies' approach to doing business as being an impediment to fostering innovation, with G1 suggesting that firms in Galicia *"have always been very traditional … and [firms in Galicia] still look at some sectors in a very traditional way. … Not so much attention is put on R&D [by companies], [the focus] is producing and selling, producing and selling, producing and selling"*. G3, on the other hand, asserted that *"the kind of human resources [sought by] companies in [Galicia] is focused on people with low educational levels, the companies are not focused on innovation and incorporating people with higher qualifications, but mainly focused on low price"*, while G4 contended that firms in Galicia *"are not so convinced that research and development is a critical investment [for] the company"*. As with G1, therefore, G4 also alluded that *"the private sector [in Galicia] is more focused on selling, on producing …"*, while G3 believed that *"the productive specialisation of Galicia is not strong in high-tech sectors, [and] this is the main factor to [explain] the real evolution of R&D activities and innovation capacity"* [78].

Likewise, in the context of Puglia, P3 suggested that *"[Puglia has] to work very hard to enlarge the base of enterprises that are able to use innovation"*, while citing the case of the agri-food sector as being *"too much of a traditional sector"*, where it is *"hard to change the behaviour of agri-food entrepreneurs"*. P1, on the other hand, contended that *"[Puglia doesn't] have a long tradition, a strong tradition of investing in innovation, or of risk investments in innovative, high-tech, risky behaviours"*, while P4,

[78] Such comments, therefore, also align with the observations of Faiña et al (2013), who have previously noted a lack of innovation culture in Galician firms, and little tradition of external collaboration, as being potential impediments to companies' ability to overcome size and technology limitations.

as noted previously, suggested that the vast majority of firms in Puglia are simply not *"touched by innovation"*[79].

At the same time, however, while attributing some influence to these perceived structural factors, several research interviews also highlighted the perceived impact of the wider socio-economic and cultural setting in each region, via the impact of the global financial and economic crisis of 2008-09 in reducing policy emphasis on R&D and innovation in both regions. In the case of Galicia, for example, G3 suggested that the post-crisis period led regional government to *"reduce the role [of R&D and innovation policy] ... in that activity and resources were suddenly reduced"*[80]. Similarly, in the context of Puglia, P2 contended that *"you can find a much weaker effect of Structural Funds on R&D because of ... this very strong exogenous shock"* arising from financial and economic crisis, while P4 asserted that *"the [post-crisis] strategy [that] was then dedicated to support 'innovation' [was] in reality not just for innovation but also to maintain employment levels"*. Such comments, therefore, align with the views of Grigolini et al (2015), which pointed to deviations from strategy in Puglia during the 2007-13 period, and especially changes in strategy that were designed to safeguard employment in the region, as a reaction to the impact of financial and economic crisis.

Related to this, and as earlier noted in Section 11.3.2, some interviewees have highlighted the perceived negative impacts of cuts in university funding and staffing on R&D and innovation capacity in Puglia, which were imposed at a national government level as a response to global financial and economic crisis. In this regard, to recap, P1 referred to a *"scarcity of funds that the universities have for hiring new researchers or trying to capitalise on investment"*, and to regional government efforts to provide a *"substitute"* or *"bridge"* for funding cuts, while P2 contended that *"the role of universities [in R&D and innovation] in [Puglia] is weaker and weaker because of*

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[79] See Section 12.3.2. The views put forward by P4, in turn, in some way echo the views put forward by Muscio (2011), who has previously pointed to a lack of awareness of potential innovation needs among small firms operating in traditional sectors in Puglia.

[80] In this regard, it is notable that financial resources at the commencement of the fourth Galician Plan for Research, Innovation and Growth 2011-15 were only confirmed for the first year (Xunta de Galicia, 2010, 2014).

national policies", which cut university expenditure at the same time that Structural Fund expenditure was being increased[81].

Policy Lessons: As noted in the previous discussion, interview perspectives would appear to endorse a view that structural factors such as firm size, the nature of firms' productive specialisation and the impact of wider socio-economic developments are to some extent limiting factors in developing R&D and innovation in both Galicia and Puglia. At the same time, however, other comments (e.g. G2, P1) would nonetheless suggest that interviewees did not discount the potential for generating greater diffusion of innovation to small firms or to firms in sectors that are not perceived to be innovative. As noted earlier, for example, G2 suggested that a *"challenge [for Galicia] is how [the region] can engage the little companies in innovation"*, while P1 also implied that a preponderance of very small firms in Puglia is not necessarily an impediment for developing non-technological forms of innovation (e.g. organisational or marketing innovation), even if it is perceived as an impediment for developing technological forms of innovation.

Such perspectives, moreover, are further evident in interview perspectives on wider policy challenges for engaging enterprise in innovation, both in Puglia and in Galicia. Opinions in the context of Puglia, for example, P1 asserted that the development of R&D and innovation policy in the region adopted a *"policy-push"* approach in the period under review, whereby it followed *"an economic theory that innovation is useful"*, but which was *"concentrated more on high-tech sectors"*. However, P1 also contended that policy in the region now *"need[s] to be more oriented to demand in some way"*, that this demand *"can be explicit or it can be hidden, non-explicit"*, and that policy could *"do more for the traditional sectors and for non-technological innovation"* with *"different policy instruments"* to promote innovation in areas such as design, organisational processes, marketing or branding. Similarly, P4 suggested that Puglia is *"still waiting for a good [innovation] strategy for small and medium enterprise"*, or a more *"interesting"* policy, which *"define[s] the innovation needs in these companies"* and explores *"what is innovation in small and medium enterprise"*,

[81] See Section 11.3.2.

though P5, in contrast, contended that R&D and innovation policy's scope to have a *"total role"* or "*total impact"* in smaller enterprises may be limited.

In the context of Galicia, meanwhile, G1 suggested that national government *"shapes policies and programmes, which don't really suit the needs of [Galicia] or the type of companies [in the region]"*, and within which *"very clearly just large companies would benefit the most, or very technological companies"*. G2 similarly suggested that a recent focus on larger co-ordinated or collaborative projects has potentially excluded "*a lot of little projects that could perhaps be useful for a little company"*. G4, on the other hand, while suggesting that *"the pattern [of investment] has been logical, first the universities, technological centres, then trying to attract innovation in the companies"*, nonetheless asserted that it had taken a long time to get to a stage where engagement with enterprise became a policy focus, and that efforts to foster such engagement could have been initiated earlier.

Related to these policy perspectives, moreover, are other less positive perspectives on the policy influence of the EU in Galicia and Puglia. In the context of Galicia, for example, G3 contended that a lot of the region's investment in R&D and innovation has been focused on infrastructure, *"reinforced by the Brussels (i.e. EU) strategy and by the strategy of the Galician government"*, but that it *"lost the opportunity"* to make *"enough utilisation of the funds to reinforce the R&D capacity of this infrastructure"*. Or, in other words, G3 has suggested that policy initiatives *"created the physical infrastructure, but [they] didn't implement the human resources [needed] to put the activities of this infrastructure at an efficient level"*. In the opinion of G3, therefore, more effort could have been made to develop human capital in ways that complemented the development of infrastructures, so as to better reinforce the capacity available in the new R&D centres, R&D institutes and R&D infrastructures that were created with EU support.

Related to this, in the context of Puglia, P1 suggested that *"general innovation policies promoted by the European Union in a way come from thinking that originated in more developed countries/regions"*, which is *"more oriented to technology, more oriented to high value added sectors"* and which is *"sometimes lacking some critical sense"* of how the baseline situation in lagging regions like Puglia differs from more advanced economy regions. Similarly, P2 asserted that *"one of the problems with the European policies is that they think that all the regions are the same, so you can replicate the same policy framework"*, while P4 also suggested that policy direction from within the EU is too much influenced by *"a small and medium enterprise size model, mechanism or methodology based on Central or Northern Europe"*, which can result in *"a strategy that will not correctly influence local [needs]"*.

11.5.3 Secondary Data v Interview Perspectives

- Interpretation of the secondary data might suggest that the nature of sectoral specialisation in Galicia and Puglia, and the preponderance of small firms, are to some extent limiting factors in both regions' ability to foster R&D and innovation activities. At the same time, as noted earlier, the evidence also points to each region's exposure to external forces, through the likely negative impact of the global financial and economic crisis on R&D and innovation performance, as the reduced R&D and innovation growth trends over the 2007-13 period coincided with the onset of that crisis, which occurred in 2008-09. In particular, increases in EU Structural Fund investment in R&D and innovation in both Galicia and Puglia coincided with these negative external developments in each region's wider socio-economic and cultural setting, which is likely to have affected the impact of this public investment over the period.
- Interview perspectives, moreover, would also appear to endorse a view that structural factors such as firm size (e.g. with limited human and financial resources), the nature of firms' productive specialisation (and the culture of such firms) and the impact of wider socio-economic developments (e.g. the impact of the global financial and economic crisis) are to some extent limiting factors in developing R&D and innovation in both Galicia and Puglia. At the same time, however, interview perspectives do not discount the potential to at least partially overcome such barriers or obstacles, and this is reflected in interview perspectives that shed some light on potential policy lessons learned from the experience of the 2000-13 period.
- In this regard, for example, interview perspectives suggest that the nature of the

policy interventions pursued over the study period appears to have been very R&D and technology oriented, while implying that the nature of many of the firms in the regions might suggest that more focus on non-R&D policy interventions would also be appropriate. Moreover, interview perspectives suggest that policy initiatives might have been somewhat guided by an EU influence that emphasised R&D and technology oriented policies, which were drawn from a more developed economy perspective that takes less account of the development context in lagging regions, while also suggesting that greater policy efforts could possibly have been targeted at fostering firms' understanding of and interest in engaging in innovation, whether R&D or non-R&D based, alongside efforts to better understand and create appetite for collaboration between actors in the regional innovation system (e.g. universities, research centres, firms).

- In the context of the research objectives and the regional innovation paradox, therefore, the research might again raise some questions regarding the appropriateness of policy interventions in the 2000-13 period, in the context of regional needs and capabilities.

11.6 Chapter Summary

In the context of this study's research objectives and the regional innovation paradox, the chapter suggests that national and regional governments in both regions demonstrated a capability to invest in R&D and innovation during the 2000-13 period, with the help of EU Structural Fund support, and thereby take steps to address perceived low levels of public assistance for innovation. In this regard, public policy developments (and the EU financial support that was associated with these developments) would thus appear to have had a positive effect in generating increased public investment in R&D and innovation during the period, thereby suggesting that regions that are perceived to be "lagging" can indeed direct funds towards investment in R&D and innovation, when they are made available.

At the same time, however, the research raises some questions regarding the effectiveness or appropriateness of policy interventions in the 2000-13 period, despite improvements in commonly used indicators for R&D and innovation activity, while also pointing to the (negative) impact of external forces, arising from global financial and economic crisis during the 2007-13 period. It provides contrasting insights on the development of university and research centre capability, for example, with more positive progress noted in Galicia than in Puglia. Yet, perceptions regarding firm engagement in R&D and innovation in both regions are mixed, highlighting a still limited pool of innovative firms, a lack of large firms to drive R&D and innovation in the regions, and poor links to the local economy among those incumbent large firms that do engage in R&D and innovation. In addition, perspectives on collaboration between universities/research centres and firms are also mixed (with the possible exception of links between technology centres and firms in Galicia), pointing to a general need to continue to develop a “culture” of collaboration between actors in the regional innovation systems.

Admittedly, both the evidence from secondary data and interview perspectives would appear to endorse a view that structural factors such as firm size and the nature of firms’ productive specialisation are limiting factors in developing R&D and innovation in Galicia and Puglia. However, interview perspectives would also suggest that the nature of the policy interventions pursued over the study period appears to have been very R&D and technology oriented, while implying that the nature of many of the firms in the regions might suggest that more focus on non-R&D policy interventions would also be appropriate.

This perception, in turn, points to possible conflicts in the governance of policy for R&D and innovation in both regions, and its mix of regional and national policy competences. In this regard, the findings of the research suggest a perceived tension or disconnect between the regional and national levels rather than an effective co-operation or co-ordination between the two, and a perceived lack of coherence and collaboration between regional government and national government in determining R&D and innovation policy, alongside some disconnect between national policies and regional needs. This, together with a perceived EU influence to emphasise R&D and technology oriented policies, might point to the influence of a more developed economy perspective, which takes less account of the development context in lagging regions.

PART D – DISCUSSION AND CONCLUSION

CHAPTER 12 – DISCUSSION

12.1 Introduction

The purpose of this chapter is to discuss the thesis findings, and in doing so place the analysis and interpretation of the data gathered in the earlier chapters (in particular, Chapters 6-7 and Chapters 9-11) within the context of the literature on innovation systems and spatial innovation perspectives (see Chapter 4, Section 4.3 and Section 4.4), but especially the literature on regional innovation systems (see Chapter 4, Section 4.5).

To do this, it is firstly important to again remind the reader of the core purpose of the research. In particular, as noted in Chapter 1 (Section 1.2), Chapter 5 (Section 5.3) and Chapter 8 (Section 8.2), the research has been inspired by the Oughton et al (2002) description of a "regional innovation paradox", i.e.:

> *"... the apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities, compared to more advanced regions" (Oughton et al, 2002, p. 98).*

Or put another way, the more that innovation is needed in lagging regions in order to improve competitiveness, the more difficult it is to invest effectively in R&D in such regions, and the more likely it is that such regions will be seen to under-invest in R&D and innovation (Oughton et al, 2002).

Furthermore, the research has also been influenced by the Oughton et al (2002) assertion that the main cause of the regional innovation paradox lay in the fragmented nature of "regional innovation systems" in lagging regions, and the institutional characteristics of such regions, rather than the availability of public funds (see Chapter 1, Section 1.2). In this regard, the proponents of the paradox thus perceived an inability to absorb public funds for R&D and innovation in lagging regions – and thereby exploit perceived economies and advantages at a regional level – to be due to both insufficient capacity for R&D and innovation among public and private actors in such regional systems (e.g. universities, research institutions/centres, firms, government) and a lack of interaction and co-operation between the different actors in those systems.

These perspectives regarding a regional innovation paradox and regional innovation systems have led this researcher, therefore, to seek to address the following research question:

> *How has public policy towards and public investment in regional innovation systems contributed to R&D and innovation performance in lagging regional economies?*

In addition, there are a number of research objectives that are underlying the research question, which are to:

- *examine how investment in R&D and innovation in lagging regions, and outputs attributed to R&D and innovation in such regions, have changed over time;*
- *explore public policy and public investment interventions that have been used to promote the development of regional innovation systems in lagging regions;*
- *understand the elements that constitute regional innovation systems in lagging regions, and the extent to which such systems have developed over time;*
- *examine how lagging regions address their region-specific characteristics when developing policies to promote regional innovation systems;*
- *examine how interaction with other spatial levels (e.g. national, EU) influences the development of policies to promote regional innovation systems in lagging regions.*

The next section in this chapter presents the over-arching discussion of research findings and learnings in the context of the research question and objectives. Thereafter, the analysis and interpretation of the key findings that underpin this discussion are placed within the context of the related research literature, before the chapter closes with a summary of key conclusions.

12.2 Public Policy in "Lagging" Regional Innovation Systems: A Discussion

As noted previously in both the current chapter and in earlier chapters, this research has been inspired by the Oughton et al (2002) description of a regional innovation paradox, which suggests that so-called "lagging" regions tend to under-invest in R&D and innovation, or not invest effectively in such activities, despite a perceived need to foster more innovation in such regions in order to improve competitiveness. Allied to this, it has drawn on the Oughton et al (2002) assertion that the main cause of this paradox lies in the fragmented nature of regional innovation systems in lagging regions, rather than the availability of public funds per se, which in turn has led the researcher to investigate:

> *"how public policy towards and public investment in regional innovation systems has contributed to R&D and innovation performance in lagging regional economies".*

In addressing this research question, in particular, the research has especially highlighted the complexity of the perceived problems that underpin the description of the paradox, and some of the nuances that might determine whether and how efforts to address under-investment in R&D and innovation in lagging regions also deliver effective investment in R&D and innovation in those regions.

In the opinion of this researcher, for example, the research suggests that public authorities in lagging regions can indeed develop policies and use public funding to promote the development of regional innovation systems in their regions, and in doing so help to increase investment in and outputs from R&D and innovation activity in these regions. This is evident in the policy ambition demonstrated by the combination of regional governments and national governments in the case study regions (i.e. Galicia and Puglia), which sought to build R&D and innovation capacity on both the supply side (e.g. universities, research centres) and the demand side (e.g. firms), while at the same time seeking to foster increased collaboration and networking between the two. It is also evident in the absorption of EU Structural Fund resources for R&D and innovation investment purposes, which could be seen in lagging regions in both the 2000-06 period and, to a lesser extent, the 2007-13 period. And it is evident in the wider growth in R&D and innovation "inputs" and "outputs" across lagging regions during the 2000-13 period, including growth in R&D expenditure, R&D personnel, patent applications and (to a somewhat lesser extent) employment in related sectors.

The research thus suggests that regional governments and national governments can make progress in tackling some of the perceived structural weaknesses affecting regional innovation systems in lagging regions, as highlighted in the Oughton et al (2002) description of the regional innovation paradox, and repeated in Chapter 8 (Section 8.3, Table 8.1). For a start, policy makers in lagging regions have clearly sought to address "low levels of public assistance for innovation" (Oughton et al, 2002, Table III, p. 103) by providing increased public funding for innovation, which has subsequently been absorbed for investment for R&D and innovation purposes. In the case study regions, this funding has in turn helped to improve the "quality and quantity of scientific and technological infrastructure" and promote the development of "technological intermediaries" that strive to identify "local business demand for innovation" and "channel it towards regional/national/international sources of innovation" (Oughton et al, 2002, Table III, p. 103).

However, this researcher also believes that the progress made in developing regional innovation systems in lagging regions has not been consistent across the different "sub-systems" of regional innovation, as described by Tödtling and Trippl (2005), while the innovation systems in these regions remain to some degree "fragmented", as defined by Oughton et al (2002). So, the most tangible evidence of progress or success in developing innovation systems in the case study regions has tended to be found within their knowledge generation and diffusion sub-systems (e.g. universities, research centres), and in "bricks and mortar"-type developments like scientific and technological infrastructures and related projects, whereas progress in developing the scale of their knowledge application and exploitation sub-systems (e.g. firms) has appeared less impressive, outside of a few "clusters", with the extent of collaboration and interaction between the sub-systems still pointing to "[relatively] weak co-operation links between public and private sectors" (Oughton et al, 2002, Table III, p. 103).

On the firm side, the evidence of the research similarly points to "[continued] sectoral specialisation in traditional industries" in regions "with little inclination for innovation", "[relatively] few large firms (multinationals) undertaking R&D, with poor links to the local economy", a "[lack of] capacity of firms to identify their needs for innovation", a "lack of structured expression of latent demand for innovation" or a "lack of an entrepreneurial culture that is prone to inter-firm co-operation" (Oughton et al, 2002, Table III, p. 103). In this regard, the findings of the case study research thus lead this researcher to question the extent to which regional innovation policy in lagging regions, and the application of a regional innovation systems approach to policy making, has taken proper account of the perceived "lagging" nature in such regions (e.g. in terms of size, geography, economy etc) and their existing capabilities, while at the same time over-emphasising an approach to regional innovation policy making that adopts a more "developed economy" perspective.

At the same time, it is the opinion of this researcher that lagging regions' interaction and inter-dependence with other spatial levels (e.g. national, continental, global) must significantly influence R&D and innovation activity in these regions, which in turn cautions against making over-exaggerated assumptions about strategic, internal cohesiveness or endogeneity in such regions. Firstly, such inter-dependence appears implicit both in (a) the R&D and innovation growth trends and (b) the more general socio-economic and human capital growth trends that have been presented in this research (i.e. the comparative growth trends that were evident between Galicia and Puglia, and indeed between Spanish lagging regions and Italian lagging regions more generally, and how these have broadly mirrored comparative national trends between Spain and Italy). Secondly, this inter-dependence appears implicit in lagging regions' more patchy growth in R&D and innovation activity in the 2007-13 period, which coincided with the global financial and economic crisis that emerged in 2008-09, and which affected both national and regional economies. And thirdly, inter-dependence appears evident in the collaborations that regional universities, research institutions and firms in lagging regions have with other actors located outside their regions, both nationally and internationally.

However, lagging regions' interaction and inter-dependence with other spatial levels is also very clearly displayed in the policy arena, in the form of the shared policy competences for R&D and innovation that exist between regional authorities and national authorities in Galicia and Puglia (and indeed between regional authorities and national authorities in other Spanish and Italian lagging regions), alongside the influence of EU policy tools and practices (as well as funding) with respect to R&D and innovation. In this regard, the evidence from this research points to perceived tensions or disconnect between the different authorities at different spatial levels, or perceptions of a lack of effective co-operation or co-ordination between the levels, which implies that any "blame" for policy weaknesses cannot rest solely with the regions themselves.

Finally, irrespective of either the strengths or weaknesses of efforts to improve R&D and innovation performance in lagging regions, it appears clear to this researcher that promoting structural change to engender R&D and innovation in such regions is a long-run game. In illustrating this, the research in the two case regions has suggested that Galicia was (a) the more "early adopter" of policies and investment in R&D and innovation and (b) the better performer in terms of R&D and innovation "inputs" and "outputs" (e.g. R&D expenditure, R&D personnel, patent applications, related employment), while also suggesting that Galicia has been relatively more successful in developing the different parts of its regional innovation system. Yet, base levels of R&D and innovation activity in both regions (and in lagging regions more generally) continue to remain below both national and EU-15 averages, while the nature of both regions (e.g. in terms of size, geography, economy etc) might ultimately also raise questions about the extent of change that can be achieved, at least from an R&D perspective.

