

6. RESEARCH, DEVELOPMENT AND INNOVATION ACROSS THE EUROPEAN TERRITORIES

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6.1. Introduction

Investment in research and innovation is one of three headline indicators identified as an important aspect of an overall growth and jobs strategy within the Smart Growth pillar of the EU2020S. Combined with more efficient use of resources, innovation is conceived as the key mechanism through which the European Union will become increasingly competitive and through which economic recovery will occur. Ahlstrom (2010: 10) argues that “steady economic growth generated through innovation plays a major role in producing increases in per capita income. Small changes in economic growth can yield very large differences in income over time, making firm growth particularly salient to societies”. Research, development and innovation thus has the potential to help deliver on at least some of the smart, inclusive and sustainable goals of the EU2020S. Strong local economies are required to ensure global competitiveness (Territorial Agenda 2020) and the Innovation Union flagship initiative identifies 34 action points to improve the conditions and access to finance for research and innovation in Europe, facilitating the transfer of innovative ideas into products and services that will create growth and jobs (European Commission, 2010a).

6.2. Expenditure on Research and Development

Expenditure on R&D is an important input indicator of the innovative strength of any economy, increasingly important for global competitiveness and for helping Europe emerge from the current economic recession. Official documents like the Lisbon Agenda and the EU2020S use GDP investment in R&D as an important benchmark for knowledge-economy development policies (Capello *et al.*, 2011: 21). The EU has set a headline target of 3% of GDP investment in R&D investment. Achieving this target by 2020 could induce the creation of 3.7 million jobs (European Commission, 2010b) and contribute

significantly to addressing a range of goals in relation to inclusive growth. Individual national targets have been set by a majority of countries in recognition of the substantial variations and different departure points across the European territory. These are outlined in the National Reform Programmes 2011 but generally most countries are beginning from a base well below the EU headline target.

