

## Chapter 2

# Innovative, Technological, and Growth Capacities of the EU Regions

### 2.1 Introduction

The role of regions as engines of economic development and growth has been widely recognized in recent years, and abundant documentation now exists of many of the successful economic examples of this phenomenon in different parts of the world. Critical elements of the economic success of regions depends on the capabilities of the local level to upgrade its productive structures and to generate, diffuse, and apply knowledge in the production of highly innovative and knowledge-intensive products and services. Accelerating technological change and moving up the technological ladder, from low to high value-added industries is a prerequisite for sustaining economic competitiveness. These industries create good jobs, expand production and trade, and drive continuous innovation. It is therefore not surprising that most developed economies increase their share of knowledge and research-intensive industries such as biotechnology, ICT, advanced manufacturing, and advanced business services.

The following chapter analyzes how EU regions perform in terms of their capacity to create, transfer, and diffuse new knowledge. The first section provides some useful facts and figures that highlight the heterogeneity of the European regional landscape regarding wealth and knowledge-creation capacities such as GDP per capita growth. Drawing on the regional Eurostat database and other economic data, the second section of the chapter looks at the economic structure and dynamics of the EU regions, starting from productivity growth and extending it to the analysis of technology and knowledge-intensive employment. The third section analyzes the factual data on innovation and knowledge absorption, diffusion, and creation capacities of the EU regions. The fourth section of the chapter benchmarks the EU regions according to their growth and innovative capacities. Finally, the last section discusses the spatial distribution of technological and innovative potential of the EU. The chapter ends with the summary and important conclusions.

## 2.2 General Economic Conditions in the EU Regions

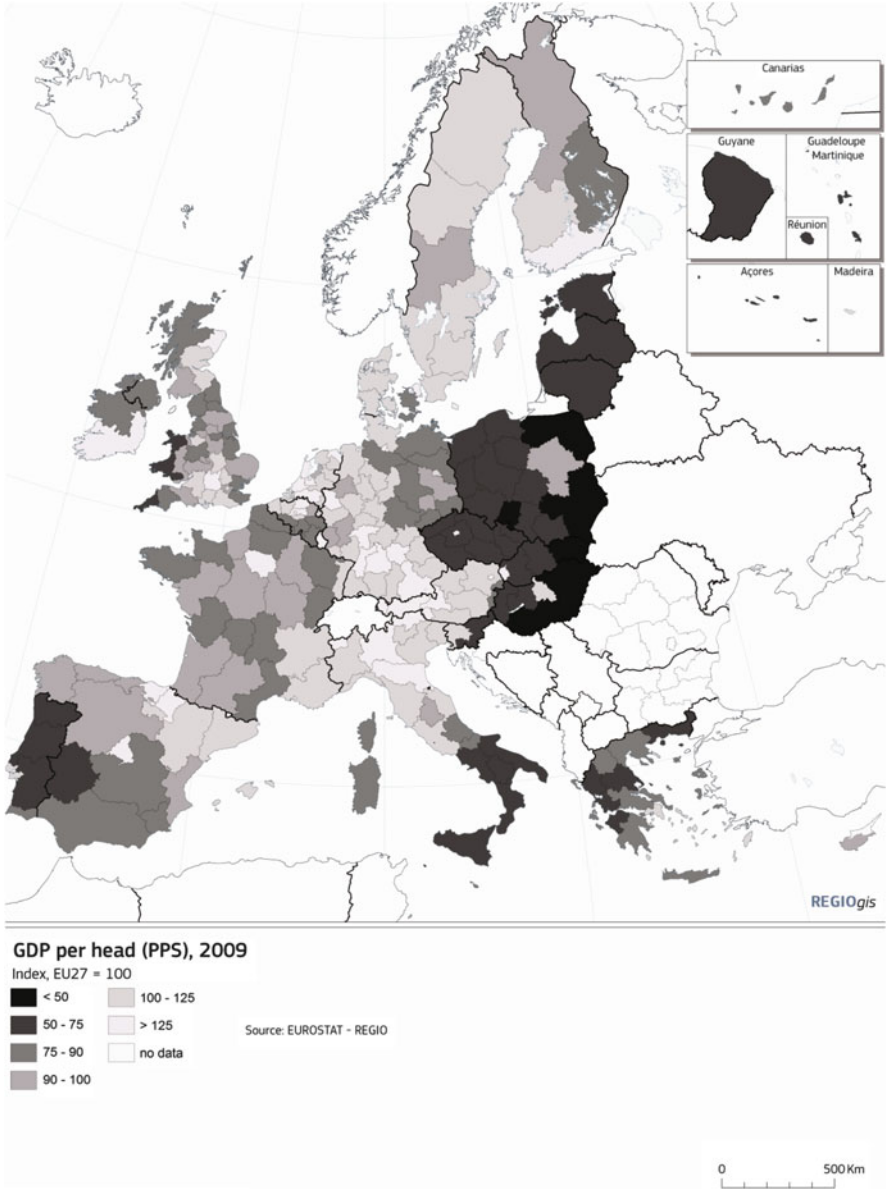
### 2.2.1 GDP Performance in the EU Regions

GDP per capita is the most frequently used indicator to evaluate and compare the economic performance of regions in terms of wealth creation. This indicator, expressed in purchasing power standards (PPS), has also been used to assess the heterogeneity of the European regional landscape and the average economic situation in each of the EU Member States regions.

Map 2.1 clearly illustrates an unequal distribution of wealth creation across the EU. Firstly, it reflects a high concentration of wealth creation (above the European average GDP per capita for 2009) only in a limited number of regions, extending from the North EU regions to the Benelux, western Germany, western Austria, and ending in the northern part of Italy. Secondly, the three regions with the highest GDP per capita over the past years have been Inner London, Brussels, and Luxembourg, followed by Hamburg, Île de France, Wien, Uusimaa, Stockholm, and Madrid. Inner London and Bruxelles are the wealthiest regions of Europe with a GDP per capita of more than twice that of the European average. Thirdly, most regions belonging to the new Member States as well as the southern European periphery, such as the Portuguese, Spanish, southern Italian, and Greek regions, are characterized by relatively low levels of GDP per capita.

Furthermore, there are significant differences in the capacity to create wealth within the EU Member States of EU national boundaries. The capacity of wealth creation of the capital and highly agglomerated regions is relatively better in Hamburg, Ile de France, Wien, London, and Stockholm in comparison with Mecklenburg-Vorpommern, Corse, Brugenland, and the North East and Mellensverige regions. Similarly, the capacity of wealth creation of the capital regions is relatively better, e.g. Budapest, Prague, Warsaw, and the Bratislava regions in comparison to Észak-Alföld, Strední Morava, Lubelskie, and Východné Slovensko. As pointed out in the theoretical part of this book (Chap. 1), the urban concentrations of capital cities lead to economic growth through local knowledge spillovers, which in turn affect local accumulation of capital and agglomeration economies, and, as a result, further growth. Consequently, this has made rich regions become richer and poor regions poorer.