In summary, this researcher therefore concludes, based on the evidence of the research, that further improvement in R&D and innovation performance in lagging regions needs more coherent policy making between regional, national and EU authorities, which takes proper account of the nature of the regions, their capabilities and their development potential, and their relations with systems at other spatial levels. Such a policy process should include:

- provision of a stronger regional input or focus at all spatial levels of policy making, which results in a better manifestation of and tailoring to regional nuances within policy making for R&D and innovation;
- better collaboration, and allocation of power or responsibility, between different spatial levels of government;
- better integration of regional innovation policy with related policy areas (e.g. higher education, labour market and skills, industrial investment);
- the need for a long-term policy commitment from regional governments, national governments and the EU in fostering innovation in lagging regions;
- the need for an increased emphasis on non-R&D innovation initiatives, which might be more attractive to a wider cohort of firms in lagging regions, including small firms;
- the need to ground regional innovation policy in an improved understanding of the prevailing culture of both firms and supply-side institutions in lagging regions, and develop associated measures to encourage both increased awareness of and receptiveness to innovation in firms or institutions;
- better measures to promote collaboration between research institutions and firms, and among firms themselves;
- targeted incentives to encourage research institutions and larger firms to increase R&D and innovation that aligns with regional needs, as part of a wider consideration of the spatial scale of R&D and innovation activity within regions and between regions and other spatial levels, while at the same time seeking to take advantage of R&D and innovation links at other spatial scales (e.g. national, international).

The rest of this chapter now describes in more detail how the researcher's opinions and conclusions, as posited in this section, are grounded in the analysis and interpretation of the research findings, and where they fit within the context of the literature on innovation systems and spatial innovation, before providing a more detailed articulation of the conclusions and proposals highlighted above.

12.3 Presentation of Key Research Findings

The discussion presented in Section 12.2, and the researcher's opinions and insights, are grounded in a series of key findings that have emerged from the research, as follows:

1. over the past 15-20 years (or more), public authorities in lagging regions have increasingly turned their attention towards developing policies to promote R&D and innovation and foster regional innovation systems in their regions …;
2. … which have contributed to both an increase in investment in R&D and innovation in such regions …;
3. … and an increase in outputs arising from R&D and innovation activity;
4. however, perceived "weaknesses" within lagging regions' innovation systems still appear to be evident, despite the progress made in developing systems and the associated growth in R&D and innovation investment and outputs …;
5. … while the progress of R&D and innovation policy and performance in such regions has also been affected by their interaction with other spatial levels …;
6. … and by the structural nature of the change being effected.

Each of these key findings is addressed individually in the remainder of this section.

1. Lagging regions can develop policies to promote regional innovation systems ...

The findings of the research clearly suggest that public authorities in lagging regions have, in recent decades, placed an increased emphasis on developing and implementing policies to promote R&D and innovation. For example, the findings of the EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b), as outlined in Chapter 6 (Section 6.5), suggest that many lagging regions sought to absorb EU Structural Funds to (a) increase public investment in and (b) support policy initiatives for R&D and innovation, both during the 2000-06 programming period and the 2007-13 programming period. In particular, the research has highlighted the absorption of EU Structural Funds for investment in R&D and innovation in 13 out of 22 regions during the 2000-06 period (e.g. most lagging regions in Spain and Portugal, Sicily in Italy) and in six out of 22 regions during the 2007-13 period (e.g. Puglia and Sardinia in Italy, Norte in Portugal).

Furthermore, the evidence from the case study regions of Galicia and Puglia suggests that public authorities in both regions have developed R&D and innovation policies over the study period, which have been clearly informed by regional innovation systems thinking, while also being backed up with increased public investment in R&D and innovation. In Galicia (see Chapter 10, Section 10.3), successive mandatory plans for the development of R&D and innovation in the region have highlighted their stated intentions to raise awareness of the perceived importance of R&D and innovation, improve scientific and technological infrastructure in universities and research centres, increase the participation of firms in R&D and innovation, and improve human capital for R&D and innovation in both the public and private sectors, while at the same time seeking to articulate a relationship between universities and firms (Conde-Pumpido, 2007) and promote improved collaboration and co-operation between different actors. Similarly, regional innovation strategies in Puglia over the 2000-06 and 2007-13 programming periods (see Chapter 10, Section 10.5) progressively emphasised a need to build supply-side infrastructure and capacity (universities and research centres), incentivise the propagation of R&D and innovation in companies, build human capital for R&D and innovation across both the public and private sectors, and develop collaborative links between universities/research institutions and firms.

Reference to the concept of a "system", an "innovation system" or a "regional innovation system", moreover, is commonly found in the descriptions of R&D and innovation policies in both Galicia and Puglia over the study period (see Chapter 10, Section 10.3 and Section 10.5), while perspectives from the research interviews (see Chapter 11, Section 11.2) point to *"clearly systemic"* frameworks for R&D and innovation policy (G3), with an emphasis on *"triggering collaboration"* (G1), *"creation of intermediary structures"* (P1) or *"collaborative research"* (P5).

The nature of the policy prescriptions in the case study regions have thus alluded to several core elements that are commonly found in the research literature on innovation systems (see Chapter 4), including the focus on building knowledge and learning across a variety of different types of actors (e.g. universities, research centres, firms), plus the emphasis on innovation as an interactive process between actors. This includes the literature on both:

- innovation systems at a national level (e.g. Nelson, 1993, Nelson and Rosenberg, 1993, Lundvall et al, 2002, Nelson and Nelson, 2002, Lundvall, 2002);
- innovation systems at a regional level (e.g. Cooke et al, 1997, Cooke, 1998, Cooke, 2001, Asheim and Isaksen, 2002, Evangelista et al, 2002, Doloreux and Parto, 2005, Iammarino, 2005, Tödtling and Trippl, 2005, Carrincazeaux and Gaschet, 2006, Asheim et al, 2011a).

In addition, both Galicia and Puglia appear to have followed the type of approach recommended by Oughton et al (2002), who contended (as outlined earlier in Chapter 1, Section 1.2) that the remedy for the regional innovation paradox required policies that:

- "... increase the innovation capacity of regions by working on both the demand and the supply side of the system to increase both private and public sector investment in innovation activity";
- "... integrate technology policy and industrial policy by encouraging expenditure on innovation activity within mainstream industrial policy [e.g. EU Structural Fund] programmes" (Oughton et al, 2002, p. 108).

In doing so, the regions therefore appear to have sought to address perceived weaknesses in lagging regions (see Oughton et al, 2002, Table III, p. 103) such as low levels of public assistance for innovation, lack of scientific/technological infrastructure, lack of innovation capacity in firms, lack of critical mass/clustering and weak co-operation links between the public and private sectors.

2. ... in ways that increase both inputs to R&D and innovation ...

In addition to the evidence for increased policy emphasis on R&D and innovation in lagging regions, the evidence provided in the research has also demonstrated that lagging regions, or the actions taken by the array of actors that influence R&D and innovation activity within those regions, have stimulated increased investment in R&D and innovation over recent decades (albeit with some distinction within the study period between the varying experiences in the 2000-06 and 2007-13 Structural Fund programming periods, and the possible effect of global financial and economic crisis during the latter period).

For example, evidence for growth in R&D and innovation investment across the sample of regions examined in Chapter 6 (Section 6.3.2 and Section 6.3.3) has shown:

- growth in total R&D investment per capita in 21 out of 22 regions between the 1994-99 and 2000-07 periods, with 19 regions growing average annual investment above the EU-15 average (21%), and with growth in 14 regions being at least twice the EU-15 average;
- growth in total R&D investment per capita in 20 out of 22 regions between the 2000-07 and 2008-12 periods, with 14 regions growing average annual investment above the EU-15 average (14%), and with growth in nine regions being at least twice the EU-15 average;
- growth in business R&D investment per capita in 17 out of 20 regions between the 1994-99 and 2000-07 periods, with 13 regions growing average annual investment by 100% or more between the periods;
- growth in business R&D investment per capita in 18 out of 21 regions between the 2000-07 and 2008-12 periods, with 12 regions growing average annual investment by 40% or more between the periods.

Similarly, the evidence provided in Chapter 6 (Section 6.3.4 and Section 6.3.5) points to comparable growth in personnel devoted to R&D and innovation in lagging regions, both in overall terms and in the business sector, while the evidence for increased investment in R&D and innovation is also evident in the experience of the chosen case study regions of Galicia and Puglia (albeit with stronger levels of growth evident in Galicia than in Puglia). In the case of Galicia, for example, the evidence provided in Chapter 9 (Section 9.3.2 and Section 9.3.3) has shown:

- growth in average annual R&D expenditure per capita of 110% between the 1994-99 and 2000-07 periods, followed by growth of 27% between the 2000-07 and 2008-12 periods;
- growth in average annual business R&D expenditure per capita of 220% between the 1994-99 and 2000-07 periods, followed by growth of 40% between the 2000-07 and 2008-12 periods.

In the case of Puglia, on the other hand, the evidence provided in Chapter 9 (Section 9.5.2 and Section 9.5.3) has shown:

- growth in average annual R&D expenditure per capita of nearly 50% between the 1994-99 and 2000-07 periods, followed by growth of 13% between the 2000-07 and 2008-12 periods;
- growth in average annual business R&D expenditure per capita of 17% between the 1994-99 and 2000-07 periods, followed by growth of 24% between the 2000-07 and 2008-12 periods.

Moreover, the evidence provided for both Galicia (see Chapter 9, Section 9.3.4 and Section 9.3.5) and Puglia (see Chapter 9, Section 9.5.4 and Section 9.5.5) again points to comparable growth in personnel devoted to R&D and innovation, both in overall terms and in the business sector.

These findings, therefore, clearly support the Oughton et al (2002) allusion that lagging regions can invest in R&D and innovation, while they also support the evidence of previous research that has pointed to incidence of increased investment in R&D and innovation in lagging regions. Such research, for example, includes the work of Rodríguez-Pose (2001), in an analysis of European regions between 1986 and 1996, which found that several "less developed" countries (which are home to many lagging regions, such as Greece, Spain and Portugal), saw their level of R&D expenditure increase in relative terms over the 10 year period.

3. … and outputs from R&D and innovation

Alongside increases in inputs, the evidence provided in the research further suggests an increase in outputs arising from R&D and innovation activity in lagging regions over recent decades, based on commonly used indicators for R&D and innovation activity (e.g. patent applications, employment in key "innovating" sectoral groups), while again making some distinction within the study period between the varying experiences in the 2000-06 and 2007-13 Structural Fund programming periods, and the possible effect of global financial and economic crisis during the latter period.

For example, between the 1994-99 and 2000-07 periods, evidence for growth in R&D and innovation outputs across the sample of regions examined in Chapter 6 (Section 6.4) has shown:

- growth in average annual patent applications per million population in 19 out of 20 regions, with 18 regions growing patents above the EU-15 average (36%), and with growth in 13 regions being at least twice the EU-15 average;
- growth in average annual employment in high and medium-high technology manufacturing (per million population) in 16 out of 17 regions, with growth in all 16 regions exceeding the EU-15 average (-2%), and with 10 regions growing employment by 20% or more between the periods;
- growth in average annual employment in knowledge intensive services (per million population) in 22 out of 22 regions, with growth in 18 regions exceeding the EU-15 average (17%), and with 13 regions growing employment by 30% or more between the periods;
- growth in average employment in high technology sectors (per million population) in 15 out of 16 regions, with growth in 13 regions exceeding the EU-15 average (16%), and with 12 regions growing employment by 30% or more between the periods.

Thereafter, the evidence in Chapter 6 (Section 6.4) also shows growth in average annual patent applications per million population in 11 out of 20 regions between the 2000-07 and 2008-11 periods, with all 11 of these regions growing patents at a rate of 11% or more (compared to an EU-15 average of less than 1%). However, trends in employment growth in high and medium-high technology manufacturing, knowledge intensive services or high technology sectors were less impressive, with falls in employment being evident in many regions, but with the global financial and economic crisis most likely being a contributor to this.

In the case study regions, meanwhile, Chapter 9 (Section 9.3 and Section 9.5) shows that average annual patent applications per million population in Galicia grew by nearly 180% between the 1994-99 and 2000-07 periods, and by a further 60% between the 2000-07 and 2008-11 periods, while they grew by nearly 120% in Puglia between the 1994-99 and 2000-07 periods, and by a further 20% between the 2000-07 and 2008-11 periods. In addition, employment growth in high and medium-high technology manufacturing, knowledge intensive services and high technology sectors was above the EU-15 average in both regions between the 1994-99 and 2000-07 periods (with the level of growth recorded in Puglia being somewhat below that recorded in Galicia), though trends in employment growth in both regions in the period after 2007 were again less impressive.

These findings, therefore, provide further evidence to support previous research that has pointed to an ability to increase outputs arising from R&D and innovation activity in lagging regions. Such research, for example, includes the work of Bilbao-Osorio and Rodríguez-Pose (2004), which found a positive association between increased investment in R&D in "peripheral" regions and increased patent applications per million population.

4. However, regional innovation systems remain under-developed and fragmented, …

In terms of innovation "system" development, the evidence provided in the research appears to suggest that R&D and innovation policy in the case study regions (Galicia and Puglia) has made some contribution to further development of the "stock" or capacity of regional innovation system actors within each region, e.g. the actors within the "knowledge generation and diffusion sub-system" and the "knowledge application and exploitation sub-system" (Tödtling and Trippl, 2005), albeit with the extent of progress appearing more pronounced in Galicia than in Puglia.

In Galicia, for example, the evidence suggests that policies to promote R&D and innovation, and the public/EU investment that has supported these policies between 2000 and 2013, have contributed to the creation of new university research centres and the upgrading of equipment and facilities in existing research centres, while they have likewise delivered support for a large volume of R&D projects, including collaborative projects between firms and research centres (e.g. see Chapter 10, Section 10.3.3). In addition, interview perspectives (see Chapter 11, Section 11.3) have suggested that *"the infrastructure for innovation has grown"*, or that *"there is a bigger focus on research in universities"* (G1), with *"reinforced research departments"* and *"new R&D centres in the universities"* (G3). And similarly, the development of "technology centre" capacity in the region has been described as an *"outstanding"* evolution, which provides the region with *"an agent in the middle ... collaborating with industry and collaborating with companies"* (G2) and which demonstrated a *"clear effort ... to create new centres, clearly oriented to the needs of the private sector for innovation"* (G3).

The evidence for Puglia, on the other hand, alludes to similar supports being provided and outputs delivered as per Galicia, though activity was more concentrated around the 2007-13 period (see Chapter 10, Section 10.5.3). This includes R&D and innovation infrastructure enhancements in universities and public research centres, funding for R&D projects in companies, funding for collaborative projects between firms and universities, and support for the establishment of TTOs within universities. In addition, there is some evidence from both regions to suggest some policy-driven progress in developing collaborative, cluster-oriented R&D and innovation activity within a small number of sectors (see Chapter 10, Section 10.2-Section 10.5 and Chapter 11, Section 11.3), with such clusters described as playing *"a quite leading role"* in promoting R&D and innovation (G1) or as providing *"good capacity to collaborate between large companies and small companies"* (P5).

At the same time, however, the evidence from the research suggests that the wider engagement of firms in R&D and innovation activity in the two regions remains limited, while the extent of collaboration between R&D and innovation actors in the regions, despite an acknowledged increase in activity in this regard, remains largely "fragmented" (Oughton et al, 2002). On the plus side, for example, Structural Fund supported NOPs and ROPs in the regions have funded hundreds of R&D and innovation projects involving firms (see Chapter 10, Section 10.3.3 and Section 10.5.3). Yet, business expenditure on R&D remains below national and EU-15 averages in both regions, albeit having experienced growth over time (see Chapter 9, Section 9.3.3 and Section 9.5.3), while interview perspectives (see Chapter 11, Section 11.3) have described the wider engagement of firms in R&D and innovation activities as *"very poor"* (G3) or *"still not widespread"* (P1), with many firms still not being *"touched by innovation"* (P4).

Furthermore, the extent of collaboration between R&D and innovation actors within the wider case study regions, or the perceived lack of a *"culture of collaboration"* (G4, P1), appears to fall short of the networking and interactive processes that are often described by proponents of innovation systems approaches (e.g. Dosi, 1998, Morgan, 1997, Lundvall et al, 2002, Nelson and Nelson, 2002, Edquist, 2004, Lundvall, 2010). As a result, the extent of "social capital" (Puttnam, 1993, Oughton et al, 2002), "culture" of collaboration (Cooke, 2001) or "embeddedness" (Cooke, 2001, Doloreux and Parto, 2005) between R&D and innovation actors in the regions would still appear to be under-developed, at least at a wider regional level.

In this regard, a large volume of projects has been funded across both regions in order to foster collaboration and interaction between firms, and between universities/research institutions and firms (see Chapter 10, Section 10.3.3 and Section 10.5.3), which demonstrated *"clear progress [in terms of collaboration]"* (G3). Yet, wider perspectives on the extent of collaboration and networking in the regions (see Chapter 11, Section 11.3) still pointed to a need *"to make more effort in that direction (collaboration)"* (G3), with universities and research institutions being perceived as *"quite disconnected from companies"* (G4), or as *"opportunistic"* in engaging with companies (P4), while firms themselves were perceived to still prefer to *"run alone"* (P1) or lack a *"level of trust [of universities]"* (G1).

5. ... and strongly influenced by systems at other spatial levels, ...

As alluded to earlier in Section 12.2, the evidence from the research clearly points to a degree of inter-dependency between the regional level, the national level and beyond, both in R&D and innovation terms and in socio-economic terms.

For example, the relative growth performances of Galicia and Puglia in terms of R&D expenditure, R&D personnel or patent applications during the study period, and the relatively better performance of Galicia over Puglia in this regard, largely mirrors the relatively better performance of Spanish lagging regions over Italian lagging regions, and of Spain over Italy more generally, in the same period (see Chapter 9, Section 9.3 and Section 9.5). At the same time, Galicia's better performance in terms of GDP or labour market trends in the period mirrors a better Spanish performance at both a regional and national level (see Chapter 9, Section 9.2 and Section 9.4), while differences in tertiary education levels between Galicia and Puglia are reflected in similar differences in education levels across regions in Spain and Italy (see Chapter 9, Section 9.2.5 and Section 9.4.5). Furthermore, the decline in growth experienced in both Galicia and Puglia over the 2007-13 period, both in R&D/innovation terms (see Chapter 9, Section 9.3 and Section 9.5) and in socio-economic terms (see Chapter 9, Section 9.2 and Section 9.4), was likewise clearly seen at both the Spanish and Italian national levels, principally because of the effect of the global financial and economic crisis that developed in 2008-09, which affected both national and regional economies for several years afterwards.

Similarly, the evidence provided in the research points to the importance of interactions between regional innovation systems and national/international innovation systems. As noted in Chapter 11, Section 11.3.2, for example, for many larger companies in Galicia, it was suggested that *"centres of decision-making and centres of R&D are outside [the region]"* or that *"the main important collaborations of the university groups are not with Galician companies, but with foreign companies"* (G3). Such evidence alludes to the assertion of Heraud (2003) that the impact of scientific, technological and educational infrastructures is not necessarily confined to a region's spatial or administrative boundaries, while the wider evidence for inter-dependencies also supports other critiques of the regional innovation systems concept, which caution against making over-exaggerated assumptions that the regional or local level is a strategic, internally cohesive unit (e.g. Asheim and Isaksen, 2002, De Bruijn and Lagendijk, 2005, Doloreux and Parto, 2005, Uyarra, 2007, Leydesdorff and Cucco, 2019) or underplaying the importance of regional connectivity (Pugh, 2016, Tödtling and Trippl, 2018).

In addition, lagging regions' interaction and inter-dependence with other spatial levels is very clearly displayed in the policy arena. In this regard, the evidence from the case study regions describes significant regional autonomy and regional government involvement in R&D and innovation policy making (see Chapter 10, Section 10.2.3, Section 10.3, Section 10.4.3 and Section 10.5), including reform of regional agencies to promote R&D and innovation and regional innovation systems. So, regional governments in both Galicia (since the 1980s) and Puglia (since the early 2000s) have had policy competence in the area of R&D and innovation, they have developed multi-annual plans and regional strategies for R&D and innovation (backed by financial support from EU Structural Fund programmes) and they have established agencies like GAIN and ARTI to assist the development of regional innovation systems. Interview perspectives, in turn (see Chapter 11, Section 11.4), have broadly described this regional policy making role in positive terms, calling it *"very visible"* (G1), *"very positive in [improving] regional innovation capacity"* (G3) and a *"strong political commitment … to perform a cultural transformation [in policy]"* (P5). Therefore, such findings would appear to endorse the views of Oughton et al (2002), which asserted that the political legitimacy and economic powers of regional governments can play a role in articulating and dynamising a regional innovation system, while they likewise resonate with the views of Cooke et al (1997), which highlighted regional autonomy, and regional budgetary influence over investment, as being important in facilitating regions' ability to influence R&D and innovation policy.

However, it was equally clear from the evidence in the case study regions that policy competence for R&D and innovation remained to some degree shared between regional authorities and national authorities, and delivered through both regional and national funding programmes, while the nature of policy in both regions drew inspiration from EU policy tools and practices with respect to R&D and innovation (see Chapter 10, Section 10.3 and Section 10.5). In this regard, interview perspectives (see Chapter 11, Section 11.4) have pointed to perceived tensions or disconnects between regional and national governments, a perceived lack of effective co-operation and co-ordination between the two, and national/EU policies that do not take sufficient account of regional contexts and needs (e.g. by being too R&D oriented, or by adopting a "developed" economy perspective to investing in R&D and innovation).