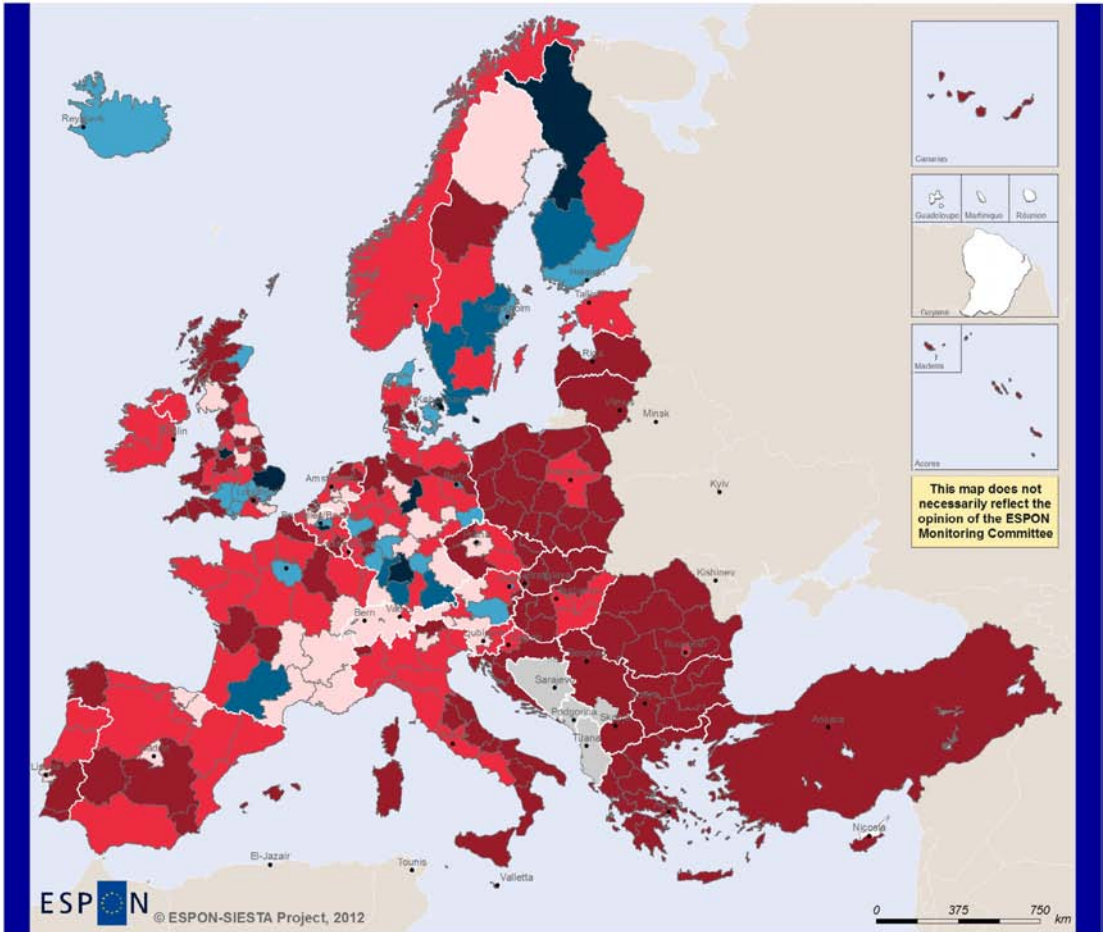
North West Europe, the Northern Baltic Sea Region and the Northern Periphery are to a great extent the current and most promising future drivers of Europe's smart economy. In terms of R&D expenditures (expressed as a percentage of GDP), 28 NUTS2 regions had already reached or exceeded the overall 3% target set by the European Union over the 2007-2010 period. This is the case, for example, of the Brabant-Walloon region in Belgium and the Braunschweig region in Southern Germany, which is also by far the most productive area of Europe in terms of patent applications to the EPO, a result perhaps of its industrial strength. This investment indicates high levels of innovative capacity and an ability to compete effectively with the most innovative regions of the US, Japan or South Korea. In macro-geographical terms, higher levels of R&D expenditures are found in parts of the Baltic Sea Region, North West Europe, and the Western part of the Danube Space. Within these spaces, some particular, transnational / transborder 'corridors of investment' can be identified. Map 6.1 illustrates a Belgian-Dutch corridor, a Copenhagen-Helsinki corridor (sprawling through much of Southern Sweden and most of Finland), and a geographically broader corridor extending from Southern France to Austria and encompassing Geneva (Switzerland) and Southern Germany. These 'corridors of investment' emerge in regions with high levels of specialisation in particular industries or services that require high levels of investment in R&D in order to maintain a competitive advantage. This is the case, for example, of the aeronautical and aerospace industry in Southern France (in the Toulouse area, where Airbus is located), or of the information and communication technologies (ICT) sector in Scandinavia.

The general pattern of higher and/or increasing levels of investment in R&D as a percentage of GDP is reflected in the territorial pattern of higher levels of Business Expenditure in R&D (BERD). These are important because they represent an indicator of a country or a region's capacity to attract and retain private sector investment, of significant importance in times of economic crisis given the impact of austerity on public expenditures. Therefore, regions with higher levels of BERD may be considered as key pillars or potential key assets in the development and consolidation of Smart Growth as defined by the EU2020S. Spatially high levels of R&D expenditures are not necessarily

linked to high levels of urbanisation, with some rural regions (most notably Pohjois-Suomi in Finland, which has the 5th highest percentage of general expenditure and 3rd highest percentage of business expenditure on R&D in Europe) rivalling some of the most dynamic metropolitan regions of Europe. Another important spatial dimension is that in a small number of cases regions of very high investment are immediately adjacent to some of the regions with very low investment. This suggests that spillovers or 'spin-offs' are relatively limited and that there are some negative externalities associated with high levels of R&D investment that may hinder inclusive goals.

Investment in Research and Development (R&D) as a percentage of GDP in South East Europe and the Danube Space is low and this is mirrored in the data for Business Expenditure on R&D (BERD). Almost all regions in Greece emerge at the bottom of the league table in relation to BERD although regions elsewhere score more poorly on general R&D investment. This pattern may indicate an historic over-reliance on public finances to drive the R&D agenda in Greece. Similarly, the particularly low levels of investment in South East Europe and the Eastern Danube Space may be heavily influenced by recent history. Many of these countries until recent decades were governed by Communist regimes and the transitional nature of their economies may explain their 'lagging' nature relative to general European averages. Some outliers do exist in parts of Romania and Bulgaria but investment appears highly localised with little spin-off to neighbouring regions. The outermost regions of Europe — Açores, Madeira, Canarias and Ciudad Autónoma de Ceuta — also demonstrate significant weaknesses in R&D investment generally but this is to be expected given their geographical location and profile.