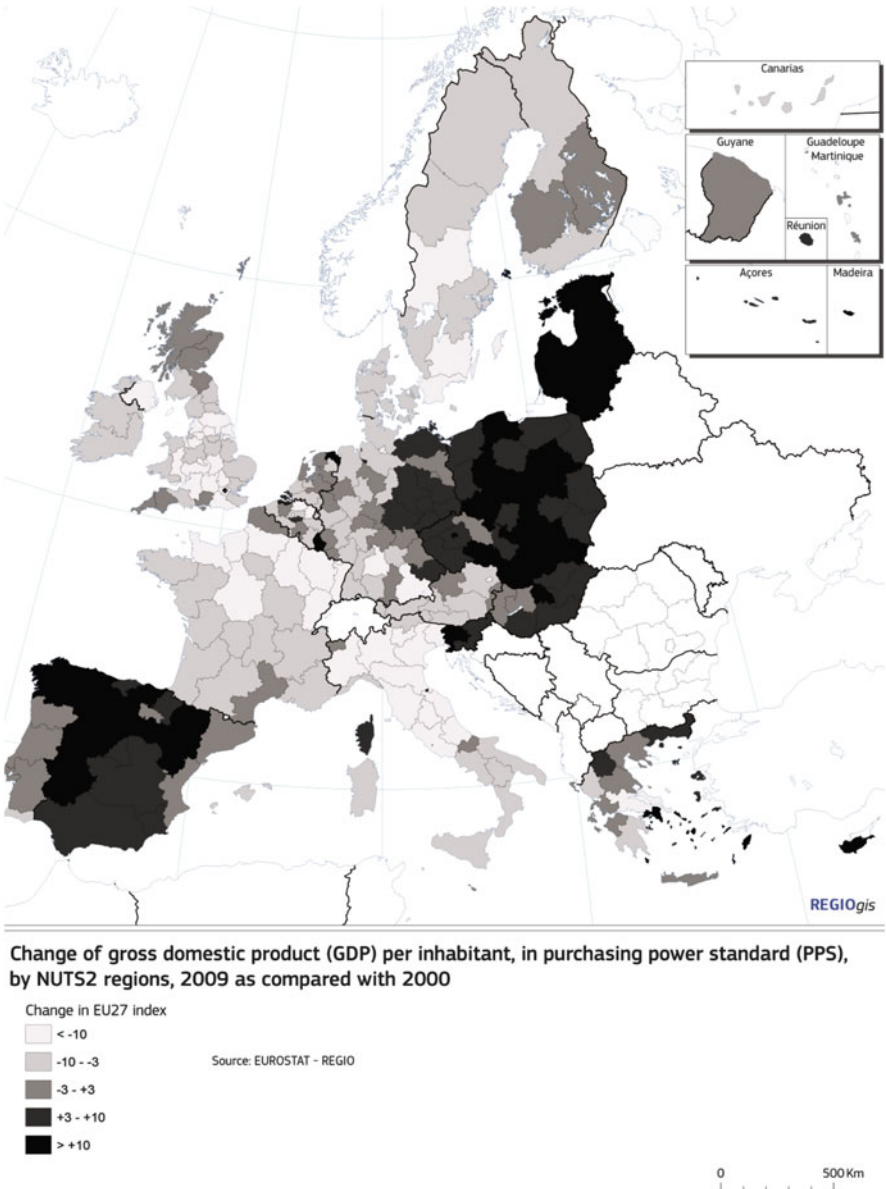
From the dynamic perspective, Map 2.2 indicates that all regions performed well. Map 2.2 shows the extent to which per capita GDP changed between 2000 and 2009 on average in the EU regions. The map shows that economic dynamism is well above average in the southwestern, eastern, and northern peripheral areas of the EU, particularly in the EU-10 Member States. Based on the most recent estimates released by Eurostat (April 13, 2011) the gap between the richest and poorest EU regions has narrowed since 2000. In 2009, only 65 regions had a GDP per capita below 75 % of the EU average, in comparison to 69 regions in 2000. This represents that 119 million people stayed below 75 % of the EU average GDP per



**Map 2.1** GDP per head (PPS) by NUTS2/3, 2009 (Source: Eurostat – REGIO)

capita, compared with 131 million people in 2000. As a result, the gap between the richest and poorest EU regions has narrowed since 2000 (see Maps 2.1 and 2.2).

Among the EU-15 Member States, strong growth was particularly evident in Spain, parts of The Netherlands and Greece, as well as the north of Finland and



**Map 2.2** Change of GDP per capita (PPS) by NUTS2/3 regions 2009 compared to 2000 (Source: Eurostat – REGIO)

Sweden. On the other hand, weak growth that started several years ago is persisting in several EU-15 regions belonging to Italy, France and Portugal, Germany, Sweden, and the UK. Among the EU-10 Member States regions of the Baltic

States, regions of Slovakia, the Czech Republic, and most of Poland have seen growth markedly above the average.

Eurostat-based regional data reveals that the catch-up process of EU-10 countries with the EU average was of the order of 1.7 % age points per year between 2000 and 2009. This fast process of catching up was driven by economic integration and restructuring of national economies. GDP per capita in the EU-10 Member States rose from 50 % of the EU-25 average in 2000 to over 60 % in 2009. In 2008, performance was particularly strong, above 3 % points. It is also important to mention that the fast catching up in the second half of the period under analysis can be explained partly by the fact that the economic and financial crisis struck first in the EU-15 Member States, some of which, like Ireland, Italy, and Denmark, were already in recession in 2008. On the other hand, among the EU-10, only Estonia and Latvia already had negative volume growth rates in 2008, and the full effects of the crisis became apparent only in 2009. EU average of GDP per capita (in PPS) dropped by 6 % between 2008 and 2009 (*Eurostat. Statistics in Focus* 41/2012). Regional GDP per capita dropped sharply in 2009 compared with 2008 in all EU Member States except for Poland (11 out of 16 Polish regions achieved absolute increases in 2008–2009).

The crisis affected mostly manufacturing, construction, and exports (including tourism) activities. Regions with the lowest per capita GDP and capital city regions suffered smaller setbacks than the EU as a whole, resulting in even bigger regional inequalities at the intra-national level in most EU Member States.

However, this fast catch up in terms of GDP per capita resulted in a sharp increase of regional disparities in EU countries. Economic liberalization and integration have favored all of the above regions with significant agglomeration economies, vast concentrations of skilled labor, and vigorous demand.

This first positioning of some European regions in terms of their capacities to create wealth and catching up naturally leads us to the following question. What determines the ability of EU regions to catch up? To what extent does productivity growth (which in turn depends on technological advances, which further depends on the quality of human capital and engaging in R&D and knowledge-intensive activities) explain a region's capacity to prosper?

### **2.2.2 Regional Productivity and Employment in Knowledge-Intensive Sectors**

The contribution of any employee in an industrial sector to the regional economy is best measured by the gross value that the individual adds (GVA). As a “residual,” the GVA indicator measures the sum of incomes generated by the process of production and thus can be used for calculating technological efficiency. With reference to the previously discussed GDP trends, GVA is a method of measuring the productivity of

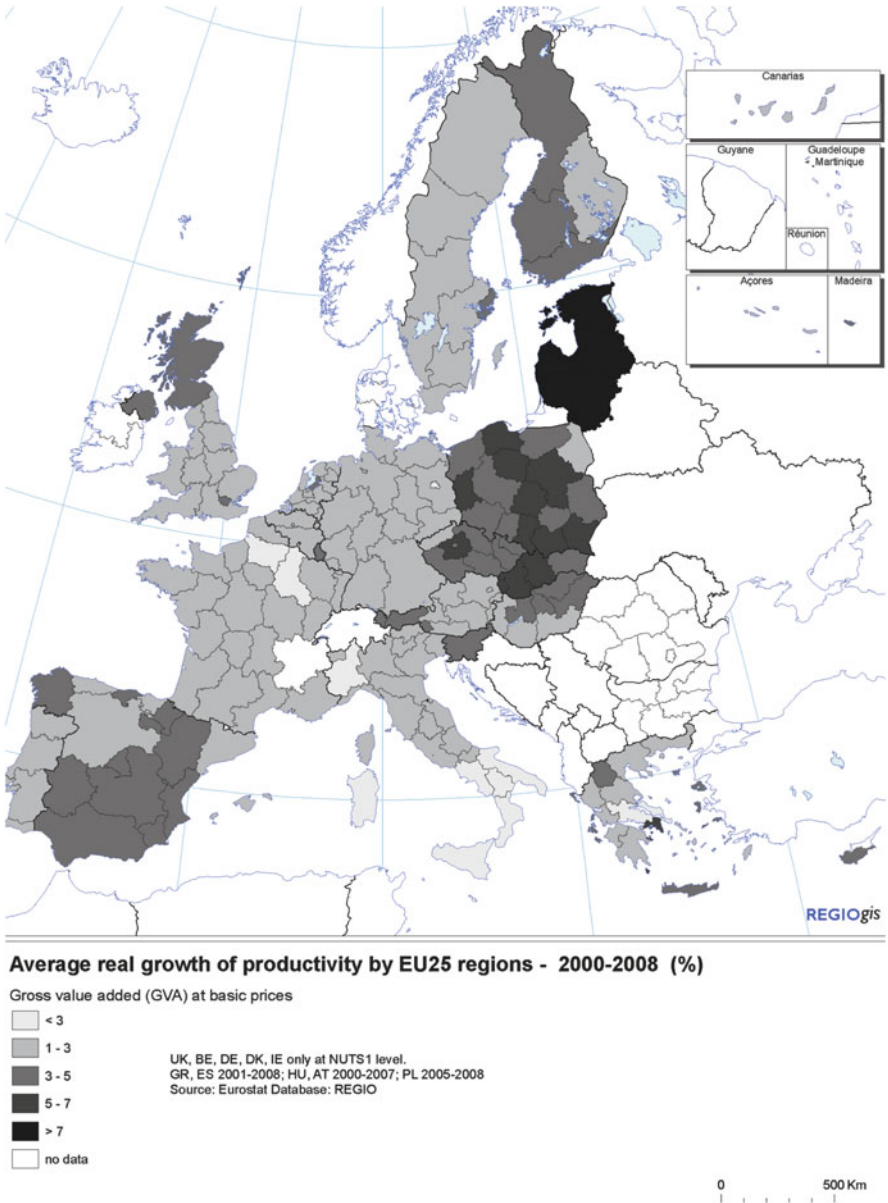
a given economy. Under the European System of Accounts 1995, the term GDP is equal to GVA plus taxes on products less subsidies on products, i.e. at market prices. At the aggregate level, data on real GDP growth has been available in the Eurostat database only since 2000. Map 2.3 shows the average dynamics of GVA in the EU regions in the period 2000–2008. The average rates of growth observed in the EU-10 regions were significantly higher than those of their EU-15 counterparts. This should lead to a sizeable decrease in the productivity gap between these two groups of regional economies. In fact, the Baltic States (Latvia, Estonia, and Lithuania) have observed above 7 % of average growth in GVA, whereas the regions of the Czech Republic (Střední Čechy), Poland (Mazowieckie, Lubuskie, Podkarpackie, Śląskie, Łódzkie, Małopolskie, Pomorskie, Kujawsko-Pomorskie, Wielkopolskie), Slovakia (Západné Slovensko, Bratislavský kraj), and Hungary (Közép-Magyarország) have experienced above 5 % growth of GVA during the above-mentioned period. This might suggest that the processes of economic integration and liberalization in these EU-10 regions contributed to the highest efficiencies in terms of organizational improvements and acceleration of technology transfer from foreign investors. The rest of the EU-10 regions have recorded above 3 % average growth of GVA.