So, in the context of Galicia, national governments have been described as *"[shaping] policies and programmes, which don't really suit the needs of [Galicia]"* (G1), providing no *"clear strategy … that could benefit Galician industry"* (G3), showing no *"want to co-ordinate so much [with regions]"* (G1) or having no *"clear will … to negotiate and to make a co-operative approach with regions"* (G3). In the context of Puglia, national governments have been similarly described as *"sometimes not taking into consideration the real needs of [the region]"* (P1) or not displaying *"any perception of national policy [taking account of Puglia]"* (P4), while perspectives also point to *"a continuous fight between the central level and the regional level"* (P1) or a lack of *"a systematic approach"* (P4) to co-operation between the regional level and the national level. And in the context of EU policies, other perspectives have contended that policy has focused on infrastructure *"reinforced by the Brussels (i.e. EU) strategy"* (G3), without sufficient complementary investment in human resources, or that EU policy thinking on R&D and innovation comes from *"more developed countries/regions"*, which is *"sometimes lacking some critical sense"* (P1) of how lagging regions differ from more advanced regions.

Such perspectives, therefore, would appear to clearly point to the observation of De Bruijn and Lagendijk (2005) that regional innovation systems thinking can sometimes understate the role of national governments or international entities in shaping policy, governance and resources at the regional level.

6. … while progress also depends on the structural nature of the change being effected

Finally, much of the research literature that critiques the regional innovation systems concept emphasises a need to take account of local contexts, while also noting that the development of such systems can take considerable time to mature. Cooke et al (1997), for example, suggest that the impacts of any policy that is designed to improve a system of innovation may take some time to mature. In the same vein, Fagerberg et al (2002) emphasise that policies addressing the need to build R&D "infrastructures" are essentially long-term and structural in nature, while Oughton et al (2002) assert that achieving wider impacts from developing regional innovation systems is a medium- to long-run task.

The evidence from the research on R&D and innovation in Galicia and Puglia, indeed, provides some evidence to support this. For example, the evidence from the two regions confirms that regional autonomy and policy making powers in R&D and innovation have been in place in Galicia for a longer period of time than in Puglia (see Chapter 10, Section 10.2.3, Section 10.3, Section 10.4.3 and Section 10.5), and that Galicia was therefore a more "early adopter" of policies and plans to invest in R&D and innovation than was Puglia. In addition, Galicia has achieved higher levels of growth in R&D and innovation activity than in Puglia (see Chapter 6 and Chapter 9), and it has arguably achieved more progress in developing its regional innovation system. Yet, base levels of

R&D and innovation activity in both regions (and, indeed, in many lagging regions more generally) continue to remain below national and EU-15 averages, in spite of an increased policy emphasis on R&D and innovation that, in the case of Galicia, has spanned more than two decades.

However, the literature also suggests that the diversity of different regions can be overlooked in the regional innovation systems approach (Iammarino, 2005, Uyarra, 2007, Asheim et al, 2011b), e.g. in terms of size, wealth, resources (Nelson, 1993, Cooke et al, 1997, Bilbao-Osorio and Rodríguez-Pose, 2004), or in terms of mix of industries (Nelson and Rosenberg, 1993, Bilbao-Osorio and Rodríguez-Pose, 2004). And similarly, the literature emphasises a need to acknowledge that there are different types or scales of innovation systems, at different levels and stages of development (Cooke, 1998, Asheim and Isaksen, 2002, Pugh, 2016, Trippl et al, 2016, Njøs and Jakobsen, 2018, Tödtling and Trippl, 2018), while it points to a lack of clarity about the appropriate geographical scale for studying regional innovation systems (Doloreux and Parto, 2005).

Much of this literature, therefore, clearly resonates with the findings of the research. For example, Galicia and Puglia each display a mix of urban and rural populations, but with significant concentrations of population in certain local territories, while most economic activity in the regions (including R&D and innovation activity) is concentrated around selected main population centres (see Chapter 9, Section 9.2 and Section 9.4). Thus, questions might be asked about the true geographical scale of any regional innovation system activity within the two regions. In addition, the vast majority of firms in the case study regions were found to be small in size, and many of the predominant economic sectors in both regions would be perceived to be "low-tech" in nature (see Chapter 9, Section 9.2 and Section 9.4). So, interview perspectives (see Chapter 11, Section 11.5) have highlighted a *"big problem [in] the really, really small size of the companies [in Galicia]"* (G4), the *"too small dimension (i.e. size of firms) [in Puglia]"* (P1) and the associated *"challenge [of] how we can engage the little companies in innovation"* (G2). Related to this, interview perspectives have also focused on the perceived *"traditional"* nature of sectors in Galicia and Puglia (e.g. G1, P3), whereby *"not so much attention is put on R&D [by companies]"* (G1), *"companies are not focused on innovation"* (G3), and firms *"are not so convinced that research and development is a critical investment"*

(G4). Thus, perceptions suggest that firms in general lack *"a strong tradition of investing in innovation, or ... risky behaviours"* (P1) and that it can be *"hard to change [firms'] behaviour"* (P3) in engaging with R&D and innovation.

In this regard, the perceived emphasis on an R&D oriented, "developed economy" perspective to investing in innovation in the regions, as alluded to earlier in the chapter, might suggest a lack of understanding of which innovation policy mixes should be applied in which types of regions, including perceived peripheral regions (Tödtling and Trippl, 2018), while continuing to raise questions about how regional innovation systems thinking is applied as a "best practice" policy tool (Asheim and Isaksen, 2002, Uyarra, 2007, Pugh, 2016). So, in the case of Galicia and Puglia, the R&D oriented tone of much of the policy prescriptions made over the 2000-13 period (see Chapter 10, Section 10.3 and Section 10.5) appears to be confirmed by interview perspectives (see Chapter 11, Section 11.5), which in turn point to a need for policies that *"could do more for the traditional sectors and for non-technological innovation"* (P1) or for *"little projects that could perhaps be useful for a little company"* (G2). Indeed, as noted in Section 12.2, the nature of both regions (e.g. in terms of size, geography, economy etc) might also raise questions about the extent of change that can be achieved, at least from an R&D perspective.

12.4 Policy Priorities for R&D and Innovation in Lagging Regions

12.4.1 Current Situation

In summary, the current research shows that public authorities in lagging regions can develop policies and use public funding to promote the development of regional innovation systems in their regions, thereby making progress in tackling some of the perceived structural weaknesses affecting regional innovation systems in lagging regions, and in doing so helping to increase investment in and outputs from R&D and innovation activity in their regions.

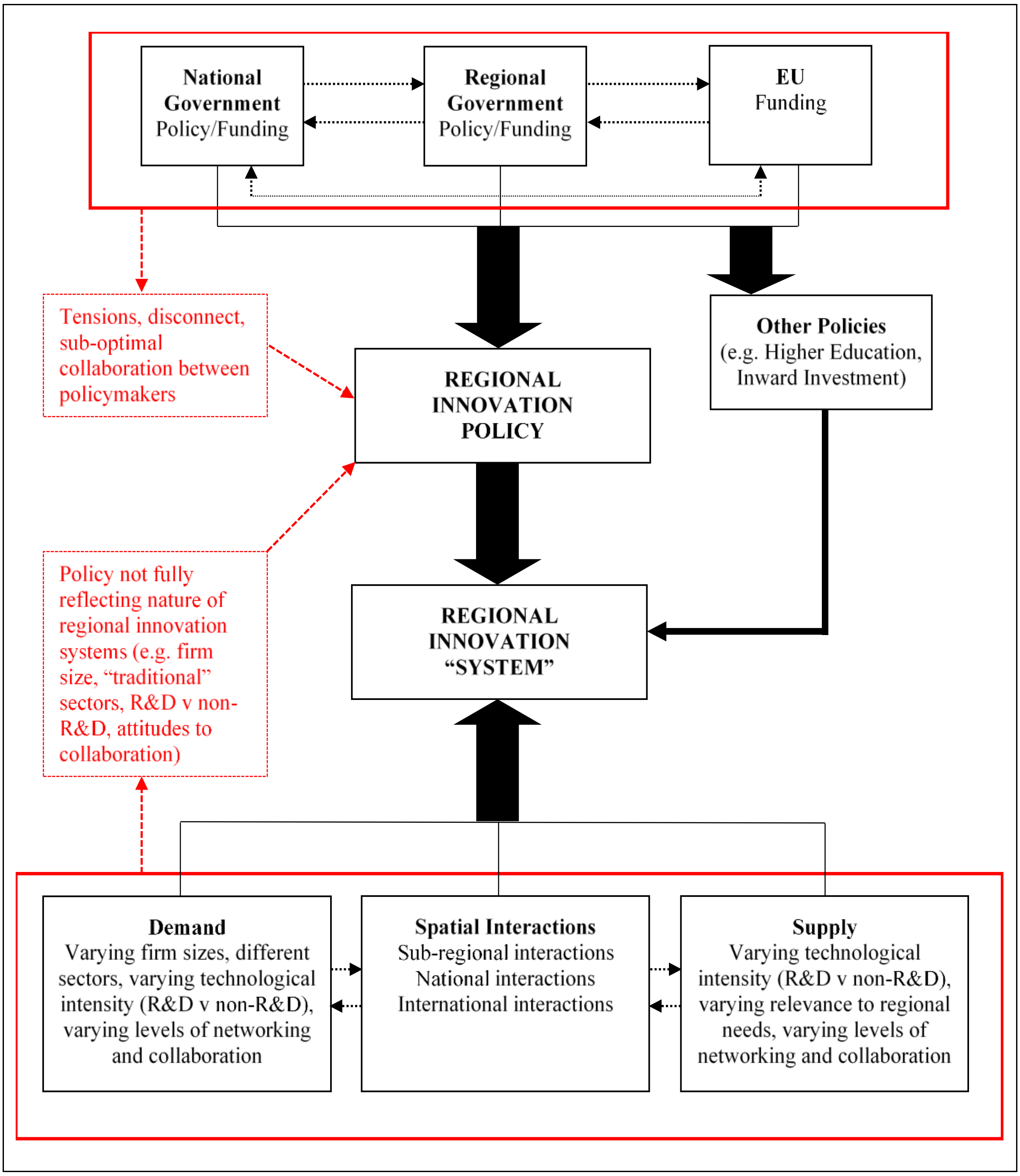
However, in terms of innovation "system" development, while the evidence points to some contribution to the further development of the infrastructural "stock" or capacity of regional innovation system actors in such regions, it nonetheless also suggests that wider engagement of firms in R&D and innovation activity can remain limited, and the extent of collaboration between R&D and innovation actors in the regions can remain largely "fragmented" (Oughton et al, 2002).

At the same time, the research shows that lagging regions' interaction and inter-dependence with other spatial levels can significantly influence R&D and innovation activity, which in turn cautions against making over-exaggerated assumptions about strategic, internal cohesiveness or endogeneity in such regions. In particular, this interaction and inter-dependence with other spatial levels has been very clearly displayed in the policy arena, in the form of shared policy competences for R&D and innovation that exist between regional authorities and national authorities, perceived tensions or disconnect between the different authorities at different spatial levels and a perceived lack of effective co-operation and co-ordination, and regional perceptions that national/EU policies do not take sufficient account of regional contexts and needs.

Nevertheless, irrespective of either the strengths or weaknesses of efforts to improve R&D and innovation performance in lagging regions, or the efficacy or coherence of policy interventions in this regard, the research further suggests that promoting structural change to engender R&D and innovation in such regions is a long-run game, while the nuances of such regions might ultimately also raise questions about the extent of change that can be achieved, at least from an R&D perspective.

A graphical illustration of the some of the key influences and inter-dependencies that impact on regional innovation systems and regional policy in lagging regions, which have been highlighted in this research, is provided in Figure 12.1.

Figure 12.1: Policy and Other Influences on Regional Innovation Systems in Lagging Regions



Source: Author

12.4.2 Future Policy Priorities for R&D and Innovation

To conclude, this researcher believes that further improvement in R&D and innovation performance in lagging regions needs to better address the highlighted influences and inter-dependencies, which in turn requires more coherent policy making between regional, national and EU authorities that takes proper account of the nature of the regions, their capabilities and their development potential. In this regard, the findings of the research allude to a number of policy "enablers", which are needed to facilitate better policy making for regional innovation in lagging regions, alongside a number of policy needs or priorities, which should be more clearly reflected in innovation policies for such regions (based on the evidence from Galicia and Puglia).

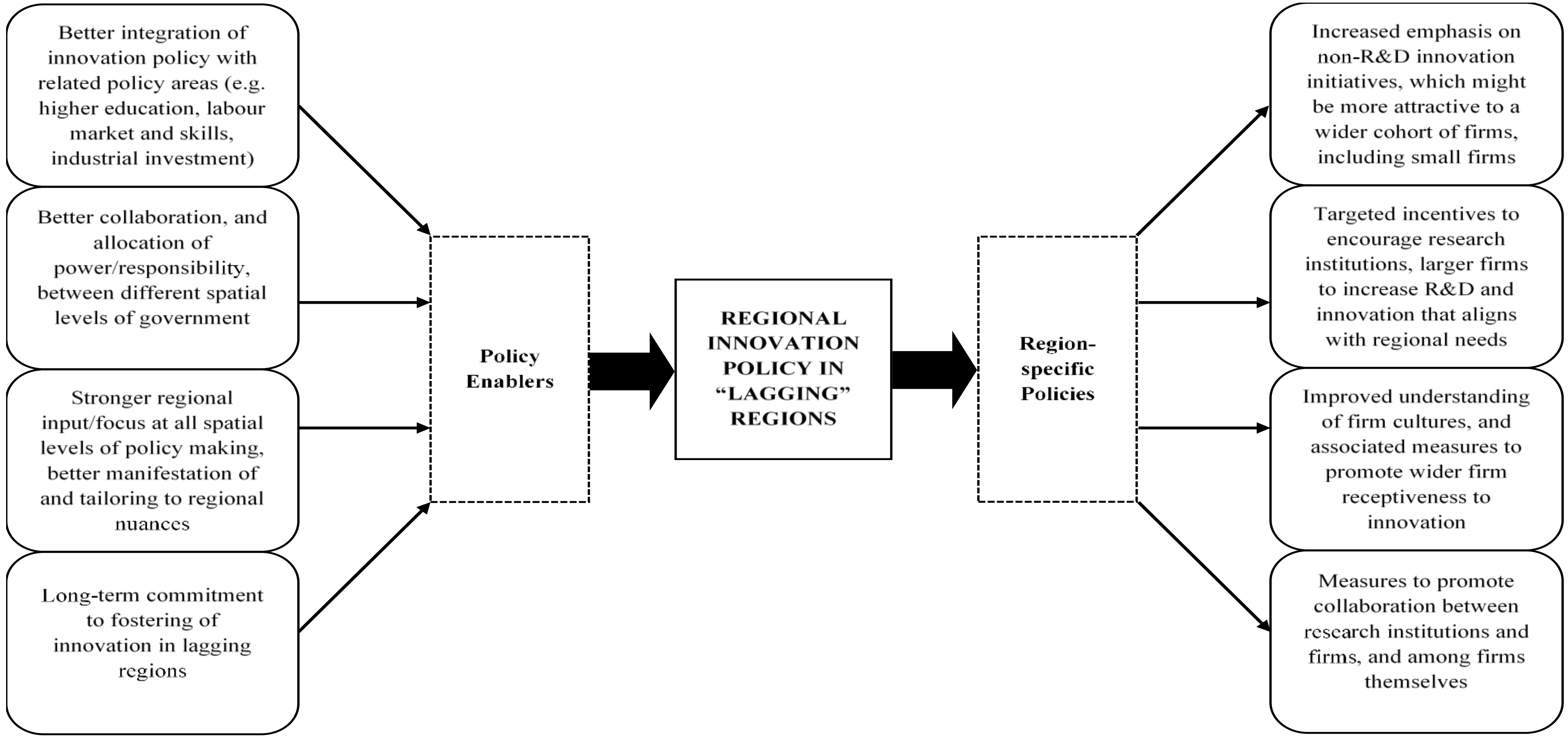
A graphical illustration of these enablers and needs/priorities is also provided in Figure 12.2, whereby the enablers provide inputs to the policy making process, while the needs or priorities emerge as (likely) outputs from that process. Policy enablers that have been highlighted by the research findings, and presented as an input to policy making in Figure 12.2, include:

- the provision of a ***stronger regional input or focus at all spatial levels of policy making***, which results in a better manifestation of and tailoring to regional nuances within policy making for R&D and innovation. This means that all policy making for lagging regions, regardless of the spatial level at which it is designed or implemented, should be grounded in a thorough understanding of such regions' strengths, weaknesses and potential, leading to proposals for the best means by which any form of innovation might be used to help address these;
- ***better collaboration, and allocation of power or responsibility, between different spatial levels of government***. While this is "far from a simple task" (Marques and Morgan, 2018) that can be contingent on levels of "goodwill provided" (Kroll, 2019), it should nonetheless strive to involve a genuine, proactive policy collaboration between regional governments and national governments (and the EU) in determining the right R&D and innovation policy and investment mix for different lagging regions, in the context of regional needs/capabilities and potential. Such a collaboration should involve a clear and logical delineation of national and regional government competences in regions, and co-operation between the two, which would allow policies to draw on local knowledge and strengths, while

benefiting from capacities that often only exist at higher levels of government (Marques and Morgan, 2018);

- ***better integration of regional innovation policy with related policy areas (e.g. higher education, labour market and skills, industrial investment)***. The need for this, for example, is hinted at by the contrasting levels of tertiary education achievement in both Galicia and Puglia, or by the incidence of research institutions/large firms in both regions that engage with R&D and innovation activities outside the regions. Also, in relation to issues of multi-level governance co-ordination, national government often has a central role in devising such policies (Hassink and Marques, 2016), and thus a clear role to play from a regional innovation perspective;
- the ***need for a long-term policy commitment*** from regional governments, national governments and the EU in fostering innovation in lagging regions. The evidence from the research, in particular, has suggested that Galicia's longer history of policy engagement in R&D and innovation may have contributed to its relatively better R&D and innovation performance over Puglia. Yet, at the same time, the research also suggests that levels of commitment to R&D and innovation policy can vary as governments change or as more challenging socio-economic conditions emerge (e.g. financial and economic crisis), which can hamper any progress made. Nevertheless, authors such as Asheim (2019) continue to remark that a long-term perspective is necessary in order to promote fundamental economic change through the means of R&D and innovation.

Figure 12.2: Policy Priorities for R&D and Innovation in Lagging Regions



Note: This "model" is not intended to present an exhaustive list of all necessary interventions, rather it highlights interventions that would appear to be needed in such regions based on the findings of this research.

Source: Author

Meanwhile, policy needs or priorities that have been suggested by the research findings, and presented as possible elements of regional innovation policy in lagging regions in Figure 12.2, include:

- the possible need for an ***increased emphasis on non-R&D innovation initiatives***, which might be more attractive to a wider cohort of firms in lagging regions, including small firms. This does not mean that investment in R&D-based innovation should be discouraged in such regions, but it does mean that policy should articulate a "realistic approach to opportunities" in such regions (Hassink and Marques, 2016) and a more appropriate balance between the promotion of R&D versus non-R&D innovation initiatives within such regions, especially within the sectoral context of the regions and the vast cohort of firms that are not technologically oriented;
- the need to ground regional innovation policy in an ***improved understanding of the prevailing culture of both firms and supply-side institutions*** in lagging regions, and develop associated measures to encourage both increased awareness of and receptiveness to innovation in firms or institutions. This may require a stronger emphasis on "soft" interventions, which give such actors the assistance or skills needed to more easily identify the benefits to be gained from innovative activities;
- better ***measures to promote collaboration*** between research institutions and firms, and among firms themselves. This may again require a stronger emphasis on "soft" interventions, and not just "bricks and mortar" hard infrastructure, to build a culture of collaboration and a culture of (R&D or non-R&D) innovation in regions;
- targeted ***incentives to encourage research institutions and larger firms to increase R&D and innovation that aligns with regional needs***, as part of a wider consideration of the spatial scale of R&D and innovation activity within regions and between regions and other spatial levels, while at the same time recognising that a region is not a "bounded, relatively closed entity" (Hassink and Marques, 2016) and seeking to take advantage of R&D and innovation links at other spatial scales (e.g. national, international).

CHAPTER 13 – CONCLUSION, CONTRIBUTION, LIMITATIONS AND RECOMMENDATIONS

13.1 Introduction

The purpose of this chapter is to conclude the thesis. Section 13.2 provides an overview of the research that has been undertaken, and its main findings, while Section 13.3 highlights the research's contribution to theory and practice. Section 13.4 addresses the limitations of the research, while Section 13.5 provides some recommendations for future research.

13.2 Overview of the Research

This research has been inspired by the regional innovation paradox (Oughton et al, 2002). This paradox contends that innovation is needed in perceived "lagging" regions in order to improve competitiveness, but it also asserts that it is more difficult to invest effectively in R&D in such regions, and that it is more likely that such regions will be seen to under-invest in R&D and innovation.

The main cause of the regional innovation paradox, meanwhile, is perceived to lie in the fragmented nature of regional innovation systems in lagging regions, and the institutional characteristics of such regions (Oughton et al, 2002). As a result, it has been argued that regional governance (via public policies) needs to focus on developing regional innovation systems in lagging regions, and improving the wider systemic capacity to absorb investment for innovation activities in such regions, by:

- increasing the innovation capacity of regions by working on both the demand and the supply side of the system to increase both private and public sector investment in innovation activity;
- integrating technology policy and industrial policy by encouraging expenditure on innovation activity within mainstream industrial policy programmes (Oughton et al, 2002, p. 108).

Such a remedy subscribes to a “systems” approach to innovation, with an emphasis on exchange of knowledge and learning, and on the importance of relationships between key actors, while also emphasising the regional dimension at its centre because of perceived external economies that exist at that level. Yet, the research literature’s critique of the complex nature of regional innovation systems appears to argue that the concept too often assumes that the regional level is a strategic, internally cohesive unit. In this regard, for example, the concept is perceived to take insufficient account of links to or the influence of the inter-regional, national or global levels, including extra-regional networks and institutions, which may influence policy, governance or resources at the regional level. Moreover, further critique suggests that the diversity, path dependency and varying patterns of development of regions can be overlooked under the regional innovation systems concept, and that such diversity can render best practice or “one size fits all” guidelines for regional systems to be of little benefit.