The current pattern of R&D investment in Europe is thus heavily geographically polarised and path-dependent and this has been recognised in the identification of lower national targets for R&D investment in lagging regions, well below the European average of 3%.



Canaries

Guadalupe, Madeira, Azores

Reunion

Corse

Madeira

Azores

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Regional level: NUTS0 and NUTS2
Source: EUROSTAT, 2012
Origin of data: EUROSTAT, 2012
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R&D in Regional GDP (%) 2009.

EU 2020 Target = 3%

Below EU 2020 Target

- 0% - 1%
- 1% - 2%
- 2% - 3%

Above EU 2020 Target

- 3% - 4%
- 4% - 5%
- > 5%

- No data (ESPON space)
- No data (No ESPON space)

Notes:
Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications.

Data for RS were provided by the Statistical Office of the Republic of Serbia.
Data for TR, CH and NO are all available for country level.
Data for MK are shown for 2007 at country level.
Data for EL are shown for 2005 and RS is shown for 2010.

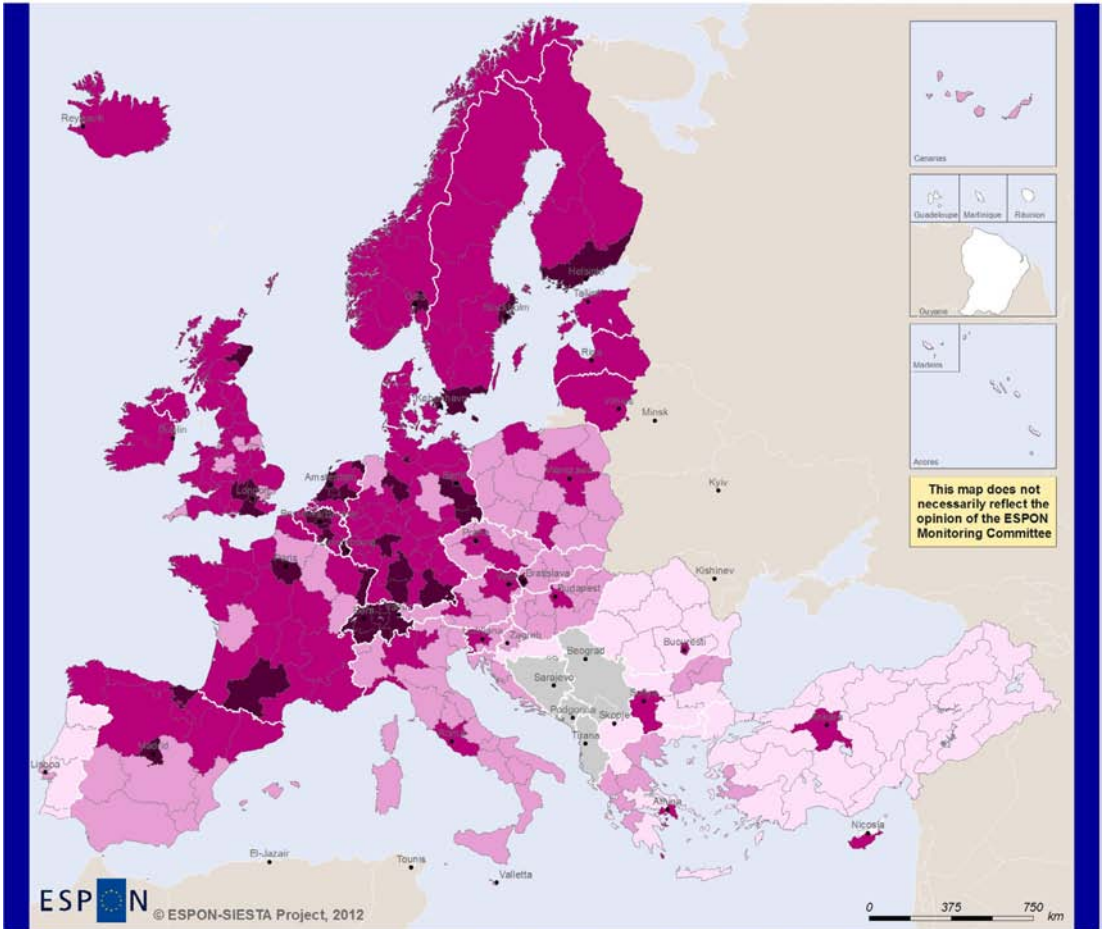
Map 6.1. General expenditure on R&D as percentage of regional GDP, 2009.