On average, productivity levels in capital cities and in large and dense agglomerations were much higher relative to the countries' national averages. This concerns the Polish Mazowieckie and Śląskie regions, the Slovakian Bratislavský and Západné Slovensko regions, Czech's Praha and Střední Čechy regions, and the Hungarian Közép-Magyarország and Közép-Dunántúl regions. High productivity in these regions relative to their national averages can be explained by the share of the manufacturing sector in their total employment, their market structure, the extent of competition, the level of communication infrastructure, and access to education and training.

Despite the relatively rapid catching-up process observed in recent years, labor productivity levels in the new EU Member States are still well below those observed in the EU-15 countries. The largest difference can be seen in manufacturing, whereas construction and market services seem to be lagging behind less. On average, the total level of productivity in industry is 2–3 times lower in the EU-10 than in the EU-15. Smaller countries such as Cyprus, Malta, and Estonia, along with the capital regions in the Czech Republic, Hungary, and the Republic of Poland have the highest productivity levels (Eurostat 2011).

All the EU-15 regions were found to have productivity above the EU's average productivity. The most productive regions include Groningen in the north of The Netherlands as well as two other Dutch regions, Zeeland and Zuid-Holland, southern and eastern Ireland, Brabant Wallon, Antwerpen and the capital region in Belgium, Sterea Ellada in Greece, the Övre Norrland in the north of Sweden, and the regions of Stockholm and Hamburg. Portuguese industry has half the EU's average productivity – the lowest among the EU-15 group, followed by the Greece, Spain, and southern Italy.

One of the reasons why an average worker in one of the EU-10 Member States still only produces about half the amount of goods and services that are produced in



**Map 2.3** Average real growth of productivity by EU-25 regions – 2000–2008 (%) (Source: Eurostat – REGIO)

the pre-enlargement EU is the difference in capital intensity (Kolasa 2005). Moreover, according to endogenous growth, productivity level is a function of the stock of accumulated knowledge. Since new Member States are surely behind a



technology frontier, the positive externalities in their regional production function are expected to emerge via knowledge spillovers and transfer of technologies from the more developed EU-15 regions.

In a nutshell, while GVA acts as a proxy for technological efficiency, the latter is important for growth and technological catch up of regions, but there is substantial variance across EU regions in GVA growth. Furthermore, there is a large heterogeneity across countries in what this “residual” TFP component entails. When talking about technological change as a driver of GVA growth, one has to carry out a more precise assessment of what these changes are really about. The next sections will analyze in more detail how the catching-up regions are doing on various knowledge economy dimensions affecting productivity growth.

A key condition for fast productivity convergence of EU-10 regions towards more productive EU-15 regions was manufacturing investment intensity and capital-embodied technology transfer as a result of trade liberalization and FDI inflows. However, their impact on technological catch up has been determined by the ability of the regions to absorb and diffuse new technologies as well as by the extent to which foreign investors and national reforms favored a structural shift towards more knowledge-intensive sectors (high-tech sectors).

Map 2.4 provides a more detailed outline of the distribution of employment in high-tech sectors across European regions. These sectors are defined according to their high R&D intensity, and comprise high-tech and medium high-tech manufacturing (see the full list of industry classification in Annex 1) as well as high-tech knowledge-intensive services, such as R&D, and computer-related activities.<sup>1</sup>

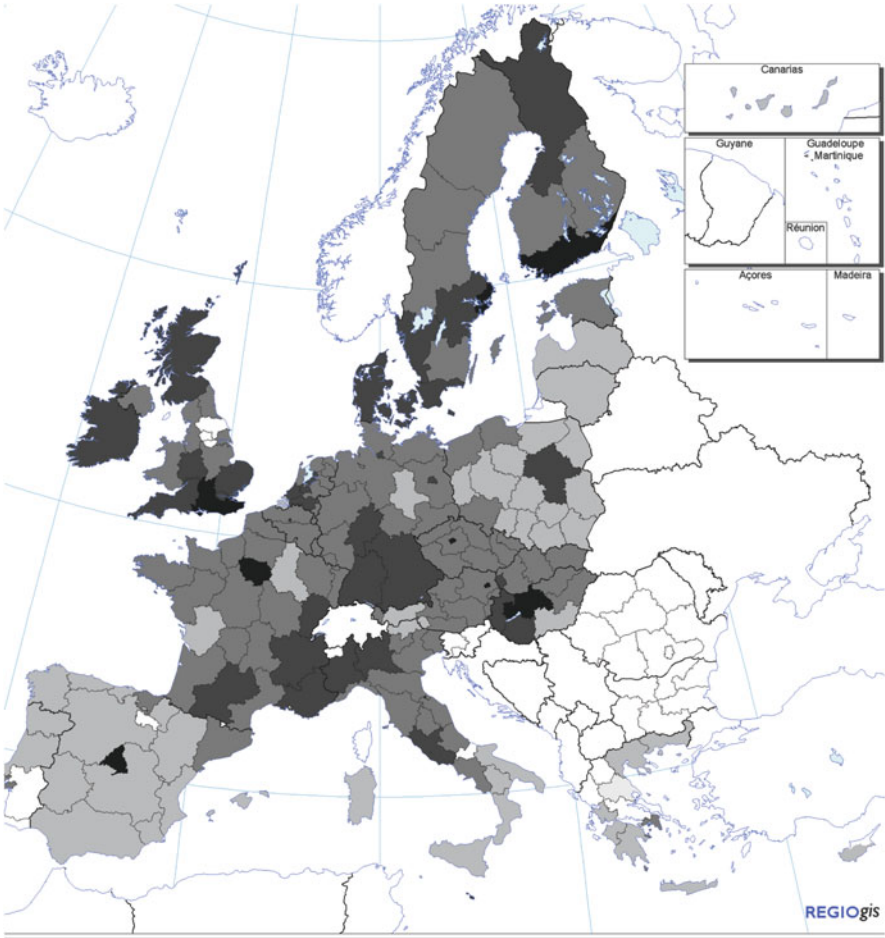
As a general rule, employment in high-tech sectors is dispersed across the EU regions. Average share of employment in high-tech sectors in 2000–2008 ranged from 0.9 % in central Greece to 10 % in the capital region of Sweden. As can be seen in Map 2.4, the regions with the highest employment in high-tech sectors include the national capital regions of EU Member States (Île de France, Etelä-Suomi Praha Bratislavský, Közép-Magyarország, Madrid, Wien, London, Berlin, Mazowieckie, and Bruxelles). All these regions on average registered a value of over 5 % of employment in high-tech sectors between 1999 and 2007. These densely populated capital or city districts have higher R&D and patenting intensity and better absorptive capacity in order to be able to benefit from knowledge spillovers.