It is against this background, therefore, that this research has sought to examine *“how public policy towards and public investment in regional innovation systems has contributed to R&D and innovation performance in lagging regional economies”*. To do this, the methodology for the research has followed a pragmatist research philosophy and adopted a mixed methods approach, which incorporated both quantitative analysis and qualitative analysis, via case study research.

The principal goal of the quantitative analysis was to use descriptive data on R&D and innovation “inputs” (investment, personnel) and “outputs” (patents, employment) to gauge whether growth in R&D and innovation inputs was associated with growth in R&D and innovation outputs in lagging regions over time, but also more importantly to identify lagging regions whose recent innovation activity and performance might provide suitable candidates for case study research. In particular, the data was used to help to categorise regions into a number of groups, from which two (2) case study regions – Galicia (Spain) and Puglia (Italy) – were then chosen.

The purpose of the case study research, on the other hand, was to perform a more in-depth analysis of the development of regional innovation systems in the selected regions, given that the nature of such systems and the institutional characteristics of lagging regions was asserted by Oughton et al (2002) to be the main cause of the regional innovation paradox. The case study research thus sought to explore what changes have occurred over time and to what extent weaknesses in regional innovation systems have been addressed, including an exploration of each region's socio-economic setting, R&D and innovation performance, regional innovation system elements (and key actors), R&D and innovation investment and policy, and governance arrangements influencing R&D and innovation policy.

To do this, the case study research drew on evidence from both secondary data (R&D/innovation and wider socio-economic datasets, national and regional policy and strategy documents, national and regional funding programme documents or sources, or other published reports and articles on development of R&D and innovation in the regions) and interviews carried out with a sample of key stakeholders in each region (e.g. policy makers, policy implementers, research institutions, industry representative bodies). The evidence from the secondary data helped to inform the research about the inputs, outputs and outcomes associated with the development of R&D and innovation in Galicia and Puglia, but the research interviews were crucial in helping to interpret this data by providing stakeholder insights, perceptions and opinions on such matters as the development of regional innovation systems and the role of key actors, the development of policy for R&D and innovation over time, and the importance of governance arrangements within the regions.

The findings of the research, in summary, suggest that public authorities in lagging regions can develop policies and use public funding to promote the development of regional innovation systems in their regions, and thus make progress to tackle perceived structural weaknesses affecting regional innovation systems in lagging regions. However, despite evidence of some contribution to the further development of the infrastructural "stock" or capacity of regional innovation system actors in such regions, the research also suggests that the wider engagement of firms in R&D and innovation activity can remain limited, while the extent of collaboration between R&D and innovation actors in the regions can remain "fragmented" (Oughton et al, 2002). In addition, the research suggests that lagging regions' interaction and inter-dependence with other spatial levels can significantly influence R&D and innovation activity, which in turn cautions against making over-exaggerated assumptions about strategic, internal cohesiveness or endogeneity in such regions. In particular, this interaction and inter-dependence with other spatial levels has been very clearly displayed in the policy arena, in the form of shared policy competences for R&D and innovation that exist between regional authorities and national authorities, perceived tensions or disconnect between the different authorities at different spatial levels and a perceived lack of effective co-operation and co-ordination, and regional perceptions that national/EU policies do not take sufficient account of regional contexts and needs.

Nevertheless, irrespective of either the strengths or weaknesses of efforts to improve R&D and innovation performance in lagging regions, or the efficacy or coherence of policy interventions in this regard, the research further suggests that promoting structural change to engender R&D and innovation in such regions is a long-run game, while the nature of such regions might ultimately also raise questions about the extent of change that can be achieved, at least from an R&D perspective.

13.3 Research Contribution

This research presents a number of important contributions to both theory and practice. Firstly, the research contributes to bridging an ongoing knowledge gap on the development of regional innovation systems in lower performing regions. This gap has been highlighted by Pugh (2016), for example, who pointed to "an established yet persistent literature gap concerning a lack of [regional innovation system] theorisation in weaker and peripheral regions", which requires research that "attempts to apply and interrogate [regional innovation system] theory in diverse regional settings that differ from 'ideal' [regional innovation systems]" (Pugh, 2016, p. 116). Secondly, the research also provides a more mixed methods approach to the investigation of the issues surrounding the regional innovation paradox, and whether and how lagging regions have sought to foster investment in R&D and innovation, which combines both quantitative and qualitative approaches. In this regard, it contrasts with the work carried out by the European Commission (2012b, 2014b) and Muscio et al (2015), which looked at the paradox from a more quantitative perspective.

Thirdly, the research further contributes to knowledge and understanding of several issues related to the application of the regional innovation systems approach in lagging regions, as critiqued in the research literature, as follows:

- it contributes to knowledge and understanding of how inter-dependencies between different spatial levels influence R&D and innovation activity in lagging regions. In particular, it provides evidence that again cautions against making over-exaggerated assumptions that the regional level is always a strategic, internally cohesive unit, while also underplaying the importance of inter-regional and intra-regional connectivity or of extra-regional networks and institutions;
- in this regard, it especially contributes to the understanding of how such inter-dependencies affect policy making for R&D and innovation in lagging regions. In particular, it highlights the role of regional governments, national governments and the EU in the policy arena, the interplay of these governance levels in shaping and implementing policy for R&D and innovation in lagging regions, and the tensions and conflicts that can arise;
- it suggests that the diversity, path dependency and varying patterns of development between advanced regions and lagging regions can be overlooked under the regional innovation systems concept, which cautions against a “one size fits all”, best practice application of the concept in lagging regions. In this regard, it especially suggests a possible over-emphasis on R&D-oriented innovation interventions in lagging regions, without taking sufficient account of local contexts, needs and capabilities.

Finally, the research contributes to practice by highlighting policy implications arising from the research and suggesting policy proposals to address these implications, as described earlier in Chapter 12 (Section 12.4), which include:

- provision of a stronger regional input or focus at all spatial levels of policy making, which results in a better manifestation of and tailoring to regional nuances within policy making for R&D and innovation;
- better collaboration, and allocation of power or responsibility, between different spatial levels of government;

- better integration of regional innovation policy with related policy areas (e.g. higher education, labour market and skills, industrial investment);
- the need for a long-term policy commitment from regional governments, national governments and the EU in fostering innovation in lagging regions;
- the need for an increased emphasis on non-R&D innovation initiatives, which might be more attractive to a wider cohort of firms in lagging regions, including small firms;
- the need to ground regional innovation policy in an improved understanding of the prevailing culture of both firms and supply-side institutions in lagging regions, and develop associated measures to encourage both increased awareness of and receptiveness to innovation in firms or institutions;
- better measures to promote collaboration between research institutions and firms, and among firms themselves;
- targeted incentives to encourage research institutions and larger firms to increase R&D and innovation that aligns with regional needs.

Furthermore, recent critiques of the regional smart specialisation strategies that EU regions were required to submit as an ex-ante requirement for Structural Fund support during the 2014-20 programming period (see Chapter 2, Section 2.4) suggest that such proposals remain pertinent for lagging regions. For example, Kroll (2019) contends that the smart specialisation policy approach has not sufficiently addressed specific needs and “points of leverage” in lagging regions, producing comparatively little change in regional policy mixes for R&D and innovation. In addition, he suggests that it has made problematic assumptions about the socio-economic environment into which local policy making is embedded, with less developed regions still being vulnerable to a “policy fashion trap” of seeking to replicate overly ambitious approaches proposed from higher political levels, under unsuitable circumstances.

Similarly, Hassink and Gong (2019) assert that guidance on smart specialisation has been largely predicated on a conventional science and technology model of innovation, and that it can encourage a “delusional transformative hope” in regions where entrepreneurial culture, dynamics of new firm formation or low levels of entrepreneurial activities make such change difficult, while Marques and Morgan (2018) also suggest that the smart specialisation policy approach needs to be less science and technology oriented and more attuned to the heterogeneity of local conditions. Moreover, with respect to governance of regional innovation policy, Kroll (2019) suggests that smart specialisation has continued to face issues of conflict about remit and resources between different spatial levels of governance, or issues of co-ordination between policy programmes, while Marques and Morgan (2018) contend that smart specialisation has again brought to the fore a reality of constant tension and conflict in multi-level governance co-ordination, not only between the EU and member states, but also within member states themselves.

Therefore, while the period of study for this research dates to the 2000-13 period, its findings and proposals nonetheless most likely remain relevant for policy making in lagging regions in the upcoming 2021-27 Structural Fund programming period.

13.4 Research Limitations

In every research study, there will always be some limitations to be noted. In the context of this research, its limitations can be described as follows:

- the quantitative analysis that was used, as a filtering process to identify possible candidate regions for case study research, was limited by the number and the nature of the indicators that are available to track R&D and innovation investment and performance. Moreover, the analysis was also limited by the fact that such indicators are often less readily available at the regional level than at the national level;
- the decision to carry out case study research for two regions was taken so as to allow for a greater depth of research investigation for each region, while also keeping the research manageable. However, focusing the research on two regions is also a possible limitation of the research, as it makes the research findings and conclusions less generalisable;
- similarly, the interviews carried out for the case study research sought to conduct in-depth, face-to-face discussions with candidates that (a) possessed experience related to R&D/innovation and regional innovation systems in the case study regions, covering both the 2000-06 and 2007-13 Structural Fund programming periods and (b) were representative of the different sub-systems of actors that are

involved in the regional innovation systems (e.g. policy makers, policy implementers, universities/research institutions, firm and industry representative bodies). However, the nature of the interviews and the resources available to the research meant that a relatively small number of interviews were conducted, which might also be construed as a possible limitation that affects generalisability;

- in addition, use of qualitative techniques, such as interviews, in any research can leave research findings open to the possible limitation of interviewee bias, and indeed researcher bias, despite sourcing a mix of experienced/credible interviewees and different types of interviewees, using a standardised interview protocol for the conduct of the semi-structured interviews, and using a consistent approach to the recording of data from interviews;
- the research time horizon was principally focused on the 2000-13 period, which was chosen because the 2000-06 and 2007-13 periods were the first two periods during which the EU introduced R&D and innovation as a major investment priority within its Structural Fund investment programmes, and investment activity across these periods was well progressed at the commencement of the current research (see Chapter 5, Section 5.4.5). While similar research into the more recent 2014-20 Structural Fund programming period could not be conducted, as policy implementation and investment activity for that period had only recently commenced when this research was started, the restriction of the study time horizon to the 2000-13 period might nonetheless be considered to be a possible limitation of the research.

13.5 Recommendations for Future Research

Following on from this research, there are also a number of recommendations that can be clearly made regarding opportunities for worthwhile future research. Key related opportunities for future research, for example, would include:

- the opportunity to carry out similar research on the progress of R&D and innovation policy and regional innovation systems in both Galicia and Puglia during the 2014-20 period, and their experience in that period's application of "smart specialisation" strategies;

- replication of similar research across multiple time periods in other "lagging" regions. This should include:
  - research in other lagging regions in the former EU-15 member states, e.g. other regions that were included in the analysis provided in Chapter 6 and Chapter 7;
  - research in lagging regions within the "new" member states that have joined the EU since 2004 (given that such regions have now had access to EU Structural Fund support for close to two decades);
  - research in regions that have regional government administrations (e.g. other lagging regions in Spain, Italy), but also in regions that do not (e.g. lagging regions in Portugal);
- more targeted research at a more localised or sub-regional level within lagging regions, i.e. to gauge the extent to which innovation systems are being fostered at this level, and the potential policy implications of this;
- more targeted research on the specific issue of the governance of R&D and innovation policy in lagging regions, so as to develop a more detailed understanding of how the different spatial levels of regional government, national government and the EU interact, and the potential policy implications of this, plus (more widely) the development of better connections between research on governance and research on regional development/regional innovation more generally;
- more targeted research on links between human capital and R&D and innovation performance in lagging regions, e.g. to explore any relationship between human capital and R&D and innovation performance in lagging regions with well-educated populations (such as Galicia, or other lagging regions in Spain).

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APPENDICES

APPENDIX A – OVERVIEW OF LAGGING REGIONS

A.1 Introduction

This appendix provides a more detailed overview of the socio-economic profile for the 22 lagging regions that were examined during the quantitative analysis for this research (see Chapters 6-7). It thus complements the summary profile of regions provided in Chapter 3 (Section 3.3).

To recap, the sample regions were drawn from 53 regions in the EU-15 which had "Objective 1" status for Structural Fund support during the 2000-06 Structural Fund programming period (see Chapter 3, Section 3.2), with these regions included over other regions based on the availability of data regarding innovation performance (see Chapter 5 and Chapter 6). While all 22 regions had Objective 1 status for Structural Fund support during the 2000-06 Structural Fund programming period, 15 regions also had "Convergence" status for support during the 2007-13 Structural Fund programming period (see Chapter 3, Section 3.2).

The data that is examined in the appendix, moreover, highlights broad similarities or differences between the regions as well as some recent trends in commonly used socio-economic indicators, based on the types of indicators that are typically used when describing regions that are classified as being "lagging". In particular, and in line with the description of such regions as per the European Commission (2017a), this includes:

- population and population density (Section A.2);
- GDP (Section A.3);
- labour market participation, employment and unemployment rates (Section A.4);
- education levels, i.e. level of tertiary education attainment (Section A.5);
- sectoral breakdown of economic activity, i.e. broad sectoral shares attributable to agriculture, industry and construction, and services (Section A.6).

The data examined looks at trends between 2000 and 2013 (to correspond with the period of analysis for innovation performance in this research – see Chapter 6), while taking note of trends between 2013 and 2018 (or most recent year available). Regional trends are also compared with EU-15 averages, where available, in line with the chosen sample of regions and study period.

As a reminder, the 22 sample regions examined, and their Structural Fund support status for both the 2000-06 programming period and the 2007-13 programming period, are again listed in Table A.1 below.

Table A.1: Lagging Regions Eligible for EU Structural Fund Assistance 2000-13 – Study Sample

Region	**Country**	**Objective 1 Region (2000-06)**	**Convergence Region (2007-13)**
Corsica	France	✓	
Basilicata	Italy	✓	✓
Calabria	Italy	✓	✓
Campania	Italy	✓	✓
Molise	Italy	✓	
Puglia	Italy	✓	✓
Sardegna	Italy	✓	
Sicilia	Italy	✓	✓
Algarve	Portugal	✓	✓
Norte	Portugal	✓	✓
Região Autónoma dos Açores	Portugal	✓	✓
Região Autónoma da Madeira	Portugal	✓	
Andalucía	Spain	✓	✓
Canarias	Spain	✓	✓
Cantabria	Spain	✓	
Castilla-la Mancha	Spain	✓	✓
Castilla y León	Spain	✓	
Comunidad Valenciana	Spain	✓	
Extremadura	Spain	✓	✓
Galicia	Spain	✓	✓
Principado de Asturias	Spain	✓	✓
Región de Murcia	Spain	✓	✓

Source: Derived from European Commission (1999, 2006)

A.2 Population

As noted in Chapter 3 (Section 3.2), the European Commission (2017a) has pointed to varying population performance in lagging regions, with some regions growing population and some regions losing population, including out-migration of younger and more educated people. This, in turn, is borne out when looking at trends in population growth in the regions between 2000 and 2013, and between 2013 and 2018.

In this regard, for example, data on population levels in the 22 lagging regions under review (based on 2018 data, sourced from Eurostat) shows that population in these regions varies considerably, ranging from a low of 240,000 (the Açores in Portugal) up to a high of 8.4 mn (the Andalucía region in Spain), with seven regions having a population of less than 1.0 mn, nine regions having a population of between 1.0 mn and 3.0 mn, and six regions having a population of more than 3.0 mn.

Table A.2, meanwhile, shows population growth for the regions between 2000 and 2013 and between 2013 and 2018. Between 2000 and 2013, it shows that population change in the regions ranged from a low of -4% (Basilicata in Italy) up to a high of about 27% (Canarias in Spain), while the EU-15 average for population growth in the period was 6%. In general, therefore, there was a noticeable trend of population decline or stagnation among most Italian regions, alongside the Norte region in Portugal and the region of Principado de Asturias in Spain, while population growth of between 1% and 8% was found in some Portuguese and Spanish regions (e.g. Castilla y León, Galicia, Extremadura, Azores, Madeira), and growth of 10% or more was found in other regions, mainly in Spain (e.g. Cantabria, Andalucía, Castilla-la Mancha, Comunidad Valenciana, Canarias and Región de Murcia). In contrast to this, however, population change between 2013 and 2018 ranged from negative growth of -4% (Castilla y León in Spain) up to positive growth of 5% (Corsica in France), with 15 regions experiencing a decline in population, and only three regions experiencing population growth (of 1% or more), compared to average EU-15 population growth of 2%. Stagnant or declining population over this period, moreover, was most likely influenced by the aftermath of the global financial and economic crisis of 2008-09, and its impact on regional economies.

Table A.2: Growth in Population in Lagging Regions 2000-13 and 2013-18

Region	Country	2000 (000s)	2013 (000s)	2018 (000s)	Growth 2000-13 (%)	Growth 2013-18 (%)
Canarias	Spain	1,659	2,105	2,177	26.9%	3.4%
Región de Murcia	Spain	1,169	1,462	1,476	25.1%	0.9%
Comunidad Valenciana	Spain	4,104	4,987	4,946	21.5%	-0.8%
Corsica	France	265	320	336	21.0%	5.1%
Castilla-la Mancha	Spain	1,742	2,094	2,033	20.2%	-3.0%
Algarve	Portugal	385	444	440	15.3%	-1.1%
Andalucía	Spain	7,286	8,393	8,410	15.2%	0.2%
Cantabria	Spain	533	590	581	10.6%	-1.5%
Região Autónoma da Madeira	Portugal	243	263	254	8.3%	-3.3%
EU (15 Countries)					5.9%	2.1%
Extremadura	Spain	1,060	1,101	1,070	3.9%	-2.8%
Região Autónoma dos Açores	Portugal	241	248	244	2.8%	-1.5%
Galicia	Spain	2,702	2,762	2,703	2.2%	-2.1%
Castilla y León	Spain	2,473	2,519	2,419	1.8%	-4.0%
Campania	Italy	5,718	5,770	5,827	0.9%	1.0%
Puglia	Italy	4,035	4,051	4,048	0.4%	-0.1%
Norte	Portugal	3,652	3,666	3,576	0.4%	-2.5%
Sicilia	Italy	4,994	5,000	5,027	0.1%	0.5%
Sardegna	Italy	1,639	1,640	1,648	0.1%	0.5%
Principado de Asturias	Spain	1,068	1,068	1,028	0.0%	-3.8%
Molise	Italy	323	313	308	-2.9%	-1.5%
Calabria	Italy	2,029	1,958	1,957	-3.5%	-0.1%
Basilicata	Italy	601	576	567	-4.2%	-1.6%

Source: Author's calculations based on Eurostat data (dated 13-09-19, extracted 20-12-19)

Table A.3, on the other hand, shows population density in the same lagging regions in the years 2000, 2013 and 2017. It shows that the population density in the regions varies considerably although, perhaps unsurprisingly, the population density in most regions has seen little change over time. The most densely populated regions include Campania, Puglia and Sicily (Italy) as well as Madeira (Portugal), Canarias and Comunidad Valenciana (Spain), while the most sparsely populated regions are found in Corsica (France), Castilla y León, Extremadura and Castilla-la Mancha (Spain).

A majority of regions have population densities that are below the EU-15 average, including: Spanish regions such as Cantabria, Principado de Asturias, Andalucía, Galicia, Castilla y León, Extremadura and Castilla-la Mancha; Portuguese regions such as Açores and Algarve; and Italian regions such as Molise, Sardinia and Basilicata. Regions with population densities above the EU-15 average, meanwhile, include: Spanish regions such as Comunidad Valenciana, Canarias and Región de Murcia;

Portuguese regions such as Madeira and Norte; and Italian regions such as Campania, Puglia, Sicily and Calabria.

Table A.3: Population Density (per Km^2) in Lagging Regions 2000, 2013 and 2017

	2000		2013		2017
Campania	427	Campania	426	Campania	428
Madeira	304	Madeira	327	Madeira	319
Canarias	224	Canarias	283	Canarias	292
Comunidad Valenciana	177	Comunidad Valenciana	216	Comunidad Valenciana	214
Puglia	210	Puglia	208	Puglia	210
Sicilia	196	Sicilia	195	Sicilia	196
Norte	172	Norte	172	Norte	170
Región de Murcia	104	Región de Murcia	130	Región de Murcia	130
Calabria	137	Calabria	129	Calabria	129
EU (15 Countries)	114	EU (15 Countries)	121	EU (15 Countries)	123
Cantabria	100	Cantabria	112	Cantabria	110
Açores	104	Açores	107	Açores	106
Principado de Asturias	101	Principado de Asturias	101	Principado de Asturias	98
Andalucía	83	Andalucía	97	Andalucía	97
Galicia	91	Galicia	94	Galicia	92
Algarve	78	Algarve	89	Algarve	89
Molise	74	Molise	70	Molise	70
Sardegna	69	Sardegna	69	Sardegna	69
Basilicata	62	Basilicata	57	Basilicata	57
Corsica	31	Corsica	37	Corsica	39
Extremadura	25	Extremadura	27	Extremadura	26
Castilla y León	26	Castilla y León	27	Castilla y León	26
Castilla-la Mancha	22	Castilla-la Mancha	26	Castilla-la Mancha	26

Source: Eurostat data (dated 13-09-19, extracted 20-12-19)

Finally, reflecting population densities, urban-rural typologies for the 22 regions would suggest a mix of either “predominantly rural” regions (whereby the rural population accounts for more than 50% of the total population) or “intermediate” regions (whereby the rural population accounts for between 20% and 50% of the total population)[82].