6.3. Human Capital as a Research and Innovation Input

Human capital is the key source of research and thus highly educated workers are essential to achieving smart growth objectives and remaining competitive vis-à-vis the US and Japan in particular (European Commission,

2010b). The Smart Growth pillar of the EU2020S provides an outline of what needs to be looked at, worked on, and strengthened in order to develop a European economy based on knowledge and innovation. The 'Innovation Union' flagship initiative, alongside the industrial objectives set out by the flagship initiative on 'Industrial Policy for the Globalisation Era' discuss the priority areas and targets to achieve the EU2020S' smart growth objectives. Crucially, smart growth is based on the development and expansion of knowledge-intensive activities, including industrial activities, in which the human component remains fundamental and thus high levels of education are crucial. The Fifth Report on Economic, Social and Territorial Cohesion (European Commission, 2010c) identifies innovation as important for all regions, whether or not they are currently research leaders. While the 'Innovation Union' communication highlights that "a number of Member States are world leaders in manufacturing, creativity, design, aerospace, telecommunications, energy and environmental technologies" (European Commission, 2010a: 6), it also attempts to put in place the necessary conditions to attract and retain talented researchers right across the European Union because innovation is so dependent on human 'brain power', expertise, and cross-fertilisation of knowledge. The proportion of people working in knowledge-intensive activities, including knowledge-intensive services, across European regions, is a key indicator of how well-positioned European regions are in terms of contributing to Europe's position on the global map of the knowledge-based economy. Understanding the distribution of human resources in science and technology (HRST) across European regions, as represented on Map 6.2, is a crucial first step in broadening scientific and technological innovation capacity.

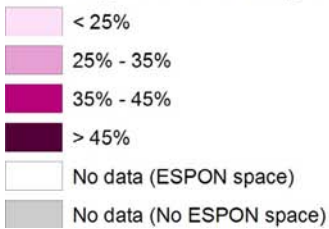
The data illustrates that level of urbanisation is an important variable in understanding the geographical distribution of Human Resources in Science and Technology (HRST) in Europe. Large cities and metropolitan areas such as London, Copenhagen, Prague, Zurich, Utrecht, etc. are clearly the European leaders in terms of HRST, employed mostly in advanced producer services, including financial services, where technology has become the key innovation. The constant development of new products is a crucial determinant of the creation and maintenance of comparative advantage and competitiveness. The presence of universities — some world-class universities, some with major research centres and spin-out companies on-site — in or around these cities is often a key advantage that provides these cities with an abundant, readily available, highly qualified pool of labour. This is again fundamental in attracting and retaining inward investment and employment.




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Regional level: NUTS2
 Source: EUROSAT
 Origin of data: EUROSAT, 2012
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Percentage of economically active population (%), 2010.



Notes:
 Data for CH are shown for 2009.

Map 6.2. Human resources in science and technology as percentage of regional active population, 2010.

Beyond capital cities and their regions, all Scandinavian regions have high levels of HRST as do the British Isles and Ireland in particular, most of the Northern Periphery, North West Europe and the Atlantic Axis. This territorial pattern is roughly mirrored by the pattern of high levels of employment

in knowledge-intensive services, for reasons that have been mentioned above, including the role of the ICT sector (especially in Scandinavia) and financial industries (in London and Luxembourg, for example).