Beyond this concentration in capital cities, there was also a high share of high-tech employment in large metropolitan regions in Germany (Baden-Württemberg, Hessen, Bayern, Hamburg), Sweden (where the major regions were Östra Mellansverige, Sydsverige, and Västsverige), Finland (Pohjois-Suomi), the UK (East of England), France (Rhône-Alpes and Midi-Pyrénées), Italy (Lombardia

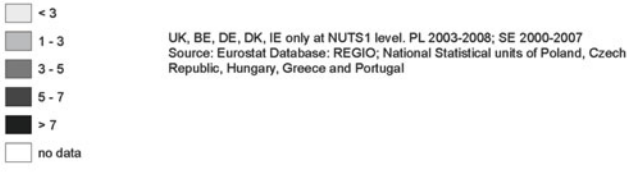
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<sup>1</sup> Employed persons are persons aged 15 and over in high-tech and knowledge-intensive services sectors (high-tech KIS-sector). The knowledge intensity reflects the integration with a generic or service-specific science and technology base. It can be seen as a combination of knowledge embedded in new equipment, personnel, and R&D intensity, Eurostat REGIO.





**Average share of employment in high-tech manufacturing and high-tech knowledge intensive services by EU25 regions - 2000-2008**



**Map 2.4** Average share of employment in high-tech sectors by EU-25 regions – 2000–2008 (Source: Eurostat – REGIO)

and Piemonte), and Hungary (Közép-Dunántúl and Nyugat-Dunántúl). Finally, there is a cluster of high-tech regions that stretches from Luxembourg, through south-eastern Belgium up to East Flanders (Flemish Brabant) in the north of

Belgium, with two regions in the southern and western part of The Netherlands (Noord-Brabant and Zuid-Holland).

## **2.3 The Innovative Potential of the EU Regions and the Efficiency of RIS**

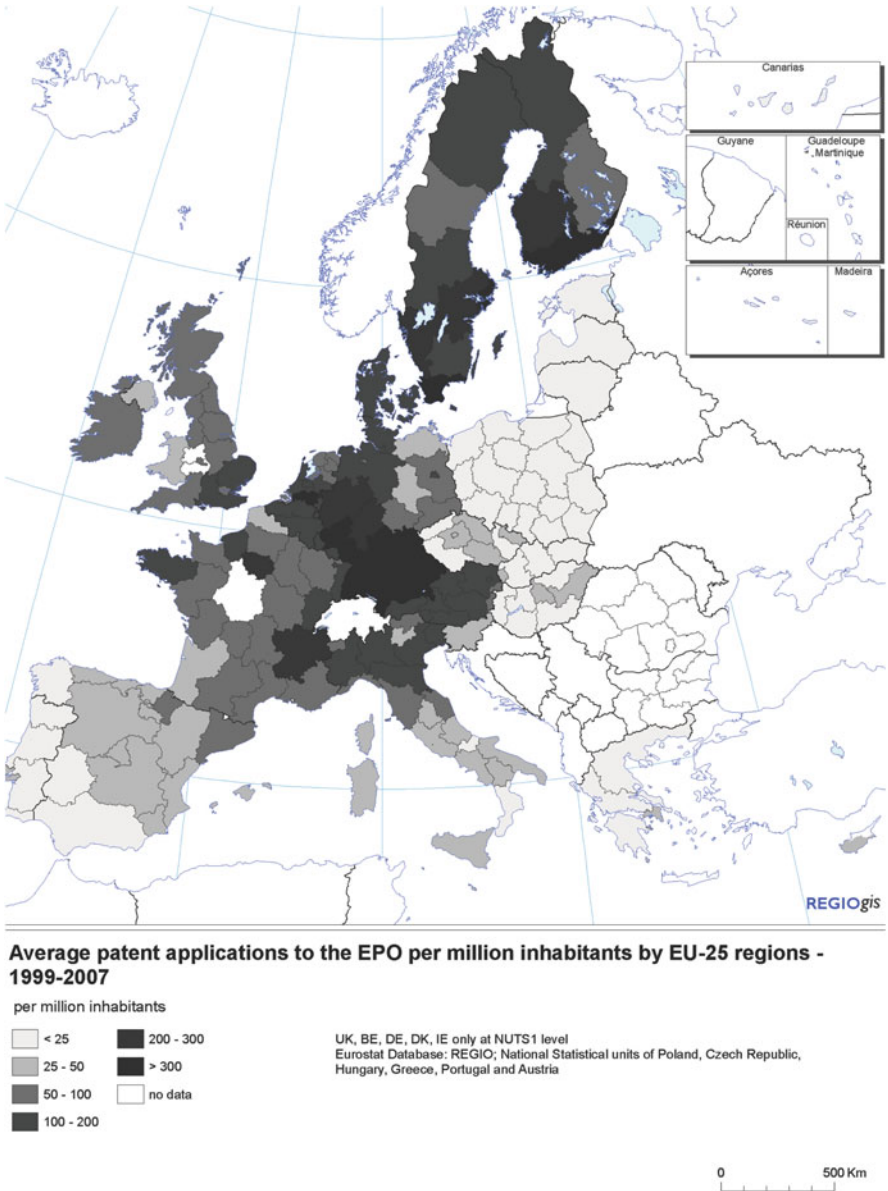
### ***2.3.1 Innovative Potential Indicators***

The previous section has highlighted significant differences regarding the average growth of GDP per capita, productivity, and high-tech employment within the EU and its regions. The following section in turn overviews some aspects regarding the structure and spatial concentration of innovative potential of the EU. Two kinds of innovation potential capacities are investigated in the present section: patent data and R&D efforts. Patent applications to the European Patent Office (EPO) act as a proxy for the knowledge creation capacity.

Globally, German, French, and the UK regions altogether accounted for half of the average number of EU patent applications to the EPO during the period 2005–2008. The southern EU member states regions contribute with some 12 %, whereas EU-10 Member States regions comprise only 3 % of the total number of patent applications. The weak innovative performance of the EU-10 countries is mainly due to the fact that at the beginning of the transition period, innovative activity was almost absent, due to the obsolete technological infrastructure. Their national innovation systems were undergoing major restructuring, and RIS were just emerging.

In terms of geographical distribution of patent applications, there are significant variations within the regional structure of the leading countries regarding patents. Regions that are active in patenting are often situated close together, forming economic clusters. Their high performance and the concentration of innovative potential may be attributed to both local externalities and inter-regional knowledge spillovers. This is the case, for example, in the southern part of Germany (Rheinland-Pfalz, Baden-Württemberg, Bayern, Hessen), the south-east of France (Île de France and Rhône-Alpes), a northern province of The Netherlands (Noord-Brabant), the western region of Austria (Vorarlberg), the southern and western regions of Finland (Etelä-Suomi and Länsi-Suomi), and the southern and western regions of Sweden (Stockholm, Sydsverige, Västsverige) (Map 2.5). All these regions recorded on average more than 200 applications for every million inhabitants during the period 1999–2007.

The best performing regions among the EU-15 southern countries are the Italian regions of Emilia-Romagna, Lombardia Piemonte Veneto Friuli-Venezia Giulia, which submitted on average more than 100 applications during 1999–2007. The EU-10 regions submitted on average less than 25 patent applications during the



**Map 2.5** Average patent applications to the EPO per million inhabitants by EU-25 regions – 1999–2007 (Source: Eurostat – REGIO)

analyzed period (except for Slovenia and Hungary’s capital region Közép-Magyarország).

Some similar trends must be highlighted regarding the spatial concentration of innovation potential across the EU regions towards their relative national average

values. Figure 1 in Annex 2 presents the best and worst regions within each EU country in terms of the number of patent applications per million inhabitants relative to the national average value. The ranking is based on average number of patent applications over the period 1996–2007. It clearly illustrates that there is a greater dispersion of patent applications at the regional level than at the national one. Furthermore, the EU-15 regions show the highest regional dispersion within their national economies in this indicator with respect to the EU-10 group. On average, over the period 1996–2007, the German Baden–Württemberg, Dutch Noord-Brabant, Austrian Vorarlberg, the Swedish capital Stockholm, French Ile de France, and Finnish Etela Suomi regions occupied the highest positions in terms of patent applications per million inhabitants.