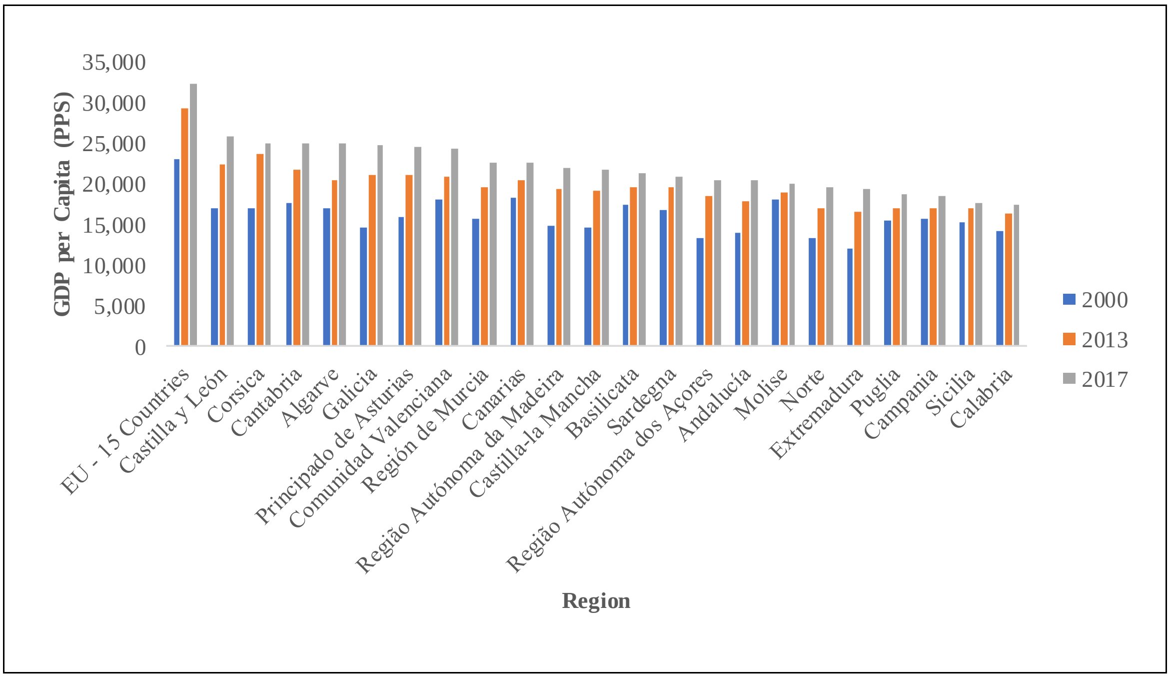
A.3 GDP

The analysis of the European Commission (2017a), as noted earlier in Chapter 3 (Section 3.2), has also pointed to lower levels of economic output in lagging regions, when compared to more advanced regions. Figure A.1, for example, provides details of GDP per capita for the 22 lagging regions studied here, in PPS terms for the years 2000,

[82] See, for example, http://ec.europa.eu/eurostat/statistics-explained/index.php/Urban-rural_typology#.

2013 and 2017. In 2013, GDP per capita in the regions ranged from a low of €16,300 (Calabria in Italy) up to a high of €23,800 (Corsica in France), with a median GDP per capita of €19,500. For all regions, therefore, GDP per capita was well below the EU-15 average of €29,300, i.e. much the same situation as was evident in 2000. By 2017, meanwhile, levels of GDP per capita in the regions had improved somewhat, ranging from a low of €17,400 (Calabria in Italy) up to a high of €25,800 (Castilla y León in Spain), though GDP per capita in the regions still remained well below the EU-15 average of €32,400.

Figure A.1: GDP per Capita (PPS) in Lagging Regions 2000, 2013 and 2017



Source: Eurostat data (dated 06-09-19, extracted 23-12-19)

Nonetheless, economic output in these regions generally grew between 2000 and 2013, though the rate of growth varied. Table A.4, for example, shows growth in GDP per capita (PPS) in current prices for the 22 regions between 2000 and 2013, and it shows that growth in many Spanish and Portuguese regions, in particular, was at a rate above the EU-15 average for the period (27%). In Spain, these regions included Galicia, Extremadura, Principado de Asturias, Castilla y León, Castilla-la Mancha and Andalucía, while in Portugal the regions included Açores, Madeira and Norte. For some other Spanish regions and all Italian regions, however, growth in GDP per capita was below the EU-15 average, and in the case of many such regions (e.g. Canarias in Spain, and Sicily, Calabria, Molise, Puglia, Basilicata and Campania in Italy), growth was well below average.

Table A.4: Growth in GDP per Capita (PPS) in Current Prices in Lagging Regions 2000-17

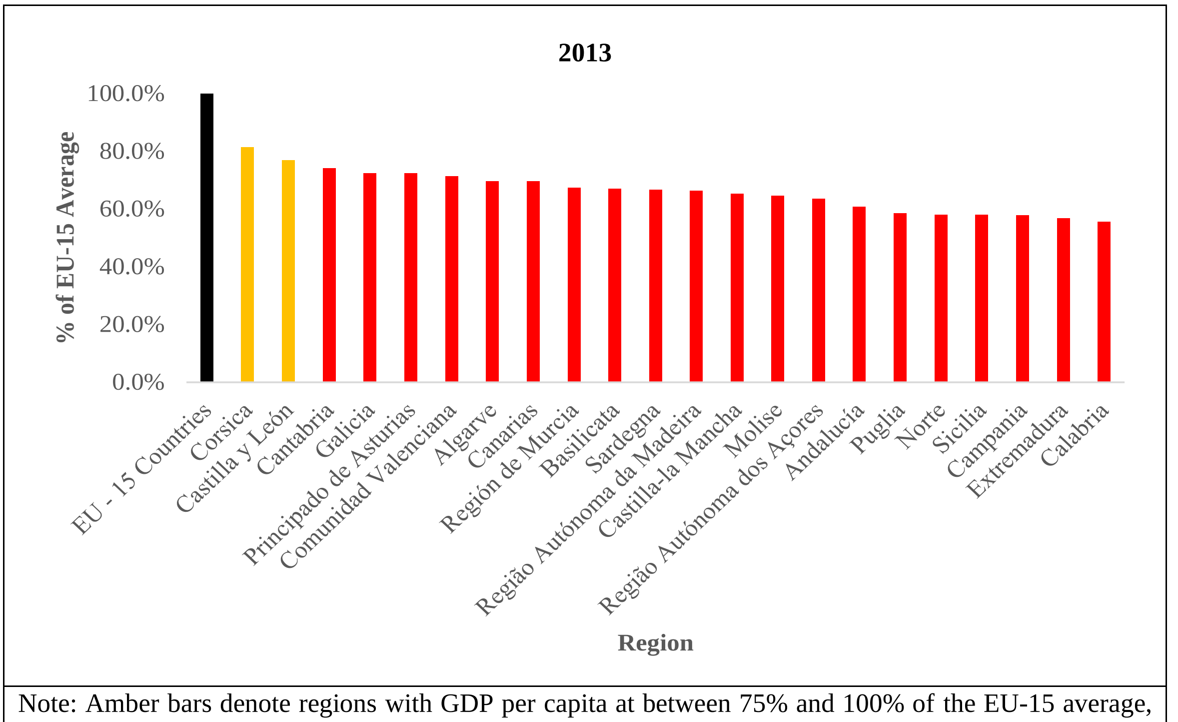
Region	Country	2000	2013	2017	Growth 2000-13 (%)	Growth 2013-17 (%)
Galicia	Spain	14,700	21,200	24,700	44.2%	16.5%
Corsica	France	17,100	23,800	25,100	39.2%	5.5%
Região Autónoma dos Açores	Portugal	13,400	18,600	20,500	38.8%	10.2%
Extremadura	Spain	12,000	16,600	19,300	38.3%	16.3%
Principado de Asturias	Spain	15,900	21,200	24,500	33.3%	15.6%
Castilla y León	Spain	17,100	22,500	25,800	31.6%	14.7%
Região Autónoma da Madeira	Portugal	14,800	19,400	22,000	31.1%	13.4%
Castilla-la Mancha	Spain	14,700	19,100	21,800	29.9%	14.1%
Norte	Portugal	13,300	17,000	19,500	27.8%	14.7%
Andalucía	Spain	14,000	17,800	20,400	27.1%	14.6%
EU (15 Countries)		23,030	29,280	32,410	27.1%	10.7%
Región de Murcia	Spain	15,800	19,700	22,700	24.7%	15.2%
Cantabria	Spain	17,600	21,700	25,000	23.3%	15.2%
Algarve	Portugal	17,000	20,400	24,900	20.0%	22.1%
Comunidad Valenciana	Spain	18,000	20,900	24,300	16.1%	16.3%
Sardegna	Italy	16,800	19,500	20,900	16.1%	7.2%
Calabria	Italy	14,200	16,300	17,400	14.8%	6.7%
Basilicata	Italy	17,400	19,600	21,400	12.6%	9.2%
Sicilia	Italy	15,300	17,000	17,700	11.1%	4.1%
Canarias	Spain	18,400	20,400	22,700	10.9%	11.3%
Puglia	Italy	15,600	17,100	18,700	9.6%	9.4%
Campania	Italy	15,700	16,900	18,500	7.6%	9.5%
Molise	Italy	18,100	18,900	20,100	4.4%	6.3%

Source: Author's calculations based on Eurostat data (dated 06-09-19, extracted 23-12-19)

Moreover, it is also notable during this period that growth in many regions was particularly strong during the 2000-07 period, while several regions then experienced a decline in GDP per capita over the 2007-13 period, following the global financial and economic crisis that occurred in 2008 and 2009. For example, between 2000 and 2007, growth in the regions ranged from a low of 15% (Puglia in Italy) up to a high of 56% (Galicia in Spain), with growth in most Spanish regions being well above the EU-15 average of 27%, while growth in the Italian regions was mainly below this. Between 2007 and 2013, on the other hand, the EU-15 average for GDP per capita experienced no growth, while all but three of the lagging regions examined here (Corsica in France, and Norte and Açores in Portugal) experienced a decline in GDP per capita, with the largest percentage declines experienced in Spanish regions (e.g. Castilla-la Mancha, Región de Murcia, Principado de Asturias, Canarias, Comunidad Valenciana, Andalucía and Cantabria). Thereafter, Table A.4 shows that there was some recovery in GDP per capita between 2013 and 2017, with 13 of the 22 regions (mainly in Spain and Portugal) experiencing growth that was higher than the EU-15 average of 11% for that period.

Lagging regions thus made some progress in converging GDP per capita towards the EU-15 average between 2000 and 2007, before experiencing a reversal of this trend in many cases between 2007 and 2013, followed by some recovery in growth between 2013 and 2017. However, Figure A.2a and Figure A.2b show that only two of the regions examined (Corsica in France and Castilla y León in Spain) had a GDP per capita that was 75% or more of the EU-15 average in 2013, though this had increased to seven regions (Castilla y León, Cantabria, Galicia, Principado de Asturias and Comunidad Valenciana in Spain, Algarve in Portugal and Corsica in France) by 2017. Also, several Italian regions, including Puglia, Sicily, Campania and Calabria, had a GDP per capita at less than 60% of the EU-15 average in both 2013 and 2017.

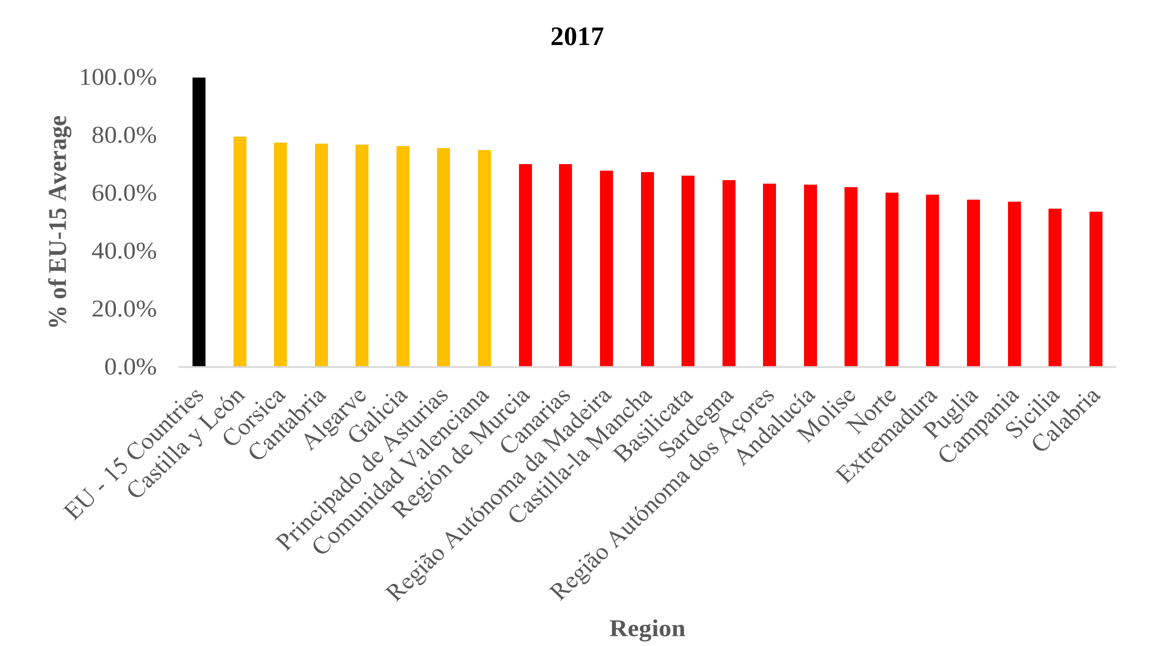
Figure A.2a: GDP per Capita (PPS) as % of EU-15 Average in Lagging Regions 2013 and 2017



Note: Amber bars denote regions with GDP per capita at between 75% and 100% of the EU-15 average, while red bars denote regions with GDP per capita at less than 75% of the EU-15 average.

Source: Author's calculations based on Eurostat data (dated 06-09-19, extracted 23-12-19)

Figure A.2b: GDP per Capita (PPS) as % of EU-15 Average in Lagging Regions 2013 and 2017



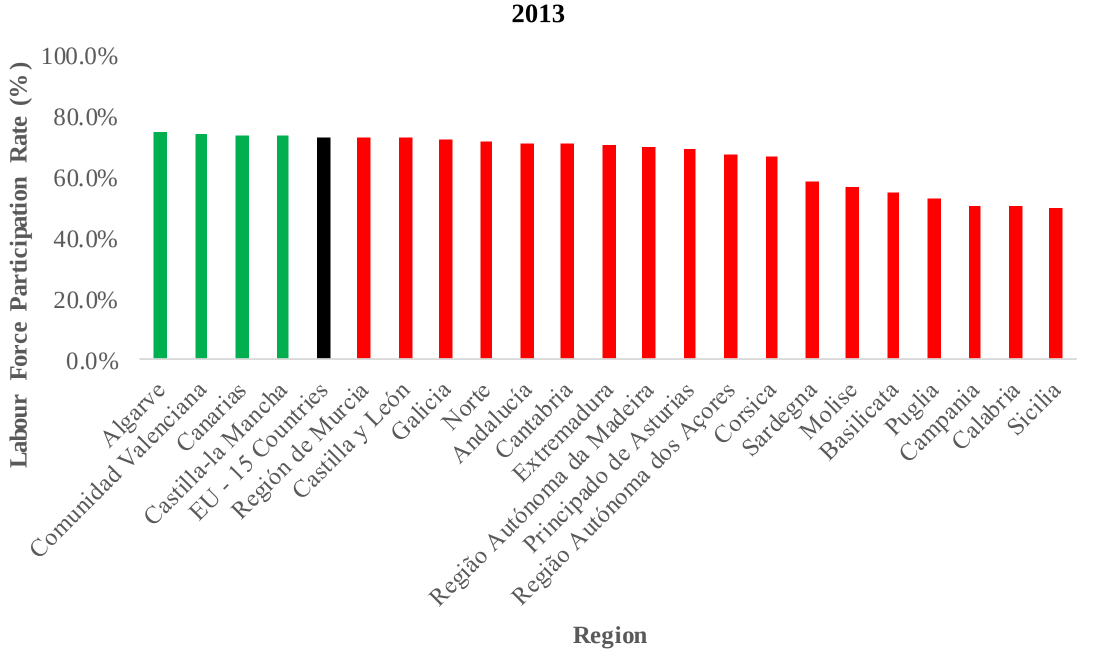
Note: Amber bars denote regions with GDP per capita at between 75% and 100% of the EU-15 average, while red bars denote regions with GDP per capita at less than 75% of the EU-15 average.

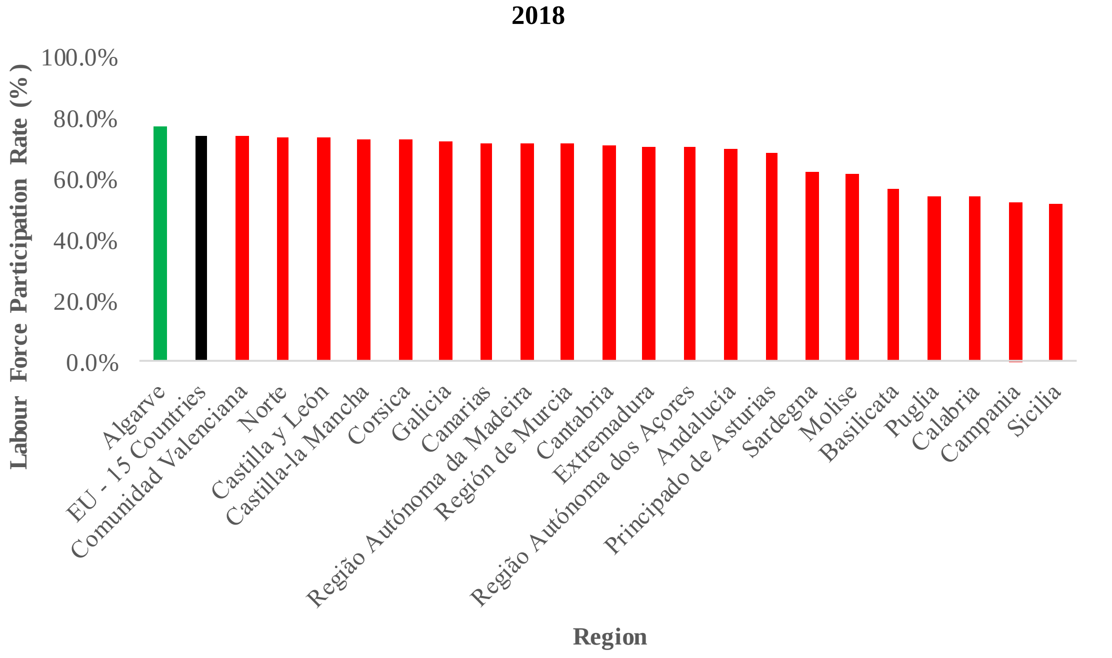
Source: Author's calculations based on Eurostat data (dated 06-09-19, extracted 23-12-19)

A.4 Labour Market

Another perceived issue or weakness in lagging regions, as alluded to by the European Commission (2017a), relates to the labour market situation in such regions, and rates of employment/unemployment. In this regard, for example, Figure A.3 shows labour force participation rates (i.e. the economically active population within the total working age population aged 15-64) in the 22 lagging regions in 2013 and 2018. The figures show that relatively few regions had a labour force participation rate that was at or above the EU-15 average in 2013 (73%), with these regions being mainly Spanish regions (Comunidad Valenciana, Canarias, Castilla-la Mancha). Furthermore, all of the Italian regions examined had labour force participation rates that were below 60% in 2013, which was significantly below the EU-15 average. By 2018, meanwhile, only Algarve in Portugal had labour force participation that was at or above the EU-15 average in that year (74%), with the Spanish regions falling very slightly behind average, while labour force participation in most of the Italian regions (Basilicata, Puglia, Calabria, Campania and Sicilia) remained below 60%.

Figure A.3: Labour Force Participation Rates in Lagging Regions 2013 and 2018



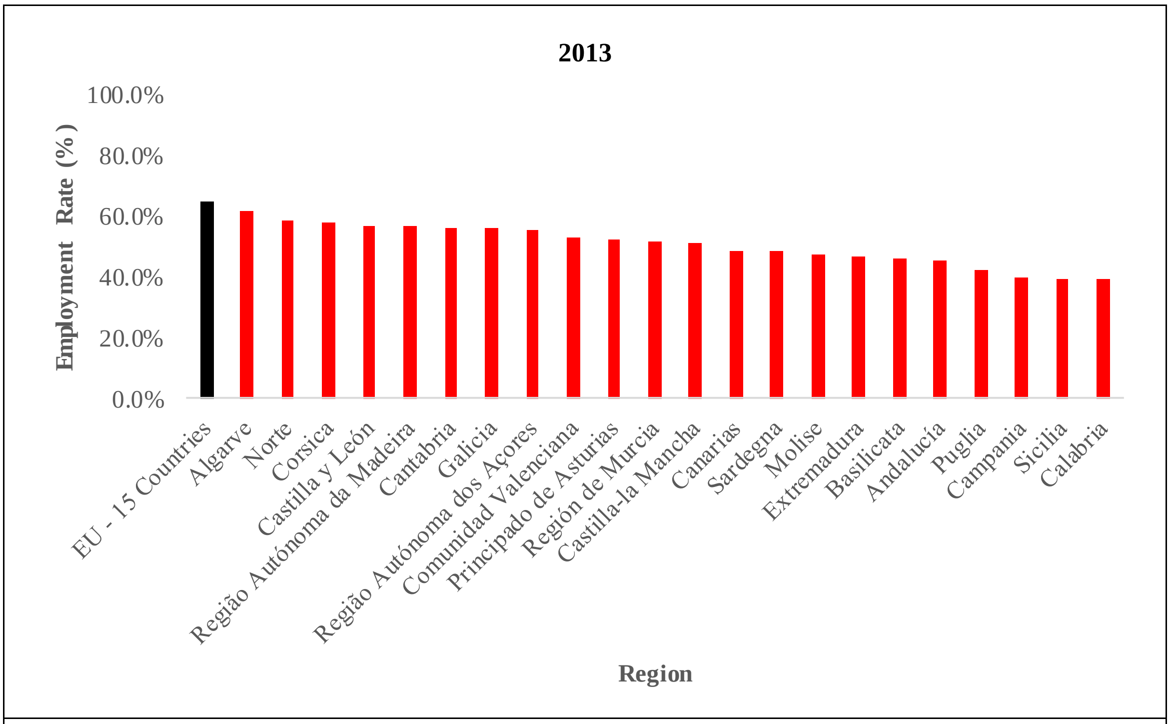


Note: Green bars denote regions with labour force participation rates at or above the EU-15 average, while red bars denote regions with labour force participation rates below the EU-15 average.