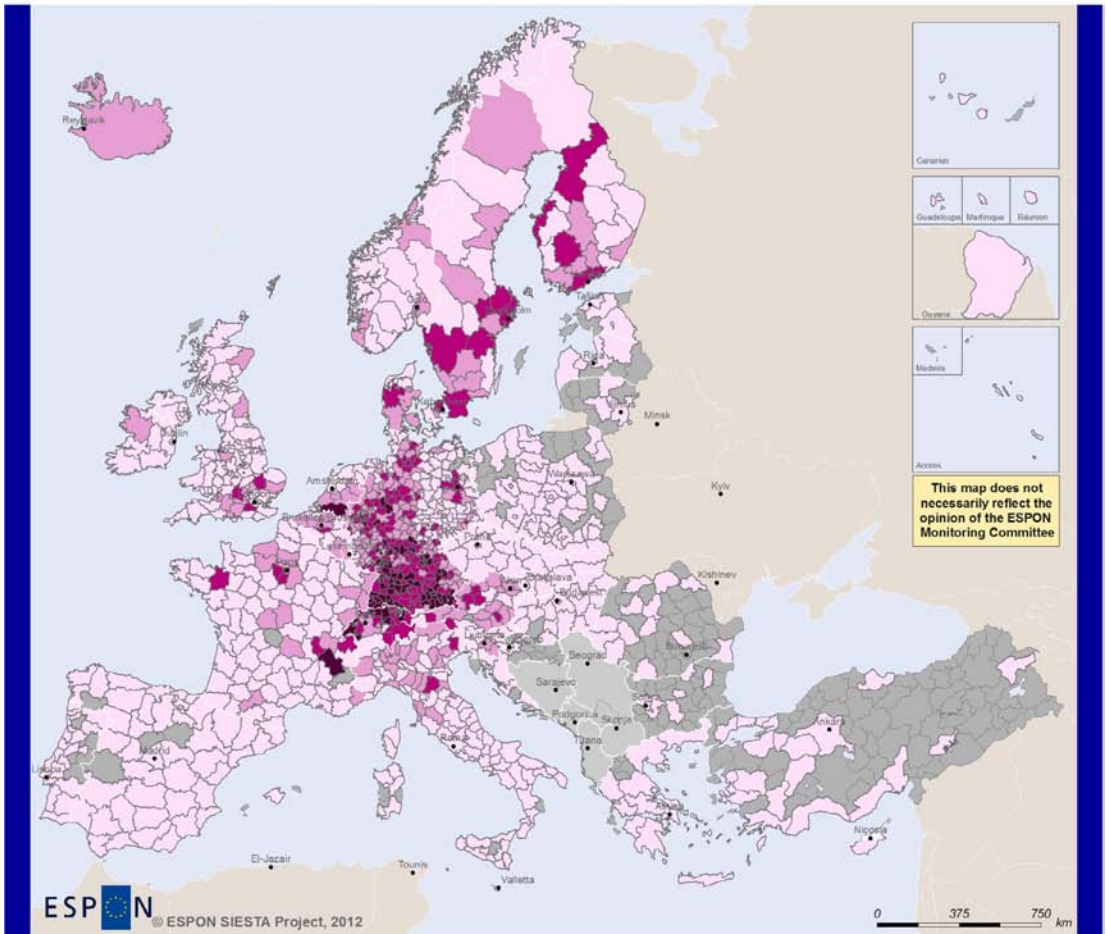
South East Europe, the Eastern Danube Space and Turkey have low levels of people working in knowledge-intensive services as well as poor levels of Human Resources in Science and Technology (HRST). Bulgaria, Macedonia, Croatia, Romania (with the exception of Bucharest) and Turkey (with the exception of Ankara and Izmir) score very poorly across these indicators. The Innovation Union Scoreboard 2011 (Pro-Inno Europe, 2012: 9) has acknowledged and highlighted this as a major challenge to be overcome on the path to economic growth and development. Countries that tend to be more rural will find it difficult to source the skilled labour pool required to promote R&D. Given the importance of path dependency, the combination of low levels of urbanisation, a history of communist or autocratic regimes in this broad region, and a traditional emphasis on labour-intensive activities such as agriculture and tourism, will make it very difficult for South East Europe in particular to meet EU targets on R&D investment.