In terms of high-tech patent applications per capita, the Swedish regions (Stockholm and Sydsverige, followed by Östra Mellansverige Övre Norrland), Finnish (Pohjois-Suomi, followed by Manner-Suomi and Länsi-Suomi), German (Bayern and Baden–Württemberg, followed by Berlin and Hesses), Dutch (Noord-Brabant and Utrecht), and French regions (Ile de France and Bretagne Rhône-Alpes) are the leaders in the total average number of high-tech patent applications submitted to the EPO between 1999 and 2007. In all these regions the number of high-tech patent applications per capita is more than twice that of the European average. The opposite can be observed in the EU-10 and the EU-15 southern regions. The best performing regions among the EU-10 regions in terms of patent applications to the EPO were the smallest countries: Estonia, Cyprus, and Malta, followed by the Hungarian regions (Dél-Dunántúl, Dél-Alföld, and Észak-Alföld), Czech regions (Praha, Jihozápad, Moravskoslezsko, and Severozápad), the Slovak Bratislava region, and the Polish regions (Lubuskie, Podkarpackie, and Mazowieckie). However, the performance of these regions was still higher in comparison to the EU-15 southern regions: Portugal (Algarve and Norte), Spain (Galicia, Iles Balears, Extremadura, Canarias, Castilla-La Mancha), and Greece (Sterea, Ellada, Thessalia).

### ***2.3.2 Social Capacity and Knowledge-Absorption Determinants***

As previously stated, knowledge creation and innovation may be the outcome of the region's own research and innovative efforts, or be accessed from external sources such as firms or R&D institutions located in other regions. It is therefore essential for these regions to develop their knowledge absorption capacities or, as Abramovitz put it, “social capability” in order to facilitate innovation and the implementation of technology spillovers. In other words, knowledge spillovers occur if regions have the capacity to integrate them.

The share of human resources involved in S&T of the working age population and the number of students in tertiary education are proxies of the EU region's endowment of "social capability" (Table 2.1).

Table 2.1 gives an overview of the current absorption capacities of the EU regions. Absorption capacity is particularly strong in the north of Europe. Without exception, all Swedish, Finnish, and UK regions, and also German regions, Denmark, along with two capital regions of Poland and the Czech Republic combine a high share of the S&T population and have been noted to have levels of educational attainment that are above the European average

In general, the EU-15 regions have better developed absorption capacities than the EU-10 states regions, with the exception of the capital regions of Slovakia (Bratislavský kraj), Poland (Mazowieckie region), the Czech Republic (Praha region), and Estonia. The Swedish, Finnish, and Dutch regions, followed by a few Spanish, French, German, and Austrian capital regions (Madrid, Ile de France, Berlin, and Wien) have the highest share of S&T human capital and level of tertiary education ratio. Moreover, compared to the French case, all Austrian regions have higher participation rates in tertiary education in comparison with S&T schooling. The German and Belgian regions are in a high position both in terms of participation in tertiary education and S&T human capital.

The majority, however, of French, Austrian, Spanish, and a few Italian regions has only moderate absorption capacities. The absorption capacity of most South Mediterranean regions (Italian, Greek, and Portuguese regions) is generally low.

A common feature of all Polish regions is their low S&T human capital and the high number of tertiary education students. A similar situation is applicable to several other EU-10 regions, e.g. Hungarian and Slovakian regions, along with Latvia and Lithuania, for which the general weakness is low S&T capital.

Following the classification of the KIT (*Knowledge, Innovation, Territory*) project, conducted within the framework of the ESPON 2013 Programme, Map 2.6 presents 'Scientific regions,' defined as those regions which simultaneously show higher than average research activity and higher than average quality of human capital. Four indicators capture the level of research activities: R&D expenditures per capita; percentage of employees in R&D; number of patents per capita for all economic sectors; number of patents per capita for the subsample of high-tech sectors.

The composite indicator is calculated as the unweighted average of the re-scaled scores for all indicators within the respective dimension (*KIT Final Report 2013*). The "scientific regions" are classified as those showing values greater than zero for both indicators. Regions showing values greater than zero for the human capital indicator, but less than zero for research activity are labelled 'human capital-intensive regions.' On the contrary, regions characterized by values greater than zero for research activity and less than zero for the human capital indicator are indicated as 'research-intensive regions.' Finally, regions showing values less than zero for both indicators are defined as regions with no specializations in knowledge activities. The KIT project identified 74 scientific regions, 30 research-intensive regions and 52 human capital-intensive regions. However, the biggest number of

**Table 2.1** “Social capability” and knowledge absorption capacities of the EU regions (2008)

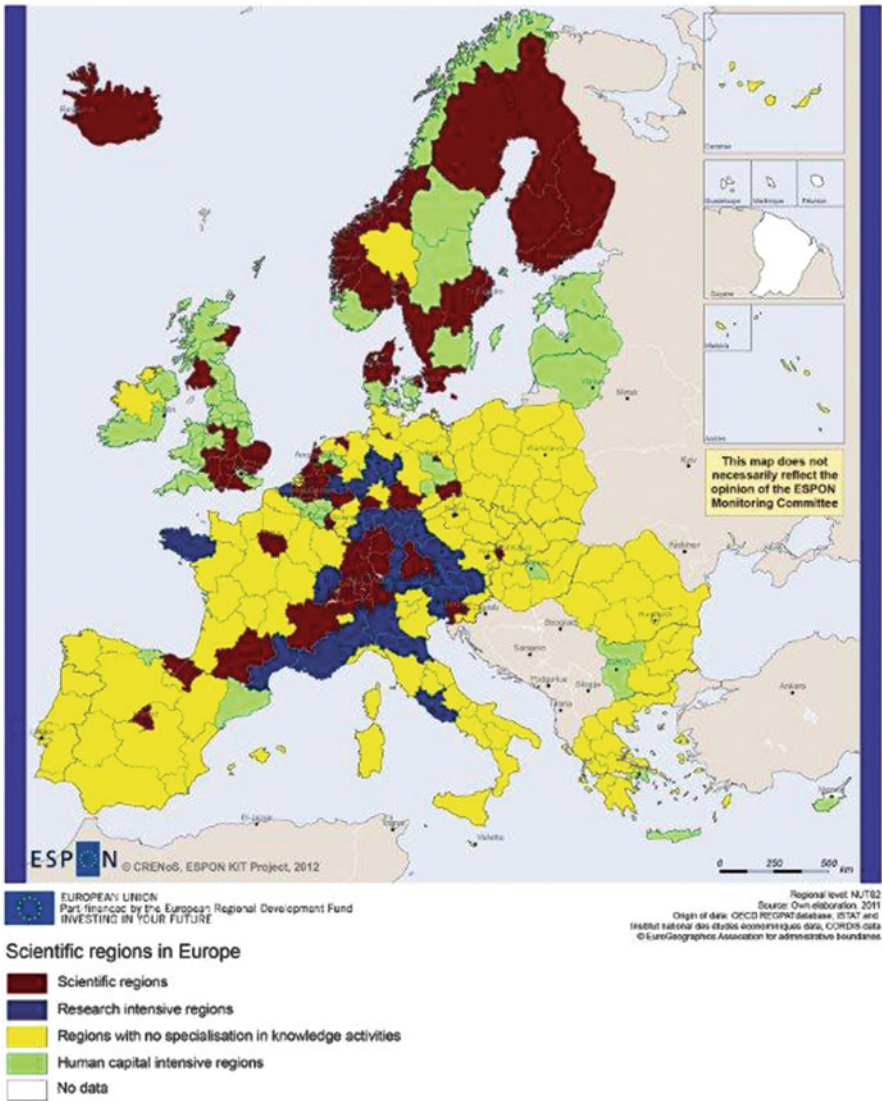
X	Students in tertiary education by NUTS2 (2008)						
	High ( $S > 111877.67$ )	Medium ( $41513.67 < S < 111877.67$ )			Low ( $S < 41513.67$ )		
Human resources as S&T by NUTS2 (2008) as % of totally economic active population	High ( $H > 30.13$ )	Vlaams Gewest Région wallonne Praha Denmark Baden-Württemberg Bayern Berlin Hessen Sachsen Ireland Com. Madrid Île de France	Rhône-Alpes Közép-Magyarország Zuid-Holland Wien Mazowieckie Manner-Suomi Etelä-Suomi East of England London South East South West Scotland	Région de Bruxelles Brandenburg Hamburg Mecklen-Vorpommern Sachsen-Anhalt Thüringen Estonia País Vasco Aragón Alsace Midi-Pyrénées	Auvergne Gelderland Utrecht Noord-Holland Noord-Brabant Bratislavský kraj Länsi-Suomi Stockholm Östra Mellansverige Sydsverige	Principado de Asturias Com F. de Navarra Cyprus Groningen Friesland Drenthe Overijssel Flevoland Zeeland Limburg Pohjois-Suomi Åland Mellersta Norrland	
	Medium (22.9 $0 < A < 30.13$ )	Niedersachsen Nordrhein-Westfalen Cataluña Comunidad Valenciana Andalucía Nord – Pas-de-Calais Prov. Alpes-Côte d’Azur Lombardia	Latvia Lithuania Pomorskie Lisboa Slovenia North West Yorkshire&H East Midlands West Midlands Emilia-Romagna Lazio	Jihovýchod Moravskoslezsko Schleswig-Holstein Galicia Castilla y León Región de Murcia Picardie Haute-Normandie Lorrain	Pays de la Loire Bretagne Poitou-Charentes Aquitaine Languedoc-Roussillon Steiermark North East (UK) Wales Northern Ireland (UK)	Střední Čechy Jihozápad Severovýchod Bremen Saarland La Rioja Basse-Normandie Bourgogne Franche-Comté Limousin Liguria	Prov. Trento Niederösterreich Kärnten Oberösterreich Salzburg Tirol Vorarlberg Itä-Suomi Småland med Öarna Norra Mellansverige