Source: Author's calculations based on Eurostat data (dated 11-12-19, extracted 20-12-19)

Figure A.4a and Figure A.4b, on the other hand, show employment levels as a share of the total working age population (people aged 15-64) in the same regions in 2013 and 2018. In this case, the data suggests that rates of employment for all regions were below the EU-15 average of 65% in 2013, with most of the regions having an employment rate of less than 60%. Furthermore, the rate of employment was below 50% in regions such as Canarias, Extremadura and Andalucía (Spain) as well as Sardinia, Molise, Basilicata and Puglia (Italy), while the rate of employment was about 40% in regions such as Campania, Sicily and Calabria (Italy). In 2018, meanwhile, employment rates in Algarve (Portugal) and Corsica (France) were higher than the EU-15 average of 69%, most Spanish regions had employment rates of between 55% and 65%, while the Italian regions of Basilicata, Puglia, Calabria, Campania and Sicily had employment rates below 50%.

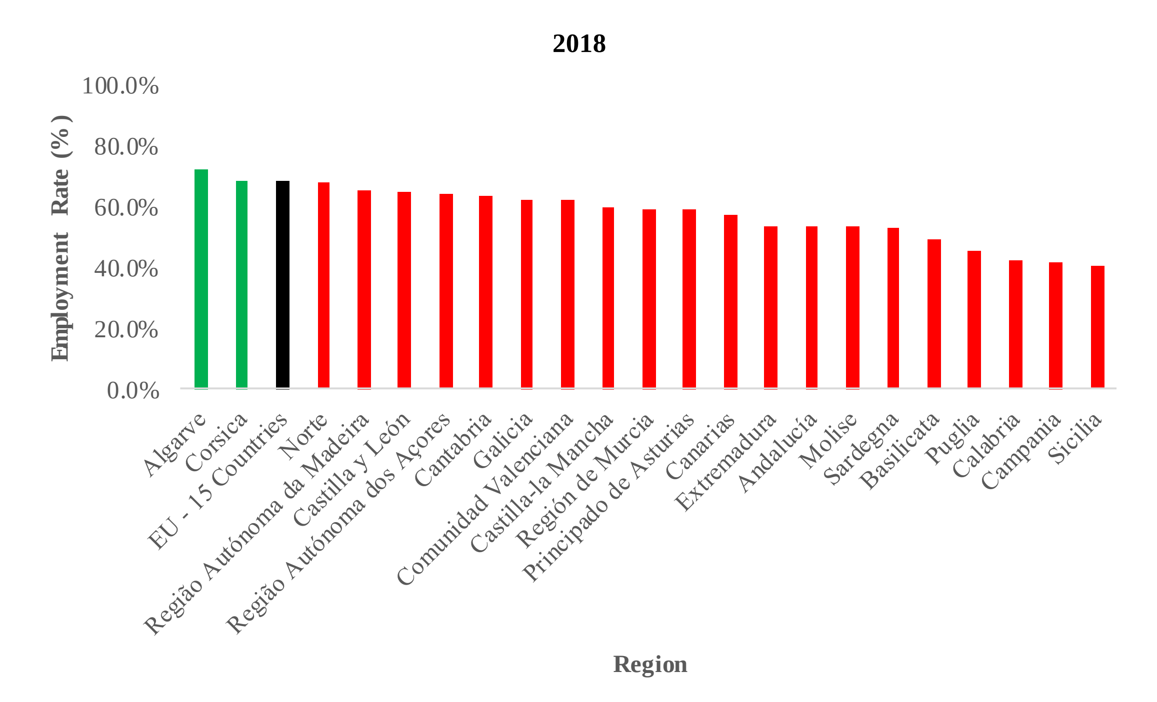
Figure A.4a: Employment Rates as % of Working Age Population (15-64) in Lagging Regions 2013 and 2018



Note: Green bars denote regions with employment rates above the EU-15 average, while red bars denote regions with employment rates below the EU-15 average.

Source: Author’s calculations based on Eurostat data (dated 11-12-19, extracted 20-12-19)

Figure A.4b: Employment Rates as % of Working Age Population (15-64) in Lagging Regions 2013 and 2018

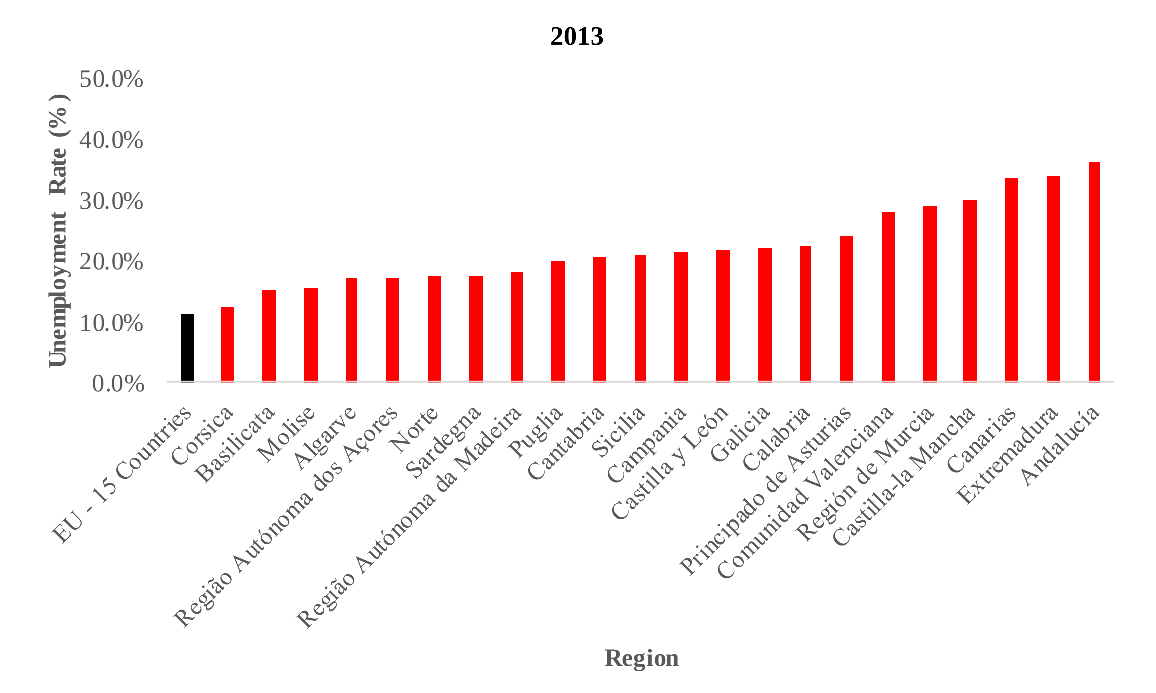


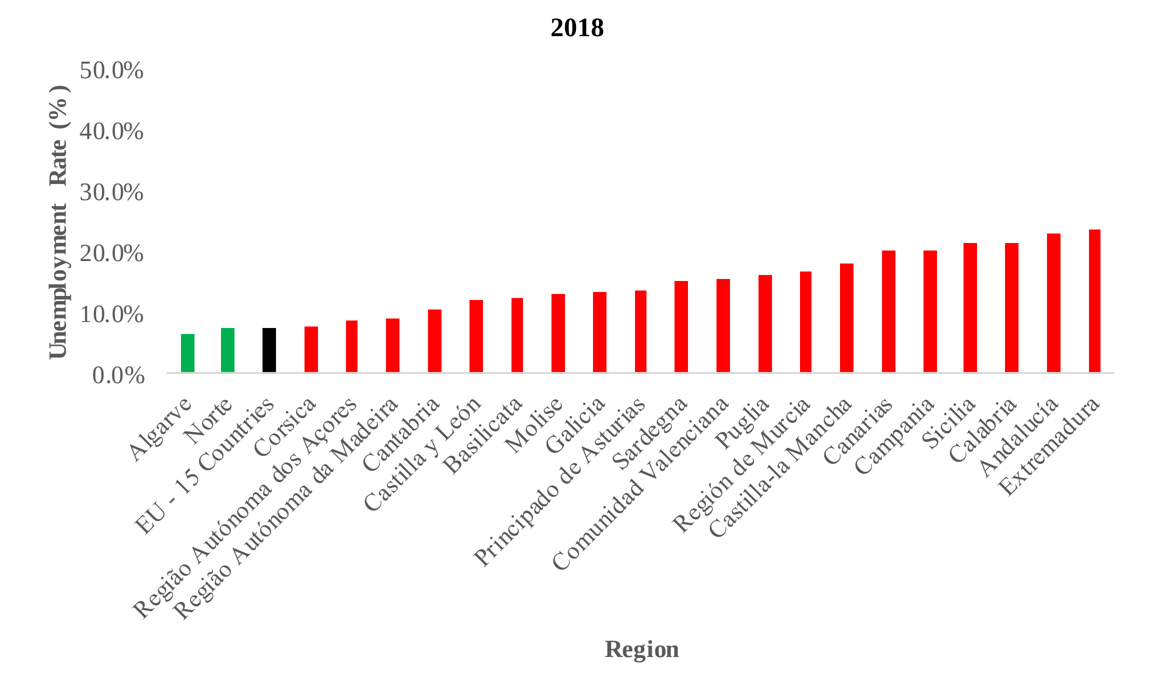
Note: Green bars denote regions with employment rates above the EU-15 average, while red bars denote regions with employment rates below the EU-15 average.

Source: Author's calculations based on Eurostat data (dated 11-12-19, extracted 20-12-19)

Lastly, Figure A.5 shows unemployment rates in each of the same regions in 2013 and 2018. Unsurprisingly, given the trends evident in labour force participation and employment levels, the data shows that unemployment rates were above the EU-15 average of 11% in all regions in 2013. However, unemployment rates were particularly high in Spanish lagging regions, ranging from about 20% in Cantabria up to 36% in Andalucía, while the unemployment rate for lagging regions in Italy and Portugal in 2013 was generally between 15% and 20%. By 2018, on the other hand, the Portuguese regions of Algarve and Norte had unemployment levels that were slightly below the EU-15 average of just over 7%. Spanish regions had also experienced a notable reduction in unemployment, ranging from 11% in Cantabria up to 24% in Extremadura, while unemployment in Italian regions ranged from about 12% in Basilicata up to about 22% in Calabria. Nonetheless, unemployment rates in most of these regions generally remained high relative to the EU-15 average.

Figure A.5: Unemployment Rates (%) in Lagging Regions 2013 and 2018





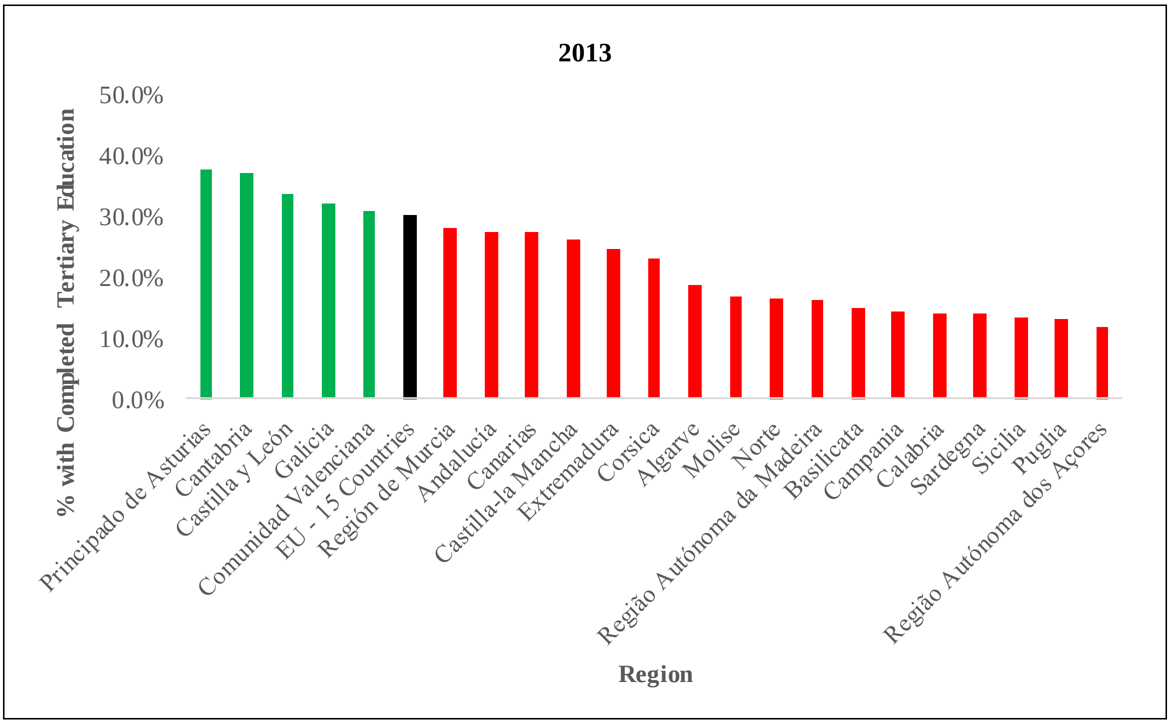
Note: Green bars denote regions with unemployment rates below the EU-15 average, while red bars denote regions with unemployment rates above the EU-15 average. Data for Corsica relates to 2013 and 2017.

Source: Author's calculations based on Eurostat data (dated 11-12-19, extracted 30-12-19)

A.5 Education

The analysis of the European Commission (2017a), as noted earlier in Chapter 3 (Section 3.2), has also pointed to lower levels of educational attainment in lagging regions, and thus lower levels of advanced skills, when compared to more advanced regions. In this regard, for example, Figure A.6a and Figure A.6b show the share of the population aged 25-64 that had completed tertiary education as of 2013 and 2018, in each of the 22 lagging regions. It shows that tertiary education levels in 17 of the regions were below the EU-15 average of 30% in 2013, with the level of tertiary education in Italian regions (Molise, Basilicata, Campania, Calabria, Sardinia, Sicily and Puglia) and Portuguese regions (Algarve, Norte, Madeira and Azores) being below 20%. A number of Spanish regions, however, had tertiary education levels that were above the EU-15 average in 2013, including Principado de Asturias, Cantabria, Castilla y León, Galicia and Comunidad Valenciana, while tertiary education levels were at 25% or more in other Spanish regions in the same year.

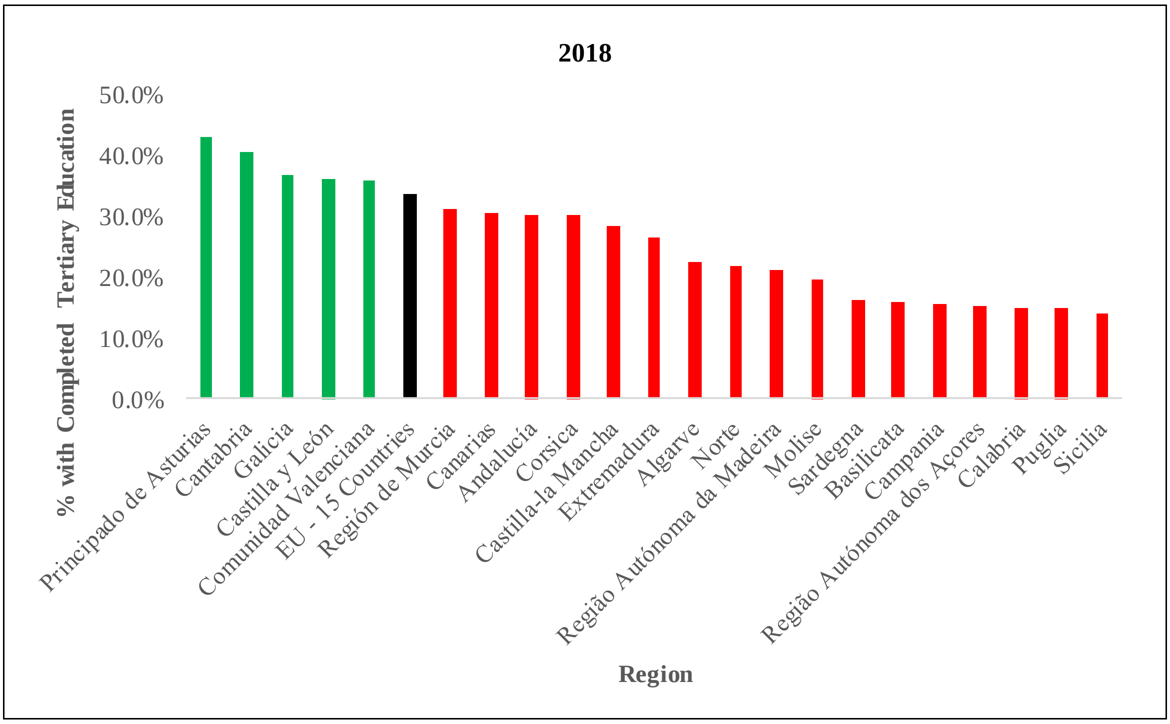
Figure A.6a: % Population Aged 25-64 with Tertiary Education Attainment in Lagging Regions 2013 and 2018



Source: Eurostat data (dated 11-12-19, extracted 20-12-19)

By 2018, moreover, the share of the population aged 25-64 with completed tertiary education remained lower in Italian and Portuguese regions, though its share in some Portuguese regions (Algarve, Norte and Madeira) had grown above 20%, while the Spanish regions of Principado de Asturias, Cantabria, Castilla y León, Galicia and Comunidad Valenciana still had tertiary education levels that were above the EU-15 average of 34% (with the level in other Spanish regions ranging from 25% to 31%).

Figure A.6b: % Population Aged 25-64 with Tertiary Education Attainment in Lagging Regions 2013 and 2018



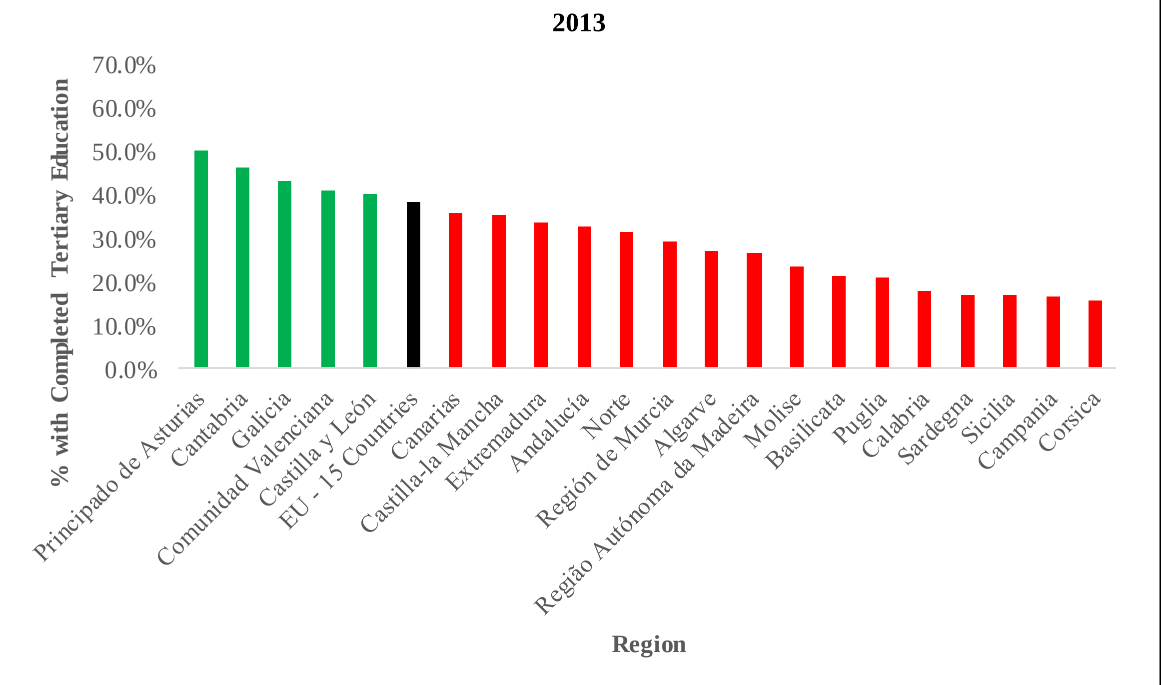
Source: Eurostat data (dated 11-12-19, extracted 20-12-19)

Figure A.7a and Figure A.7b, on the other hand, show the share of the population in the narrower 30-34 age group that had completed tertiary education as of 2013 and 2018, in 21 of the lagging regions[83]. Similarly to the broader 25-64 age group, this data shows that tertiary education levels for this age group were below the EU-15 average of 38% in 16 of the regions examined in 2013. Among the Italian regions, for example, the level of tertiary education among 30-34 year olds ranged from 16% (Campania) up to 24% (Molise), while among Portuguese regions it ranged from 27% (Algarve and Madeira)

[83] The focus on the narrower 30-34 age group has previously been highlighted in other European Commission studies, such as its Regional Innovation Scoreboard (European Commission, 2014b, 2016, 2017b, 2019), in order to better reflect the potential impact of changes in educational policies that are intended to lead to more tertiary graduates in countries/regions.

up to 31% (Norte). Among the Spanish regions, on the other hand, the share of population with completed tertiary education in this age group ranged from 29% (Región de Murcia) up to 50% (Principado de Asturias), with Principado de Asturias, Cantabria, Castilla y León, Galicia and Comunidad Valenciana again all being above the EU-15 average in this regard.