6.4. Research Specialisation

Patent and patent statistics are commonly used by economists to identify sources of economic growth, to assess rates of technological change, and to understand differentials in levels of competitiveness (Griliches, 1998). Crucially, patent statistics are used as tools or proxies to measure levels of innovation, to see how they compare across space and to understand differentials in levels of 'inventiveness' and abilities to transform R&D into innovation. These differentials are fundamental drivers of competitiveness, insofar as they are a key factor in creating competitive advantages. The Innovation Union flagship initiative (European Commission, 2010a) highlights the urgent need to reform the patent system in Europe, which is costly and fragmented, to create a single innovation market. As explained in the Communication, "a critical issue for innovation investments in Europe is the cost and complexity of patenting. Obtaining a patent protection for all 27 EU Member States is currently at least 15 times more expensive than patent protection in the US¹⁹, largely due to translation and legal fees. The absence of a cheap and simple EU patent is a tax on innovation" (European Commission, 2010a: 15). The initiative recommends the development of a cheap, simple, single EU patent system by 2014 as a first key step to remove "remaining barriers for entrepreneurs to bring 'ideas to market'" (European Commission, 2010a: 3) and thus facilitate the commercialisation of R&D.

While the Innovation Union Communication states that “the United States and Japan continue to lead the EU in innovation performance” (European Commission, 2010a: 8), according to OECD statistics (<<http://stats.oecd.org/>> Accessed 2.4.2013) the EU27 member states are performing well on at least one innovation indicator, namely patent applications. In 2008, the EU27 had filed a total of 359,558.15 patents under the Patent Cooperation Treaty (PTC), compared to 357,447.20 for the United States, 227,845.18 for Japan, 60,464.65 for South Korea, 55,488.01 for China, and 8,241.76 for India. However, as we will see in our discussion of Map 6.3, a majority of patent applications emerged from one particular part of Europe, the European geography of patent applications being very uneven and characterised by a very high concentration of high-performers within a fairly defined part of Central Europe that is endowed with high-quality human capital (Capello *et al.*, 2011: 17).

Our ranking of regions reveals a very distinct and polarised European geography of patent applications with a particular focus on southern Germany. The wider area around this highest-performing cluster, including the whole of Germany and the Northern part of Switzerland, also experiences higher ratios of patent applications than in the rest of Europe, resulting in 19 of the 20 highest performing regions being German, as are 28 of the top 30 regions. In the 100 top performing regions (out of 1,352 for which we have data), only 11 were not German: 10 were Swiss regions, one was located in Austria. A key explanatory factor for the overwhelming lead of Germany in terms of patent applications has to do with the status of Germany as Europe’s industrial leader through its many large industrial groups such as Bosch, Siemens, or Daimler Chrysler to name a few, which tend to file for several hundred or even several thousand patents every year. Patents are especially important in the manufacturing and science-and-technology-based sectors of the economy; firms introducing more advanced innovations are heavily reliant on both R&D and patenting (Tödtling *et al.*, 2009). By contrast, service sectors (e.g. tourism, finance, etc.) have little or no patents at all. Therefore, a country that has a substantial high-tech manufacturing sector would be expected to have a higher patent count than one that does not. Moreover, the propensity to patent varies significantly across industrial sectors. For instance, patenting in telecommunication technologies and in chemicals and pharmaceuticals is by a factor of 1,000 higher than in textiles, paper manufacturing, or similar activities (Chabchoub and Niosi, 2005). Accordingly, a country like Germany that is heavily involved in the former sectors — telecommunications and chemicals — would be expected to have a higher patent count.