Low ( $A < 22.90$ )	Canarias (ES)	Podlaskie	Severozápad	Basilicata
	Piemonte	Zachodniopomorskie	Strední	Közép-Dunántúl
	Marche	Opolskie	Morava	Nyugat-Dunántúl
	Abruzzo	Kujawsko-Pomorskie	Castilla-la Mancha	Dél-Dunántúl
	Calabria	Warminsko-Mazurskie	Extremadura	Észak-Magyarország
	Sardegna	Centro (PT)	Illes Balears	Malta
	Észak-Alföld	Západné Slovensko	Champagne-Ardenne	Burgenland
	Dél-Alföld	Stredné Slovensko	Corse	Lubuskie
	Podkarpackie	Východné Slovensko	Valle d' Aosta	Algarve
	Świętokrzyskie		Pr. Bolzano	Alentejo
			Friuli-Venezia Giulia	Reg Aut dos Açores
				Reg Aut da Madeira
				Umbria
				Molise

Source: Runiewicz (2013)  
The indicator is indexed by the EU-25 average, and the respective values are given in parenthesis



## Scientific regions in Europe, 2007



**Map 2.6** “Scientific regions” in Europe (Source: KIT (Knowledge, Innovation, Territory) Final report 2013, [www.espon.eu](http://www.espon.eu))

EU regions – 126 were those with no specialization in knowledge activities. Among the 74 scientific regions, 59 belonged to EU-15 Member States countries and three belonged to the EU-10 group of countries (including Bulgaria and Romania). Strong scientific regions were mostly agglomerated and located in central and northern Europe, namely in Austria, Belgium, Luxembourg, France

(Paris), Germany, Ireland (Dublin), Denmark, Finland, and Sweden, with some notable exceptions in the east, such as Praha, Cyprus, and Estonia, and in the south, such as Lisboa and Attiki. Regions with no specialization in knowledge activities were located mainly on the peripheral territories of Europe, and ‘research-intensive regions’ were concentrated in territories characterized by a manufacturing productive specialization (Northern Italy, German regions). Finally, as expected, ‘human capital-intensive regions’ were located mainly in northern Europe.

In general, the KIT project highlighted that knowledge accumulation inside a region also requires networking activity or the acquisition of knowledge from outside. Consequently, scientific regions were also identified as networking regions. Furthermore, the report concluded that a very high number of EU regions, mainly in eastern countries and in the southern peripheral countries were below the EU average in terms of innovation and knowledge-creation capacities.

### ***2.3.3 Knowledge Transfer Capacity: University, Business, and Government R&D Intensities***

Technological externalities require efficient innovation systems that connect universities, private enterprises, and government institutions. In some regions such as the EU-10 countries’ regions, the innovation system and the underlying technological infrastructure are not sufficiently developed. These regions are generally characterized by relatively low business R&D intensities. For these regions, absorption capacity is embodied mainly in university labs and government research centers. Therefore, transfer capacities and institutional interfaces are necessary conditions for knowledge diffusion within the productive system. Since the direct measures of knowledge transfer among institutional sectors such as higher education, the private business sector, and the government sector are not available, some imperfect proxies, such as R&D intensities could be applied. These measures, along with the regional endowment of knowledge-intensive services (KIS), communication infrastructure, and population density, which enable the carrying of ideas from one individual to another, are discussed below for the EU regions.

Globally, the EU-15 Member States are performing much better in terms of total R&D investments. Finland, Sweden, Germany, Austria, and France belong to the group of leading countries in terms of R&D intensities (with share of total R&D expenditure ranging from 2 % to 3.5 % for 2007 (Eurostat 2011)). Sweden is clearly Europe’s best performing country, with an R&D intensity about twice that of the European average.

For new Member States of the EU-10 group of countries, R&D intensities are still relatively low, despite strong positive tendencies during the considered period (ranging from 0.4 % in Cyprus to 1.5 % in the Czech Republic in 2007) (Eurostat 2011). The latter, and smaller states such as Estonia and Slovenia, have caught up

significantly. Currently, Slovenia and the Czech Republic outperform some of the EU-15 states (mainly Spain, Portugal, and Italy) in terms of R&D intensity.

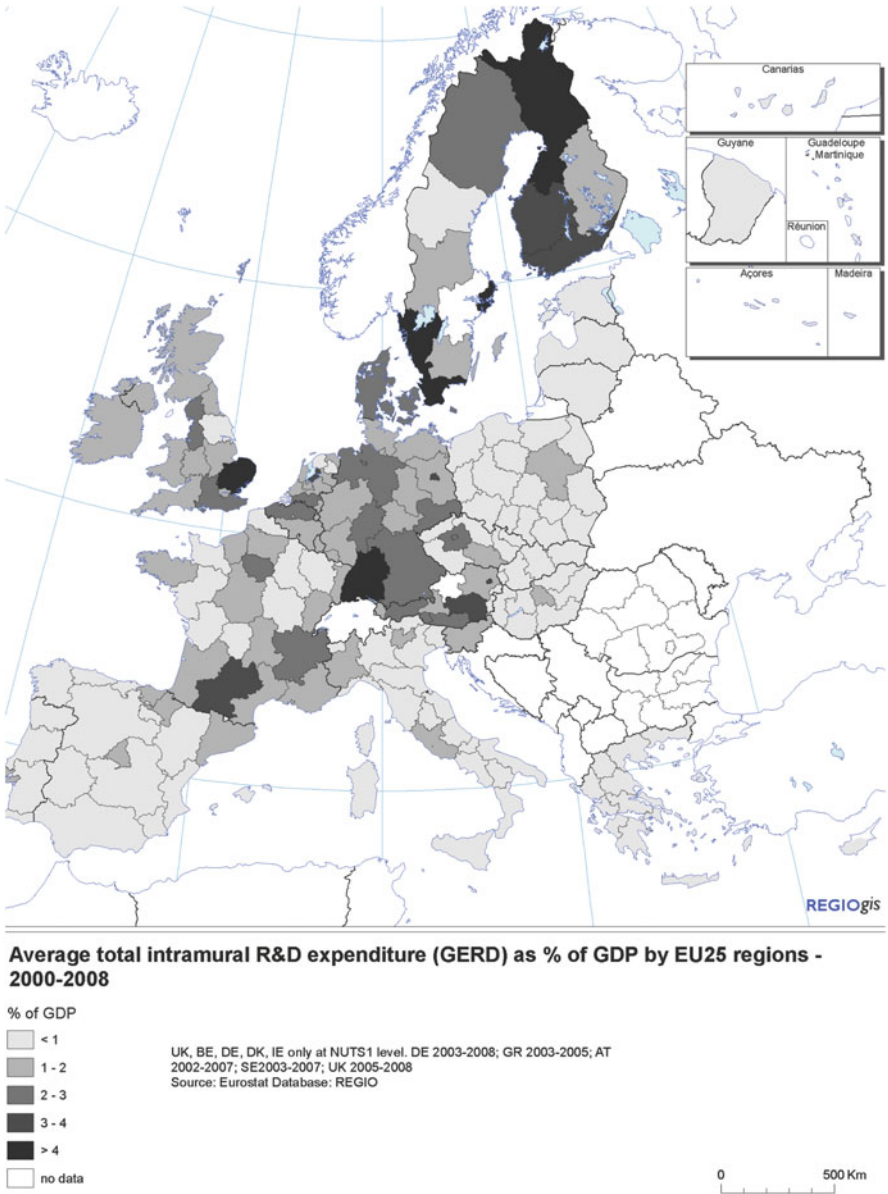
Broadly, the business sector realizes about two thirds of total R&D spending on average in the EU. Private sector R&D is considered especially crucial for the innovation and economic growth of regions. It results in the technology that brings new products and services to the market place. However, only a few of the EU Member States have relatively high R&D expenditure performed by the business sector; they are Finland, Sweden, Germany, Austria, and France. The EU-10 states, along with some southern EU-15 states, have relatively lower performance in business R&D. This fact suggests that for new Member States public R&D can still play an important role in the field of knowledge transmission. Government R&D expenditures as a percentage of total R&D is particularly significant for Poland.