Figure A.7a: % Population Aged 30-34 with Tertiary Education Attainment in Lagging Regions 2013 and 2018

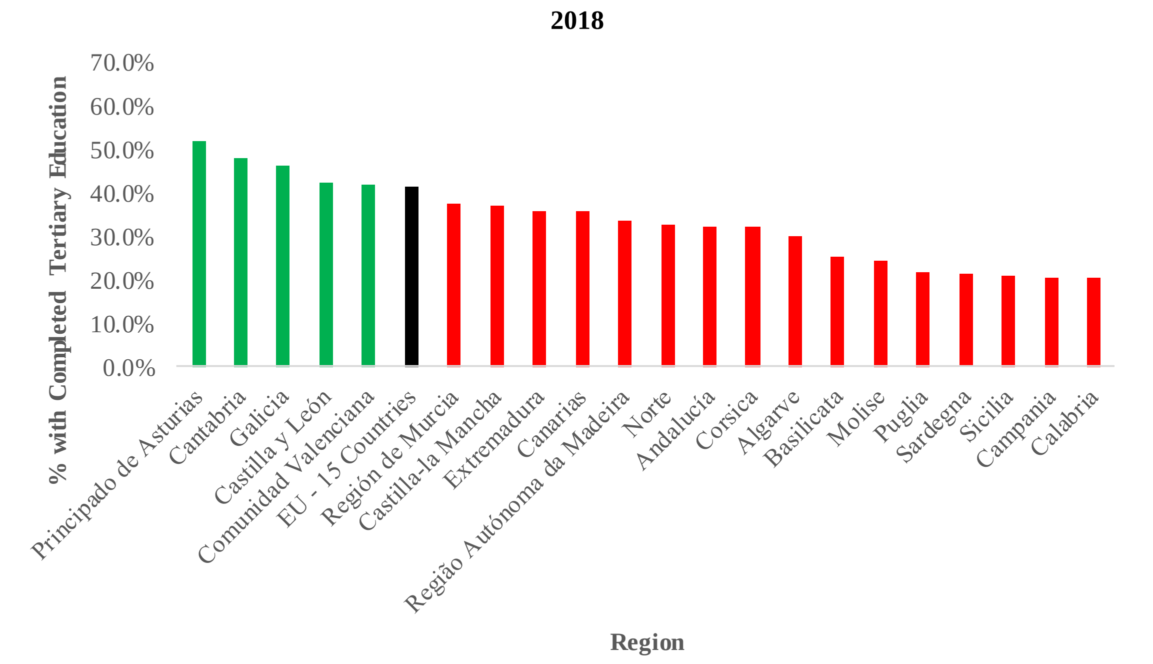


Note: Data for Corsica relates to 2013 and 2017.

Source: Eurostat data (dated 11-12-19, extracted 20-12-19)

By 2018, meanwhile, the share of the population aged 30-34 that had completed tertiary education remained lower in Italian and Portuguese regions, though its share in all regions had grown to more than 20%. Among the Italian regions, the level of tertiary education among 30-34 year olds at this time ranged from 20% (Calabria, Campania) up to 25% (Basilicata), while among Portuguese regions it ranged from 30% (Algarve) up to 34% (Madeira). Again, the Spanish regions of Principado de Asturias, Cantabria, Castilla y León, Galicia and Comunidad Valenciana had tertiary education levels for the age group that were above the EU-15 average of 41% in 2018, with the level in other Spanish regions ranging from 33% to 38%.

Figure A.7b: % Population Aged 30-34 with Tertiary Education Attainment in Lagging Regions 2013 and 2018



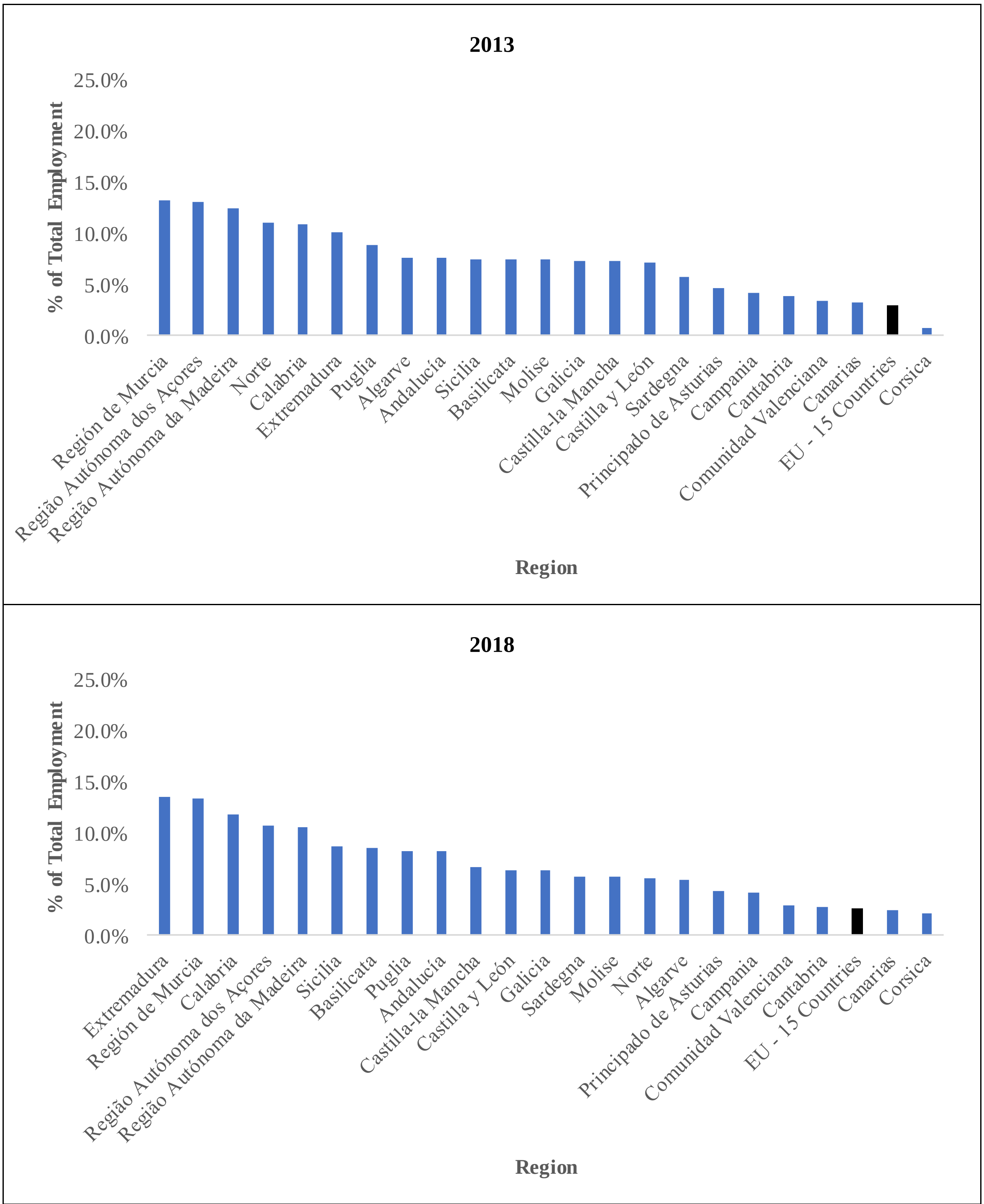
Note: Data for Corsica relates to 2013 and 2017.

Source: Eurostat data (dated 11-12-19, extracted 20-12-19)

A.6 Sectors

Finally, it is also informative to look at the sectoral breakdown of economic activity in lagging regions (i.e. the broad sectoral shares attributable to agriculture, industry and construction, and services) and how it compares to EU-15 averages. Figure A.8, for example, shows that the share of employment in agriculture in these regions, with the exception of Corsica in France, was higher than the EU-15 average of nearly 3% in 2013, with the relative importance of agriculture in these regions ranging from the EU-15 average level of 3% (e.g. Canarias, Comunidad Valenciana in Spain) up to more than 13% (e.g. Región de Murcia in Spain and the Azores region in Portugal). Share of employment in agriculture was above 7% in 15 of the regions, while it was above 10% in six regions. By 2018, meanwhile, just two regions (Corsica in France and Canarias in Spain) had a share of employment in agriculture that was lower than the EU-15 average of about 3%, while its share of employment in other regions ranged from about 3% (Cantabria and Comunidad Valenciana in Spain) up to more than 13% (Extremadura and Región de Murcia in Spain). However, just nine regions had a share of employment in agriculture that was above 7% in 2018 (compared to 15 regions in 2013), while five regions had a share of employment above 10%.

Figure A.8: Agriculture as a % of Employment in Lagging Regions 2013 and 2018

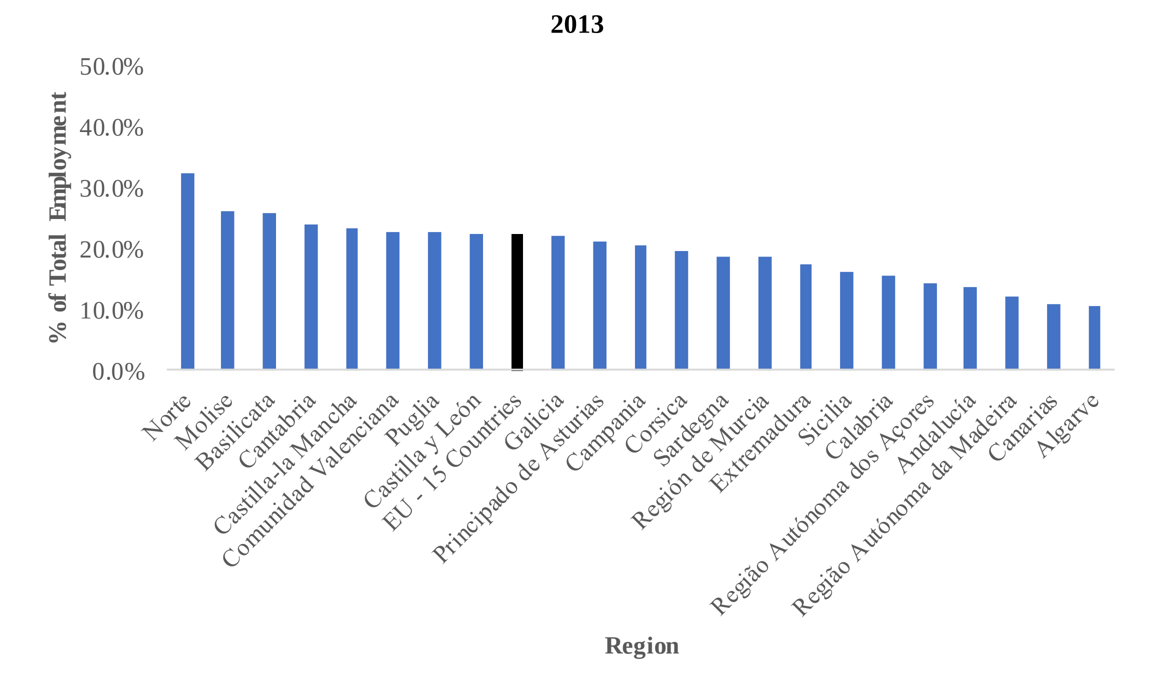


Note: Data for Corsica relates to 2014 and 2017.

Source: Author’s calculations based on Eurostat data (dated 11-12-19, extracted 20-12-19)

Figure A.9a and Figure A.9b, on the other hand, show the share of employment that was attributable to industry and construction in the regions in 2013 and 2018. It shows that a majority of regions (14) had a share of employment in these sectors that was below the EU-15 average of 23% in 2013, though some regions also had a relatively high level of activity in these sectors. In this regard, share of activity therefore ranged from as low as 10%-12% (e.g. Canarias in Spain, and the Algarve and Madeira regions in Portugal) up to as high as 33% (e.g. the Norte region in Portugal). Moreover, there was relatively little change in the share of employment in industry and construction in the regions between 2013 and 2018, with 14 regions having a share of employment in these sectors that was below the EU-15 average of 22% in 2018, while sectoral share ranged from as low as 10%-12% (e.g. Canarias in Spain, Algarve in Portugal and Corsica in France) up to as high as 34% (e.g. the Norte region in Portugal).

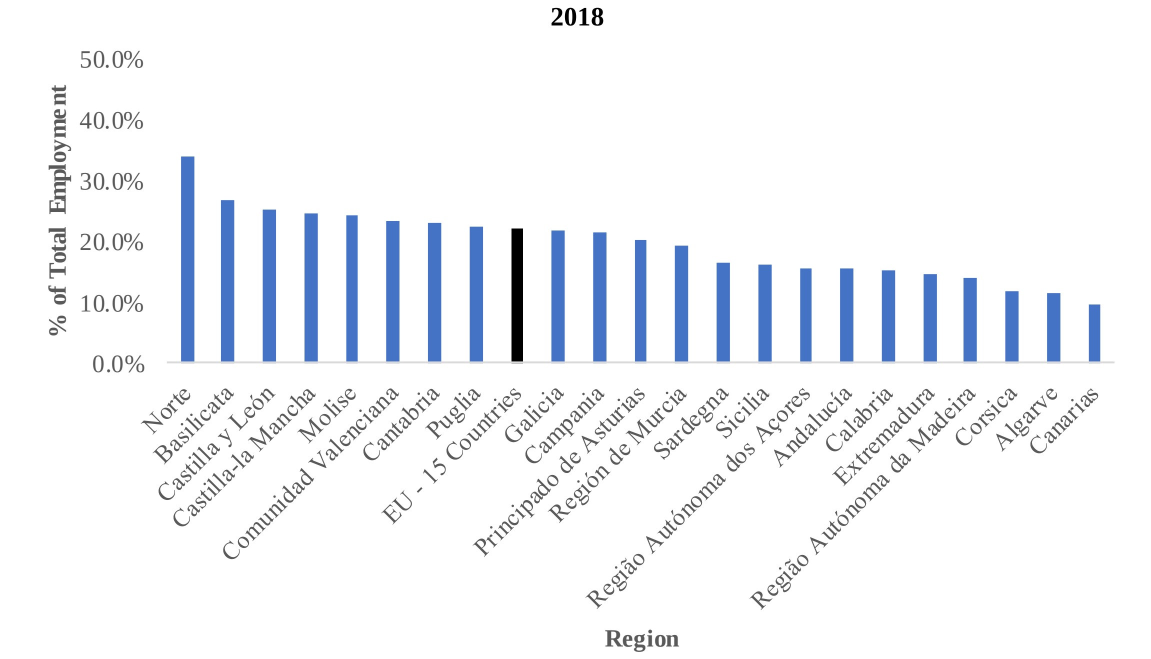
Figure A.9a: Industry and Construction as a % of Employment in Lagging Regions 2013 and 2018



Note: Data for Corsica relates to 2013 and 2017.

Source: Author’s calculations based on Eurostat data (dated 11-12-19, extracted 20-12-19)

Figure A.9b: Industry and Construction as a % of Employment in Lagging Regions 2013 and 2018

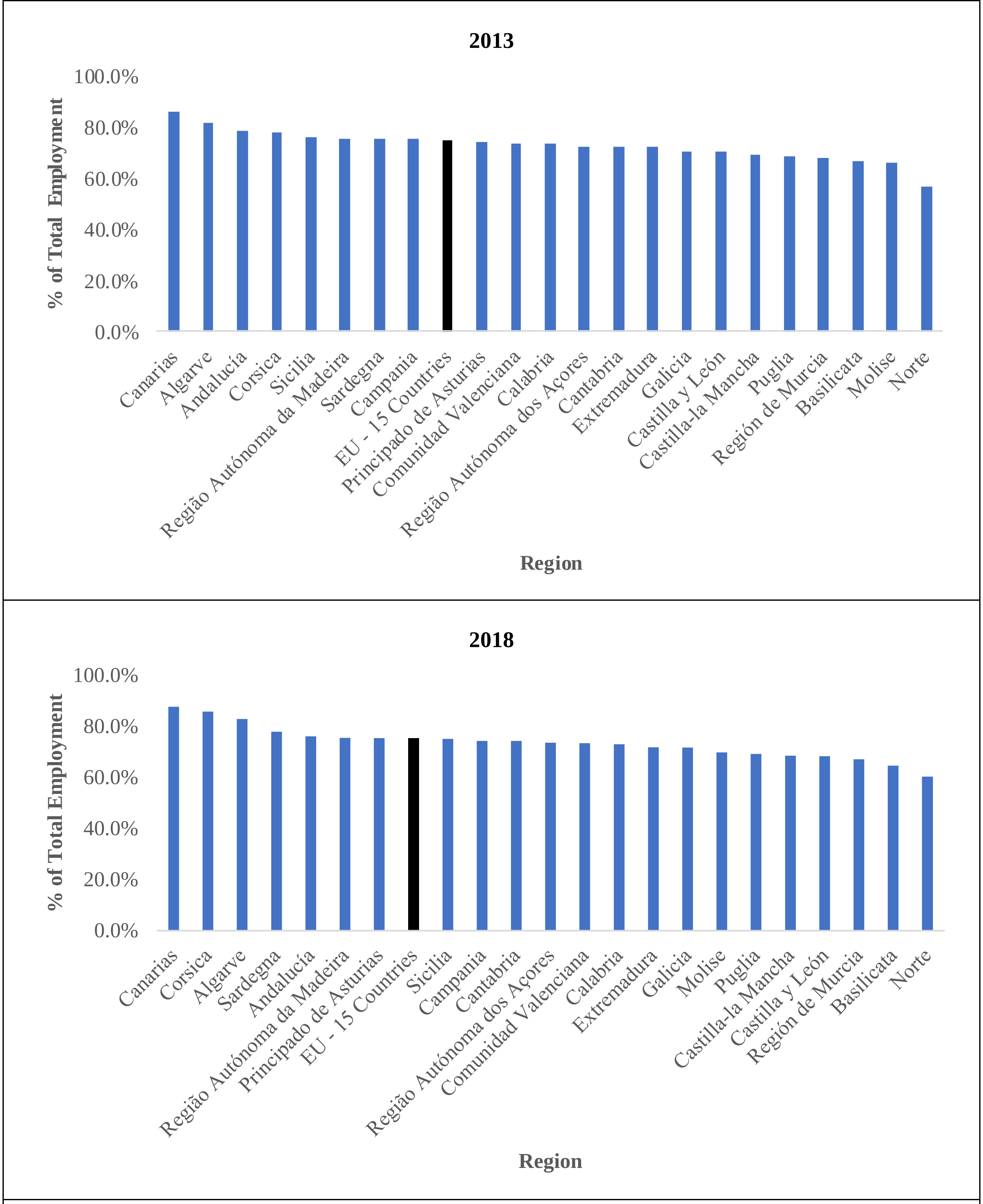


Note: Data for Corsica relates to 2013 and 2017.

Source: Author's calculations based on Eurostat data (dated 11-12-19, extracted 20-12-19)

Lastly, Figure A.10 shows the share of employment that was attributable to services across the 22 regions in 2013 and 2018. The data, for example, suggests that a majority of the regions (15) had a share of employment in services that was below the EU-15 average of 75% in 2013, though with some regions also having a relatively high level of activity in the sector, and with share of services activity ranging from less than 60% of total employment (e.g. the Norte region in Portugal) up to more than 80% of total employment (e.g. Canarias in Spain, the Algarve region in Portugal). Moreover, there was again relatively little change in the share of employment in services in these regions between 2013 and 2018, with 15 regions having a share of employment in services that was below the EU-15 average of 75% in 2018, while sectoral share ranged from 60% (e.g. the Norte region in Portugal) up to more than 80% (e.g. Canarias in Spain, the Algarve region in Portugal and Corsica in France).

Figure A.10: Services as a % of Employment in Lagging Regions 2013 and 2018



Note: Data for Corsica relates to 2014 and 2017.

Source: Author’s calculations based on Eurostat data (dated 11-12-19, extracted 20-12-19)

APPENDIX B – EXAMINATIONS OF INNOVATION IN LAGGING REGIONS

B.1 Introduction

The purpose of this appendix is to review previous research, referred to earlier in Section 6.1.2, that has sought to categorise the innovation performance of regions that have been classified as "lagging", and which provides some context for the descriptive quantitative analysis and categorisation of regions in Chapter 6 and Chapter 7. This includes:

- Section B.2, which examines evidence for the classification of such regions according to the EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b, 2016, 2017b, 2019);
- Section B.3, which looks at evidence from selected other typologies and classifications of regions in the research literature, including Navarro et al (2008), Pinto (2009) and Capello and Lenzi (2013).

B.2 Innovation Performance – Regional Innovation Scoreboard

B.2.1 Overview

The EU's Regional Innovation Scoreboard (European Commission, 2012b, 2014b, 2016, 2017b, 2019) provides a comparative assessment of relative innovation performance below the EU member state level, but particularly across NUTS I and NUTS II regions.

For example, the most recent regional assessment, published in 2019, provides a comparative assessment of innovation performance across 238 regions in 23 EU member states, plus Norway, Serbia and Switzerland. In addition, it includes Cyprus, Estonia, Latvia, Luxembourg and Malta at the country level, as there is no regional classification in these countries.