Canarian

Guadeloupe Martinique Réunion

Corsica

Moldova

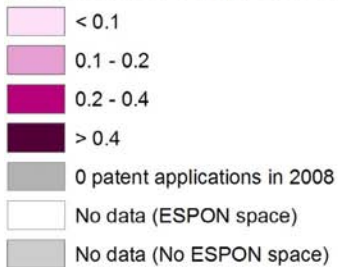
Acrotiri

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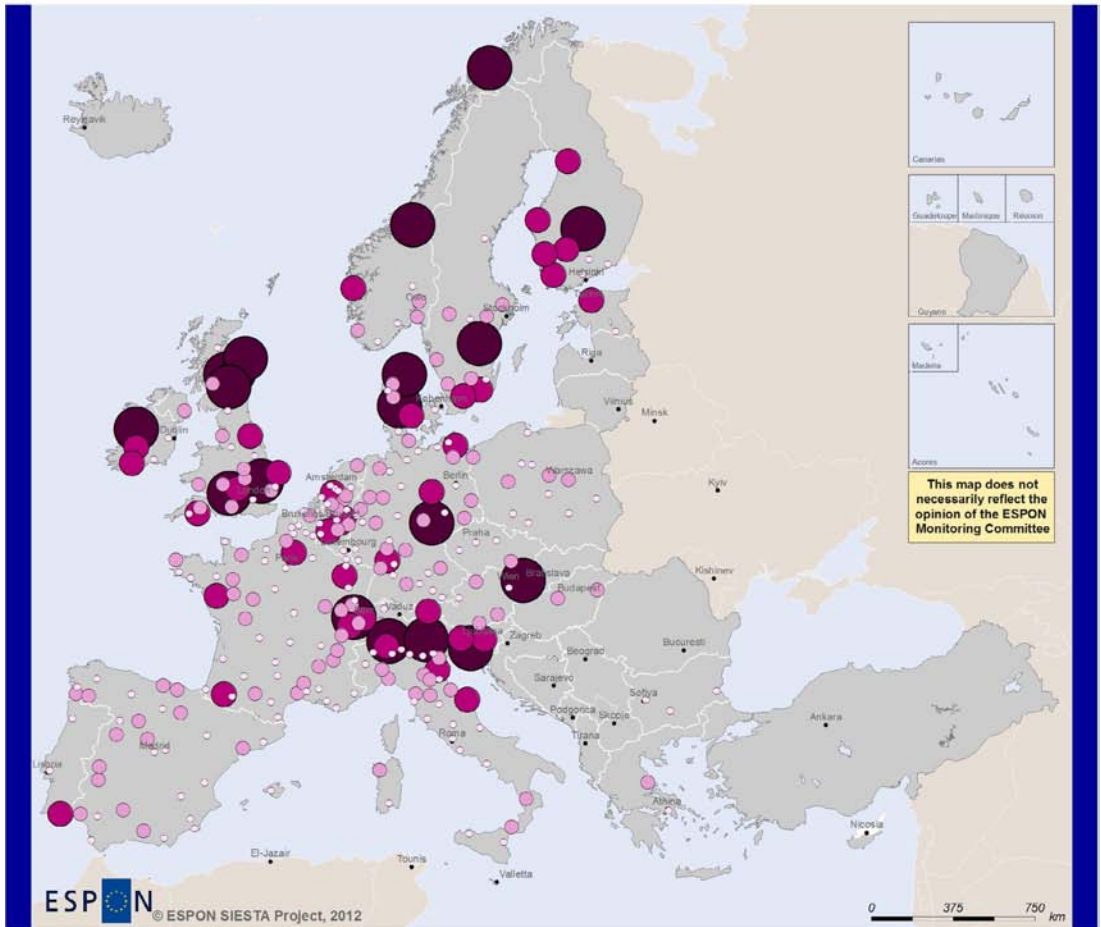
Regional level: NUTS3, NUTS2
Source: EUROSTAT and OECD Regpat database
Origin of data: EUROSTAT and OECD Regpat database
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Number of patent applications to the EPO per 1000 inhabitants, 2008.



Notes:
NL and EL are shown at NUTS2 level.
IS is shown at country level.

Map 6.3. Patent applications to the EPO per 1,000 inhabitants by inventor's region of residence, 2008.



NBIC specialization index*, 2010.

- 0.0000 - 0.0015
- 0.0015 - 0.0030
- 0.0030 - 0.0060
- > 0.0060

Notes:
 Methodology: Number of research projects participation of a city / population of the given city.
 *NBIC technologies: nanotechnology, biotechnology, information technology and cognitive science.

Map 6.4. Research specialisation in NBIC technologies in FUAs, 1986-2006.

While the patent data reveals a concentration of particular innovative capacity in Central Europe linked to initial advantage and historic economic development patterns, specialisation appears an important factor in attracting public investment in R&D to new economic activities. This is exemplified through a closer look at NBIC (Nanotechnology, Biotechnology, Information technology and Cognitive science) technologies — considered as emerging technologies with the potential to drive future growth. Developed by the FOCI