In general, Map 2.7 shows that R&D intensities tend to concentrate geographically around capital cities or in big metropolitan areas, where they can benefit from the economies of agglomeration and urbanisation. The Swedish and Finnish regions are clearly the best performing ones, with Västssverige spending almost 5 % on average between 2000 and 2008, followed by Sydsverige (4.3 %), Pohjois-Suomi (4.2 %), Stockholm (4.2 %), and Södra Sverige (4.1 %). The situation is similar for the spatial distribution of business and R&D expenditures. The average value of Swedish regions' business R&D intensity is higher than the ones obtained by most European regions. The latter indicates a higher potential for knowledge creation and diffusion. The situation is slightly different in the field of government R&D intensity. While Sweden clearly outperformed all other European countries in terms of university and business R&D intensities, it holds a weak position in the field of government R&D. The average university, business, and government R&D intensities of the EU regions relative to their country average are illustrated in Figs. 2, 3, 4, 5, 6 and 7 in the Annex 2.

Similarly, the German regions of Baden-Württemberg (4.2 %) and Berlin (3.7 %), followed by the Austrian regions of Wien (3.4 %) and Steiermark (3.4 %), performed very well in terms of average share of R&D expenditure during the considered period. For these regions, absorption capability has been shown to be strong, and their high performance in terms of business R&D intensity suggests an important potential for knowledge creation capacity (see Annex 2).

On average, the potential for knowledge transfer capacities of the southern periphery of the EU is relatively weak. This is especially true for the Greek, Portuguese, and Spanish regions. With the exception of the two capital regions, Madrid and Lisbon, the average levels of R&D intensities for the Greek, Portuguese, and Spanish regions are low and range from 0.3 % to 0.5 % on average for the period 2000–2008. The only region performing relatively well in business R&D is the Cataluña region in Spain (with the number above 1 %).

Among the EU-10's best performing regions are the Czech regions of Střední Čechy (2.5 %) and Praha (2.1 %), followed by Slovenia (1.30 %) and the capital regions of Hungary and Poland – Közép-Magyarország (1.2 %) and Mazowieckie (1 %). The rest of the EU-10 regions spent well below 1 % of their GDP on R&D



**Map 2.7** Average intramural R&D expenditure as percentage of GDP in EU regions (2000–2008) (Source: Eurostat – REGIO)

activities. This is also a common trend for most of the southern regions of the EU-15: Portugal, Spain, Italy, and Greece, with some exceptions for Province Trento in Italy. For many of the EU-10 regions structural funds and public R&S sources have become a significant, if not the main source, of R&D funding.

Given their extremely low levels of R&D intensity, especially in the private business sector, it is questionable whether sufficient resources are devoted to the development of knowledge transmission mechanisms such as private-public interfaces in the above-mentioned regions.

### ***2.3.4 Potential Knowledge and Innovation Diffusion Capacities***

Knowledge externalities are considered to be the most compelling in the context of cities. The spatial concentration of individuals, capacities, information, and knowledge within a limited geographic area provides an environment, in which ideas flow quickly from one person to another. Furthermore, since dynamic externalities arise from communication between economic agents, their effects should be more readily observable within an environment where both physical proximity and infrastructure communications are in place.

Table 2.2 illustrates that the EU-15's northern and capital regions have greater potential for knowledge diffusion when communication and population density are taken into consideration. Among those listed are capital regions such as: the Berlin, London, Wien, Stockholm, Madrid, and Amsterdam regions (Noord-Holland). The rest of the EU-15, especially the southern regions such as Italy, Spain, and Portugal, as well as Finland and Sweden, have relatively low levels of broadband access and degree of population density (based on data from 2008).

Only a few of the EU-10 regions, mainly the Czech, Polish, and Hungarian capital regions of Praha, Mazowieckie, and Budapest, along with the bigger Polish agglomerations – Śląskie, Małopolskie, and Dolnośląskie – have the highest knowledge diffusion potential among this group of regions. The differences in knowledge diffusion potential in these regions are also determined by their distinct administrative devolution. The capital of Poland, Warsaw, is incorporated into the Mazowieckie region, whereas Prague and Bratislava are city regions. Given their relatively high broadband access, these regions could have better opportunities for outsourcing and in-sourcing activities. Although there isn't any strong evidence to show how Internet technologies affect innovation processes, Web-based communication technologies such as browsers, Websites, search engines, online forums, email, blogs, and wikis enable easy exchange of information and retrieval of digitalised knowledge content.

There is a small group of regions for which both the level of broadband and the population density are relatively low. This group contains more peripheral regions, predominantly rural or mountain regions of Spain, Italy, and some islands such as Açores or Madeira. For these regions, the broadband infrastructure can only be treated as compensation for their relatively sparsely populated areas. The widespread use of ICT systems and equipment can promote teleworking and lifelong learning and accelerate information diffusion (Runiewicz-Wardyn 2008b).

Table 2.2 Knowledge diffusion potential in the context of high-density regions

Y	X		
	Population density by NUTS2 (2008)		
	High (X > 195.83)	Medium (85.1 < X < 195.83)	Low (X < 85.1)
Households with broadband access	High Y > 63		
	Vlaams Gewest Noord-Brabant Malta South West Utrecht Hamburg East Midlands Hessen East of England North East Baden-Württe Stockholm Yorkshire&H	Berlin Limburg West Midlands Gelderland Wien South East London North West Noord-Hol Nordrhein- Westfalen Zuid-Hol Com.de Madrid	Norra Mellansverige Flevoland Manner-Suomi Åland Länsi-Suomi Småland med öarna Övre Norrland Östra Mellansverige Pohjois-Suomi Zeeland Mellersta Norrland Västssverige Friesland (NL) Etelä-Suomi Scotland Itä-Suomi Kärnten Südösterreich Mecklenburg- Vorpommern Lubuskie Zachodniopomorskie Salzburg Burgenland Dunántúl Niederösterreich
Medium	50 < Y < 63		
	Région wallonne Bruxelles-Capitale Lisboa Rheinland-Pfalz Illes Balears Małopolskie Cataluña Praha Canarias (ES) País Vasco	Ireland Aragón Algarve Estonia Latvia Lithuania Tirol Comunidad Navarra Podlaskie	

(continued)

Table 2.2 (continued)

Y	X	
	Population density by NUTS2 (2008)	
	High ( $X > 195.83$ )	Medium ( $85.1 < X < 195.83$ ) Low ( $X < 85.1$ )
Low $Y < 50$	Śląskie Közép-Magyarország Oberösterreich Pomorskie Łódzkie Thüringen Nyugat-Dunántúl Westösterreich Közép-Dunántúl	Valle d'Aosta Prov Bolzano Reg. Açores (PT) Reg. Madeira (PT) Castilla-la Mancha Extremadura Castilla y León Warmińsko-Mazurskie La Rioja Dél-Dunántúl Jihozápad Dél-Alföld Steiermark
	Emilia-Romagna Veneto Liguria Lazio Lombardia Atiki Com. Valenciana Sachsen Contiente Centro (PT) Norte	Severovýchod Northern Ireland Reg de Murcia Severozápad Strední Morava Észak-Alföld Brandenburg Lubelskie Észak-Magyar Galicia Andalucía Świętokrzyskie Střední Čechy Jihovýchod

Source: own calculations based on data from Eurostat – REGIO



## 2.4 Regional Typology of Innovative Potential and Technological Capabilities in the EU

On the basis of the different aspects of innovative potential, technological leadership, and growth of the EU regions, which were investigated in the previous sections, this section presents a more integrated view of the EU-25 Member States regions. Table 2.3 reveals the relationship between economic and technological development of the EU regions. All the EU regions were grouped into six different categories of regions according to their average GDP per capita (for 2000–2008 in PPP) and innovative and technological potential.