To provide its comparative assessment, the Regional Innovation Scoreboard assembles evidence from a range of innovation-related indicators, which it then uses to derive a composite indicator or score for each region, which is known as the Regional Innovation Index (RII). In calculating the RII, the Regional Innovation Scoreboard generally uses a sub-set of the indicators that are used in the EU's Innovation Union Scoreboard, which monitors national innovation performance across EU member states and gives a comparative assessment of relative innovation performance at the member state level. This is because regional data for innovation-related indicators is generally more limited than national data, and data at a sub-national level is often not available for many indicators.

B.2.2 Indicators

The Regional Innovation Scoreboard used 17 indicators in 2019 (spread across four different indicator types – framework conditions, investments, innovation activities and impacts – see Table B.1) whereas the Innovation Union Scoreboard, which examines innovation performance at a national level, used 27 indicators for the same year. Indicator coverage for previous regional scoreboards, for comparison, included 12 indicators in 2012, 11 indicators in 2014, 12 indicators in 2016 and 18 indicators in 2017.

There are some caveats, however, which have to be considered when looking at Regional Innovation Scoreboard results. Indicators at the regional level, for example, can be subject to missing data, so data imputation techniques regularly have to be used to provide proxies for such missing data. Moreover, the most recent base year data that is available for each indicator can also vary. In this regard, for the Regional Innovation Scoreboard 2019, the most recent data refers to 2017 for six indicators, 2016 for 10 indicators and 2015 for one indicator. Performance as per the 2019 results, therefore, is interpreted as referring to data about three years prior to the 2019 reference year, i.e. 2016, and the same provision would apply to reports for previous years.

For information, the indicators used in the Regional Innovation Scoreboard 2019 are outlined in Table B.1 below.

Table B.1: Innovation Indicators in the Regional Innovation Scoreboard 2019

FRAMEWORK CONDITIONS	**SOURCE**
Human Resources	
▪ % of population aged 30-34 having completed tertiary education*	Eurostat
▪ % of population aged 25-64 participating in lifelong learning	Eurostat
Attractive Research Systems	
▪ International scientific co-publications per million population	Web of Science/Eurostat
▪ Scientific publications among the Top 10% most cited publications worldwide (as a % of total scientific publications in the region)	Web of Science
INVESTMENTS	**SOURCE**
Finance and Support	
▪ R&D expenditure in the public sector (% of GDP)	Eurostat
▪ R&D expenditure in the business sector (% of GDP)	Eurostat
▪ Non-R&D innovation expenditures in SMEs (% of turnover)	Eurostat (CIS)[+]
INNOVATION ACTIVITIES	**SOURCE**
Innovators	
▪ SMEs introducing product/process innovations (% of SMEs)	Eurostat (CIS)
▪ SMEs introducing marketing/organisational innovations (% of SMEs)	Eurostat (CIS)
▪ SMEs innovating in-house (% of SMEs)	Eurostat (CIS)
Linkages and Entrepreneurship	
▪ Innovative SMEs collaborating with others (% of SMEs)	Eurostat (CIS)
▪ Public-private co-publications per million population	Web of Science/Eurostat
Intellectual Assets	
▪ EPO patent applications per €1 bn GDP (expressed in PPS)	Eurostat
▪ Trademark applications per €1 bn GDP (expressed in PPS)	Science Metrix/Eurostat
▪ Individual design applications per €1 bn GDP (expressed in PPS)	Science Metrix/Eurostat
IMPACTS	**SOURCE**
Employment Impacts	
▪ Employment in medium-high/high-tech manufacturing and knowledge intensive services (% of total employment)	Eurostat
Sales Impacts	
▪ Sales of new-to-market/new-to-firm innovations in SMEs (% of turnover)	Eurostat (CIS)

* Different indicator to that used up to the Regional Innovation Scoreboard 2014, which looked at the percentage of the population aged 25-64 with completed tertiary education.
[+] "CIS" refers to the Community Innovation Survey.

Source: European Commission (2019)

B.2.3 Regional Performance Groups

As with the Innovation Union Scoreboard at a national level, the Regional Innovation Scoreboard categorises regions into four groups, based on the RII score for each region, with groups being categorised as follows:

- *Innovation Leaders* – regions with a relative performance of 20% or more above the EU average;
- *Strong Innovators (formerly Innovation Followers)* – regions with a relative performance of between 90% and 120% of the EU average;
- *Moderate Innovators* – regions with a relative performance of between 50% and 90% of the EU average;
- *Modest Innovators* – regions with a relative performance below 50% of the EU average.

In addition, from 2017, the Regional Innovation Scoreboard introduced three sub-groups within each performance group – the top one-third regions (denoted with a "+"), the middle one-third regions and the bottom one-third regions (denoted with a "-").

B.2.4 Categorisation of Lagging Regions

Table B.2 focuses on the sample of regions used in this study, and outlines their respective categorisation over time according to the Regional Innovation Scoreboard. It shows, for the most part, that all of the regions being examined in this study have generally been classified as either Moderate Innovators or Modest Innovators, i.e. regions with below par R&D and innovation performance relative to EU averages, based on the indicators used. Furthermore, it also shows that very few of the regions have moved between categories over time, though with some exceptions:

- Norte (Portugal) moved from a Moderate Innovator (up to 2017) into the lower third of Strong Innovators (from 2019), while Calabria (Italy) moved from a Modest Innovator (in 2008) to a Moderate Innovator (from 2010 onwards);
- Castilla-la Mancha (Spain) has moved from a Moderate Innovator (up to 2017) to a Modest Innovator (from 2019), while regions like Extremadura (Spain), Sardinia (Italy), Azores (Portugal) and Madeira (Portugal) fluctuated between Moderate Innovator and Modest Innovator classifications over time.

Table B.2: Classification of Lagging Regions in the Regional Innovation Scoreboard 2008-19

Region	Country	2008	2010	2012	2014	2016	2017	2019
Galicia	Spain	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -
Principado de Asturias	Spain	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -
Cantabria	Spain	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate +	Moderate
Castilla y León	Spain	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -
Castilla-la Mancha	Spain	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Modest +
Comunidad Valenciana	Spain	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate +	Moderate
Andalucía	Spain	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -
Región de Murcia	Spain	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Campania	Italy	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -	Moderate
Puglia	Italy	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -	Moderate
Basilicata	Italy	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -	Moderate
Sicilia	Italy	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -	Moderate -
Norte	Portugal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate +	Strong -
Molise	Italy	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -
Calabria	Italy	Modest	Moderate	Moderate	Moderate	Moderate	Moderate -	Moderate -
Algarve	Portugal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate -	Moderate
Extremadura	Spain	Moderate	Modest	Modest	Modest	Modest	Moderate -	Modest +
Canarias	Spain	Modest	Modest	Modest	Modest	Modest	Modest +	Modest +
Sardegna	Italy	Modest	Modest	Moderate	Moderate	Modest	Moderate -	Moderate -
Região Autónoma dos Açores	Portugal	Moderate	Moderate	Moderate	Moderate	Modest	Moderate -	Moderate
Região Autónoma da Madeira	Portugal	Moderate	Modest	Modest	Modest	Modest	Moderate -	Moderate

Note: Corsica (France) is not included in the Regional Innovation Scoreboard analysis.

Source: European Commission (2012b, 2014b, 2016, 2017b, 2019)

B.3 Innovation Performance – Other Categorisations

A basic requirement in learning from regional benchmarking and comparative studies is to compare homogenous regions rather than heterogeneous regions, taking account of regional context and structural conditions, in order to learn appropriate lessons (European Commission, 2014a). In this regard, as noted in Chapter 3, all the perceived "lagging" regions examined in this study have already been classified as being similar, in GDP per capita terms, based on Structural Fund programming designations.

Alongside this, there are also other typologies and classifications of European regions, drawn from the research literature, that have complemented the Regional Innovation Scoreboard findings by further suggesting that these regions "under-perform" in fostering R&D and innovation. Such studies, for example, include:

- a typology of patterns of innovation in EU-25 regions by Navarro et al (2008);
- a study by Pinto (2009) regarding innovation dimensions and profiles in the EU.

Each of these studies used a variety of indicators to develop their typologies and classifications, and these studies again included commonly used innovation indicators and other socio-economic and structural indicators, which are often used to assess regions' broader economic development. For example:

- Navarro et al (2008) included about 20 indicators in developing their typology, incorporating socio-economic indicators alongside more innovation-oriented indicators, that cover variables such as population density, peripherality, GDP per capita, employment rate, productivity rate and education levels;
- Pinto (2009) drew on about 30 indicators, which also included socio-economic indicators alongside innovation indicators, such as: population and population density; age profile; GDP per capita and GDP growth; employment rate, unemployment rate and sectoral spread of employment (agriculture, industry, services); and education levels.

Further details on the indicators used for both of these studies is provided in Table B.3.

Table B.3: Indicators Used to Determine Selected Typologies of Innovation

	Innovation Indicators	Other Indicators
Navarro et al (2008)	▪ Total R&D expenditure (% of GDP) ▪ Government R&D expenditure (% of GDP) ▪ Higher education R&D expenditure (% of GDP) ▪ Business R&D expenditure (% of GDP) ▪ R&D expenditure per employment in R&D (PPS) ▪ Patents per million population ▪ High-tech patents per million population ▪ Human resources in core science and technology (%) ▪ Employment in medium-high and high technology manufacturing ▪ Employment in high-tech services	▪ GDP per capita (PPS) ▪ Employment rate (%) ▪ GDP per persons employed (PPS) ▪ Population density (km^2) ▪ Peripherality (index) ▪ Employment in primary sectors (%) ▪ Employment in industry (%) ▪ Employment in business and financial services (%) ▪ Youth education level (%) ▪ Population aged 25-64 with tertiary education (%) ▪ Population aged 25-64 participating in lifelong learning (%)
Pinto (2009)	▪ Public R&D expenditure as % of GDP ▪ Private R&D expenditure as % of GDP ▪ Total number of patents ▪ High technology patents (% of total) ▪ Patents per million population ▪ Employment in medium-high technology industries ▪ Employment in medium-high technology services	▪ Population ▪ % population aged < 15 years ▪ % population aged 15-64 years ▪ % population aged 65+ years ▪ Population density (km^2) ▪ GDP per capita (€) ▪ GDP per capita (EU-15/EU-25 = 100) ▪ GDP growth (%) ▪ Employment in agriculture (%) ▪ Employment in industry (%) ▪ Employment in services (%) ▪ Employment rate (%) ▪ Unemployment rate (%) ▪ Long-term unemployed (% of total unemployed) ▪ Female unemployment rate (%) ▪ Youth unemployment rate (%) ▪ Population aged 25-64 with low education (%) ▪ Population aged 25-64 with medium education (%) ▪ Population aged 25-64 with high education (%) ▪ % population with tertiary education ▪ % population participating in lifelong learning

Source: Navarro et al (2008), Pinto (2009)

For their typology, Navarro et al (2008) used data for the 21 indicators to conduct principal components and cluster analyses across 186 regions in the EU, from which they summarised the regions into seven groups:

- restructuring industrial regions with strong weaknesses;
- regions with a weak economic and technological performance;
- regions with an average economic and technological performance;
- advanced regions, with a certain industrial specialisation;
- innovative regions, with a high level of economic and technological development;
- capital regions, with a certain specialisation in high value-added services;
- innovative capital regions, specialised in high value-added services.

Table B.4, meanwhile, shows that the lagging regions that make up the sample for this study were found in the first three of these groups, i.e. “restructuring industrial regions with strong weaknesses”, “regions with a weak economic and technological performance” and “regions with an average economic and technological performance”. In particular, Navarro et al (2008) classified 15 of the sample regions as being regions with a weak economic and technological performance, with three (3) regions classified as restructuring industrial regions with strong weaknesses and two (2) regions classified as regions with average economic and technological performance. In this regard, according to Navarro et al (2008):

- “regions with a weak economic and technological performance” are classified as having low levels of economic and technological development. Per capita income in these regions is generally lower than EU averages, as are investment in R&D, levels of tertiary education and lifelong learning, levels of employment, and human resources in science and technology. Also, such regions typically have a low population density and low accessibility, with low levels of industrial activity and a greater reliance on the agriculture and service sectors;
- “restructuring industrial regions with strong weaknesses” typically have low levels of income relative to EU averages. Added to this, they have low levels of achievement in tertiary education and lifelong learning, poor accessibility, low level of expenditure on R&D and low levels of human resources in science and

technology. However, the size of the manufacturing sector in these regions is relatively large;

- "regions with average economic and technological performance" have levels of economic and technological development that are closer to EU averages, though performance among such regions can be heterogeneous and their productive structures are quite varied.

Table B.4: Typology of Patterns of Innovation – Selected Lagging Regions

Region	Classification
Galicia	Region with a weak economic and technological performance
Principado de Asturias	Region with a weak economic and technological performance
Cantabria	Region with an average economic and technological performance
Castilla y León	Region with a weak economic and technological performance
Castilla-la Mancha	Region with a weak economic and technological performance
Comunidad Valenciana	Region with an average economic and technological performance
Andalucía	Region with a weak economic and technological performance
Región de Murcia	Region with a weak economic and technological performance
Campania	Region with a weak economic and technological performance
Puglia	Region with a weak economic and technological performance
Basilicata	Restructuring industrial region with strong weaknesses
Sicilia	Region with a weak economic and technological performance
Norte	Restructuring industrial region with strong weaknesses
Molise	Restructuring industrial region with strong weaknesses
Calabria	Region with a weak economic and technological performance
Algarve	Region with a weak economic and technological performance
Extremadura	Region with a weak economic and technological performance
Canarias	Region with a weak economic and technological performance
Sardegna	Region with a weak economic and technological performance
Região Autónoma dos Açores	n/a
Região Autónoma da Madeira	n/a
Corsica	Region with a weak economic and technological performance

"n/a" = not available.
Source: Navarro et al (2008)

The classification of regions developed by Pinto (2009), on the other hand, used a factorial analysis to extract four "latent dimensions" of innovation from the 30 regional indicators used, with these dimensions being:

- *technological innovation* – incorporating variables related to patent registration, private investment in R&D and employment in high/medium technology industries;
- *human capital* – incorporating variables related to education, training and public investment in R&D;

- *economic structure* – incorporating variables relating to GDP and employment in services (on the basis that employment in services reflects the tertiarisation of regional economies and a correlation with higher levels of production per capita);
- *labour market availability* – incorporating variables relating to levels of employment and the rate of individuals with intermediate education levels.

Thereafter, a cluster analysis was used to develop typologies covering more than 170 regions, taking account of regional performances under these four dimensions, which resulted in the identification of five different groups of regions: large economic centres; average regions; disadvantaged regions; innovating regions; and central regions.

In this regard, Table B.5 shows that all of the regions being examined as part of this research were identified as disadvantaged regions, with such regions being so classified because they generally recorded the lowest performance in terms of technological innovation, economic structure and labour market availability, while they also rated poorly in terms of their human capital performance.

Table B.5: Innovation Dimension and Profiles – Selected Lagging Regions

Region	**Classification**
Galicia	Disadvantaged region
Principado de Asturias	Disadvantaged region
Cantabria	Disadvantaged region
Castilla y León	Disadvantaged region
Castilla-la Mancha	Disadvantaged region
Comunidad Valenciana	Disadvantaged region
Andalucía	Disadvantaged region
Región de Murcia	Disadvantaged region
Campania	Disadvantaged region
Puglia	Disadvantaged region
Basilicata	Disadvantaged region
Sicilia	Disadvantaged region
Norte	Disadvantaged region
Molise	Disadvantaged region
Calabria	Disadvantaged region
Algarve	Disadvantaged region
Extremadura	Disadvantaged region
Canarias	Disadvantaged region
Sardegna	Disadvantaged region
Região Autónoma dos Açores	Disadvantaged region
Região Autónoma da Madeira	Disadvantaged region

Source: Pinto (2009)

At the same time, not all typologies or taxonomies of innovation in European regions have concluded that perceived lagging regions are simply “disadvantaged” or have “weak” or “average” economic and technological performance in R&D and innovation terms. Capello and Lenzi (2013), for example, developed a further taxonomy of innovative regions in Europe, using factorial and cluster analysis of an extensive and diverse array of indicators, which sought to characterise not only knowledge and innovation creation within regions but also their ability to absorb external knowledge and innovation, and the regional preconditions needed to facilitate both of these. This taxonomy, which covered over 260 regions in the EU, classified regions into five clusters as follows:

- European science-based areas;
- applied science areas;
- smart technological application areas;
- smart and creative diversification areas;
- imitative innovation areas.

The first two of these clusters – “European science-based areas” and “applied science areas” – are typically regions that are perceived to be more advanced, both in socio-economic and R&D/innovation terms, with greater internal capacity for knowledge and innovation creation, and with the suggested preconditions to provide this (e.g. human capital, agglomeration, accessibility). In contrast, the other three clusters – “smart technological application areas”, “smart and creative diversification areas” and “imitative innovation areas” – showed less internal capacity for knowledge and innovation creation, and its associated preconditions, but they were nonetheless judged to possess possible traits in terms of levels of entrepreneurship, creativity and attractiveness (e.g. wage levels), which could aid the acquisition and adaptation of external knowledge and innovation. How each of the regions examined for this research have been classified by Capello and Lenzi (2013), meanwhile, is outlined in Table B.6.

Table B.6: Taxonomy of Innovative Regions in Europe – Selected Lagging Regions

Region	**Classification**
Galicia	Smart and creative diversification area
Principado de Asturias	Smart and creative diversification area
Cantabria	Smart and creative diversification area
Castilla y León	Smart and creative diversification area
Castilla-la Mancha	Smart and creative diversification area
Comunidad Valenciana	Smart and creative diversification area
Andalucía	Smart and creative diversification area
Región de Murcia	Imitative innovation area
Campania	Smart and creative diversification area
Puglia	Imitative innovation area
Basilicata	Imitative innovation area
Sicilia	Imitative innovation area
Norte	Smart technological application area
Molise	Smart and creative diversification area
Calabria	Imitative innovation area
Algarve	Smart and creative diversification area
Extremadura	Smart and creative diversification area
Canarias	Smart and creative diversification area
Sardegna	Imitative innovation area
Região Autónoma dos Açores	Smart and creative diversification area
Região Autónoma da Madeira	Smart and creative diversification area

Source: Capello and Lenzi (2013)

In conclusion, Capello and Lenzi (2013) contended that the local specificities that differentiate the pathways to innovation within regions require “ad hoc” policy interventions at the regional level. Thus, whereas maximum return to R&D investments may be the right goal for a region with a strong capacity for knowledge creation, it cannot be the right policy goal for regions that innovate by exploiting external knowledge or imitating innovation processes (Capello and Lenzi, 2013).

APPENDIX C – CHECKLIST/PROTOCOL FOR RESEARCH INTERVIEWS

A. Innovation Performance

A.1. What is your perception of how the region (Galicia/Puglia) has performed, over the last 15-20 years, in terms of fostering innovation activity, e.g. levels of investment in R&D, numbers of personnel involved in R&D, levels of patent activity, employment in key innovating sectors, innovative start-ups and spin-offs, SME engagement with innovative activities?

- *Has activity been focused on R&D activities or non-R&D activities, or both, and has this changed over time?*
- *Has activity focused on certain sectors, and has this changed over time?*
- *Has activity focused on certain geographical areas, and has this changed over time?*
- *Has activity focused on larger or smaller enterprises, and has this changed over time?*

A.2. What, in your opinion, have been the key factors that explain the region's success (or lack of success) in these areas over the last 15-20 years?

A.3. What ongoing structural or other factors in the regional economy (if any) continue to hinder success in these areas?

B. Innovation Policy

B.1. How would you assess the development of policies to foster R&D, science and technology, and innovation in industry and enterprise in the region in the last 15-20 years? How, in your opinion, have such policies evolved over the period?

- *How have policies changed over the 1994-99, 2000-06 and 2007-13 periods?*
- *Did the importance of policy in these areas increase relative to other policy priorities, and was this justified?*
- *To what extent have policies matched the needs and capabilities of the key actors involved in fostering innovation in the region, and how has this changed over time?*
- *How would you assess steps taken to stimulate demand for innovation in regional firms, and how they have changed over time?*

B.2. How would you assess the development of other policies that affected R&D, science and technology, and innovation in industry and enterprise in the region in the last 15-20 years (e.g. education), and how have they developed over time?

B.3. To what extent have policies to foster R&D, science and technology, and innovation in industry and enterprise been integrated with other wider policy priorities in the region in the last 15-20 years (e.g. education)?

C. Regional Innovation System

C.1. How would you assess the role of each of the following groups of key players in fostering innovation in the region in the last 15-20 years, and how has it progressed over time?

- regional government, regional agencies and regional autonomy
- national government and national agencies
- universities and other research institutions
- large enterprises
- SMEs
- other intermediary organisations or institutions (e.g. finance, business services, industry associations etc)

C.2. To what extent has networking, interaction, co-operation and collaboration developed between these key players in fostering innovation in the region in the last 15-20 years, and how has this manifested?

- *To what extent has networking, interaction, co-operation and collaboration between firms and research institutions (e.g. universities) improved?*
- *To what extent has networking, interaction, co-operation and collaboration between firms and government improved?*
- *To what extent has networking, interaction, co-operation and collaboration among firms improved?*
- *To what extent has networking, interaction, co-operation and collaboration between research institutions and government improved?*
- *To what extent has networking, interaction, co-operation and collaboration between regional and national government improved?*
- *To what extent is networking, interaction, co-operation and collaboration now embedded within the regional innovation system in the region?*

D. Other Issues

D.1. How would you assess the role played by the EU in fostering innovation in the region in the last 15-20 years?

- *How would you assess the impact of EU Structural Funds on the development of innovation in the region?*
- *How would you assess the wider influence of the EU on the development of innovation in the region?*

D.2. In your opinion, what would the region have achieved in innovation terms in the last 15-20 years in the absence of the various policy interventions and institutional changes?

D.3. Realistically, in your opinion, what is the optimal level of innovation performance and development that the region can hope to achieve in the future?

D.4. In your opinion, what further steps need to be taken to further improve innovation levels in the region?