Project team (Comin *et al.*, 2010), the index of specialisation in NBIC research highlights some major urban clusters in Europe (Map 6.4), and very strong specialisation in nano-sciences and nanotechnologies is evident in Scotland. The British Isles (the United Kingdom and Ireland) as a whole can be considered as one of Europe's major NBIC clusters especially around towns or cities with major universities. In Ireland for example, Cork and Limerick cities are examples of where the biotechnology/NBIC investment has paid massive dividends drawing on the universities and institutes of technology as well as FDI. The two other significant clusters of investment in NBIC technologies are located in the Western part of the Danube Space (in Slovakia, Germany and Switzerland) and in the Northern part of the Baltic Sea Region. A few outliers were also identified, such as Faro in Portugal and Compiègne in France. The presence of universities with a history of specialisation in NBIC-related fields of research closely aligned to the research requirements of industry is perhaps the key explanatory variable. In our analysis we have found repeated evidence of the role of universities in supporting the innovation agenda in Europe.

Besides the availability of highly qualified workers, companies are interested in other agglomeration effects, including those specifically related to innovation. The cross-fertilisation of ideas and expertise that is enhanced by geographical proximity, and a supportive policy-environment are considered key to local and regional economic development in particular places, for example financial services in London/the UK (Harding *et al.*, 2010).

6.5. Smart Growth Overview

The Territorial Agenda 2020 (Informal Ministerial Meeting of Ministers..., 2011: 7) for Europe argues that "the development of innovation and smart specialisation strategies in a place-based approach can play a key role" in meeting the growth agenda for Europe. Vieira *et al.* (2011: 1269) have argued that in order for a region to attract foreign capital, and thus generate employment and growth, productivity is key and innovation is a major driver. This smart growth generates significant social as well as economic returns (Griffith *et al.*, 2001), clearly linking the smart and inclusive growth pillars of the EU2020S.

The picture of research and innovation in Europe is a complex one with clear evidence of national as well as pan-European disparities. Our analysis has identified a number of strengths, weaknesses, opportunities and threats across the European territory in relation to research and innovation and the capacity of regions to meet established goals. European cohesion policy seeks to enable all regions to develop their full potential in order to promote more bal-

anced regional development. Relatively few regions have already exceeded or are close to reaching EU2020S targets, and those that have tended to be in North West Europe and the Northern Periphery. In general South East Europe and parts of the Eastern Danube Space are performing poorly on the indicators examined. Similar to the conclusions of the ESPON-KIT project (Capello *et al.*, 2012), the headline message from our analysis is that a ‘one-size-fits-all’ conception and approach to innovation is not appropriate and that Europe’s innovative strength lies in its diverse innovative capacity.

This diversity needs to be further bolstered within the current and future official communications. Currently there is a very narrow conception of innovation promoted centred primarily on high-technology activities. This fails to acknowledge the potential of bottom-up innovative capacity and structurally disadvantages parts of Europe dominated by other kinds of economic activity. Labelling South East Europe, Turkey and parts of the Danube Space as lacking innovation or an innovative capacity significantly undermines both current and future growth strategies. Another cautionary note should be sounded in relation to the equation of R&D investment with innovative capacity. Some of the international academic literature would suggest that there is not a straightforward or direct link between investment and innovation, and it may be that the most innovative regions are those where commercialisation rather than investment occurs. In other words, the understanding of innovation being used by policymakers requires further analysis and investigation of its underlying premises.

Similarly, much of the argument appears to suggest that generating R&D investment will directly lead to economic growth and spin-off benefits. The analysis undertaken for this research has highlighted the limited and potentially negative effects of strong investment clustering. In both the UK and Austria, regions ranking in the highest performing categories in Europe directly bound some of the poorest performing regions (e.g. Cumbria in the UK). There is no evidence of spillover occurring and in fact, it may even be possible that the concentration of investment within some areas with an initial advantage is effectively acting as a barrier to investment in neighbouring regions. While the approach in terms of industrial policy in Germany appears more redistributive, in other countries clear polarisation in innovation opportunity is becoming apparent which has the capacity to undermine many of the inclusivity and sustainability goals of the EU2020S.

Finally, a number of official documents suggest that Europe is significantly lagging behind its global counterparts. We have found evidence where this is not the case and in fact OECD statistics have illustrated how Europe is lead-

ing the field in terms of patent applications. We would also suggest that while R&D investment in particular in Europe on first analysis seems to be much lower than international competitors, these data may not be directly comparable and may need controlling for other factors such as defence spending.

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