Regions that belong to the technological and economic leaders' category have a high GDP per capita (2008), a high number of high-tech patent applications per capita, and a high share of employment in the high-tech manufacturing and services sectors. This group includes only the EU-15 group regions, especially their capital regions and big agglomerations such as London, Stockholm, Hamburg, Île de France, Bruxelles, Wien and Groningen, Åland, Utrecht, Bremen, and others. The regions that belong to the category of the innovative, technological, and economic leaders manage their entire innovation process well.

Table 2.3 shows that there aren't any regions meeting the criteria of high GDP per capita and poor innovative and technological performance. This suggests that innovation and particularly technological innovation are key drivers of economic growth. It is through the 'knowledge externalities' that new knowledge quickly becomes social knowledge, acts to enhance productivity at the enterprise level, and contributes to sustained long-term economic prosperity.

Innovation and technological leaders achieving average GDP per capita levels, may have well-developed innovation (R&D intensity) and technological capacities (high-tech patents), but may not be very efficient in valorising their technological achievements. Their important technological advances have been accompanied by relatively lower GDP per capita (2008) in comparison to other EU regions. These regions include the French regions (Alsace, Bretagne, Franche-Comté, Midi-Pyrénées, Provence-Alpes-Côte d'Azur, Rhône-Alpes), the Spanish capital (Madrid), Dutch (Flevoland and Limburg), German (Niederösterreich, Nordrhein-Westfalen, and Rheinhessen-Pfalz), Austrian (Kärnten and Steiermark), Finnish (Länsi-Suomi and Pohjois-Suomi), Swedish (Östra Mellansverige), the UK (South West), and Belgium (Vlaams Gewest). It can be expected that if these regions succeed in improving their efficiencies in exploiting their innovative and technological opportunities to produce higher productivity and added value, they will join the group of "technological and economic leaders."

The next group of regions includes areas with average innovative and technological potential, but high GDP per capita (2008). This group includes the Swedish (Mellersta Norrland, Norra Mellansverige, and Småland med öarna), the Dutch (Groningen and Zeeland), the German (Bremen), the Austrian (Oberösterreich, Vorarlberg, and Salzburg), the Italian (Lazio and Emilia-Romagna), and Luxembourg regions. These could be classified as highly productive, with high

**Table 2.3** Regional typology of innovative potential and technological capabilities in the EU

GDP p.c. 2008	High innovative potential and technological leadership	Average innovative potential and technological leadership	Poor innovative potential and technological followership	
High ( $Y > 28,100$ )	Åland Baden-Württemberg Bayern Berlin East of London Etelä-Suomi Hamburg Hessen Île de France Lombardia London Luxembourg Manner-Suomi	Noord-Brabant Noord-Holland Norra Mellansverige Övre Norrland Bruxelles South East Stockholm Sydsverige Utrecht Västverige Wien Zuid-Holland Mell Norrland	Mellersta Norrland Groningen Bremen Groningen Luxembourg Vorarlberg Salzburg Oberösterreich Lazio Norra Mellansverige Emilia-Romagna	Zeeland Småland med öarna
Medium ( $20,266 < Y < 28,100$ )	Alsace Bretagne Madrid Flevoland Franche-Comté Kärnten Länsi-Suomi Limburg Midi-Pyrénées Niederösterreich	Nordrhein-Westfalen Östra Mellansverige Pohjois-Suomi Provence-Alpes-Côte d'Azur Rheinessen-Pfalz Rhône-Alpes South West Steiermark Vlaams Gewest	Aquitaine Auvergne Basse-Normandie Cataluña Centre (FR) Drenthe East Midlands Friuli-Venezia Giulia Gelderland Haute-Normandie Itä-Suomi L. Roussillon Liguria	Lisboa Aquitaine Aragón Bourgne Com de Navarra Corse Friesland (NL) Illes Balears La Rioja Limousin Lisboa Lorraine Marche Nord – Pas-de-Calais País Vasco Sch-Holstein Toscana West Midlands Zeeland

Low ( $Y < 20,266$ )				Poitou-Charentes
Bratislava	Brandenburg	Notio Aigaio	Umbria	
Cyprus	Észak-Magyarország	Abruzzo	Lithuania	
Estonia	Jihovýchod	Alentejo	Łódzkie	
Észak-Alföld	Mecklenburg-Vorpommern	Algarve	Lubelskie	
Jihozápad	Podkarpacie	Andalucía	Małopolskie	
Közép-Dunántúl	Nyugat-Dunántúl	Attiki	Molise	
Közép-Magyarország	Pomorskie	Basilicata	Peloponnisos	
Malta	Reg. Açores	Calabria	Podlaskie	
Moravskoslezsko	Sachsen	Campania	Pr. de Asturias	
Dél-Dunántúl	Sachsen-Anhalt	Canarias (ES)	Puglia	
Dél-Alföld	Severovýchod	Cantabria	Reg. Madeira	
Praha	Sicilia	Castilla y León	Región de Murcia	
Severozápad	Stredné Slovensko	Castilla-la	Śląskie	
Slovenia	Strední Čechy	Mancha	Stereia Ellada	
Mazowieckie	Strední Morava	Centro (PT)	Świętokrzyskie	
	Thüringen	Comunidad	Thessalia	
	Západné Slovensko	Valenciana	Východné	
		Dolnośląskie	Slovensko	
		Dytiki Ellada	Warm-	
		Extremadura	Mazurskie	
		Galicia	Wielkopolskie	
		Ipeiros	Zachodniopom	
		Kentr.	Latvia Kuj.	
		Makedonia	Pomorskie	

Note: Within each cell, regions are listed in decreasing order of GDP per capita (2008)

innovative potential but less focus on high-technology sectors. Although the number of patents is relatively high in these regions, it is less fruitful in terms of high-tech industries.

The regions with average innovative potential and technological leadership and an average level of GDP per capita include the Finnish (Itä-Suomi), the Spanish (Cataluña), the Dutch (Overijssel, Gelderland, and Drenthe), the German (Niedersachsen, Nordrhein-Westfalen, and Schleswig-Holstein), the UK (East Midlands, West Midlands, North East, and North West), the French (Aquitaine, Auvergne, Basse-Normandie, Centre (FR), Haute-Normandie, Languedoc-Roussillon, Pays de la Loire, and Provence-Alpes-Côte d'Azur), the Italian (Friuli-Venezia Giulia, Liguria, Piemonte, and Toscana), the Belgian (Région Wallonne) regions, and the Portuguese capital, the Lisboa area. Regions belonging to this group have a low number of high-tech applications and relatively high knowledge-intensive employment capacities compared to the other EU regions.

Despite the fact that their innovation systems perform weakly, these regions achieve average levels of GDP per capita. They cannot reach the level of wealth obtained by technological and economic “leaders.”

The reasons for that can be both outside as well as within their specific local aspects (e.g. lack of presence of high-tech clusters). For the regions belonging to this group, sustained economic development requires a significant strengthening of their technological and innovative bases. It can also be that some regions are actually ready to upgrade their technological capacities and could soon shift into the category of technological or economic leaders.

It is also possible to see that none of the regions belonging to the EU-10 countries is prone to concentrate in the group of either average and high-positioned technological and economic leaders. As indicated in Table 2.3, these regions are characterized by poor wealth creation, despite their high or average technological and innovative capacities. Without exception, all the Hungarian, Czech, Polish, and Slovakian regions belong to this category. Compared to the other EU-10 regions, several capital regions of the above-mentioned countries, such as Közép-Magyarország, Praha, Mazowieckie, and Bratislava, followed by other EU-10 regions (Észak-Alföld, Jihozápad, Közép-Dunántúl, Moravskoslezsko, Dél-Dunántúl, Dél-Alföld, Severozápad) and smaller member countries of the EU-10 (Cyprus, Estonia, Malta, Slovenia) possess high innovative potential and technological leadership. It is expected that these regions, in turn, are first to achieve higher levels of GDP per capita compared to the other EU-10 or southern EU-15 regions.

The regions with average innovative potential and technological leadership, but with poor levels of GDP per capita include the rest of the Hungarian areas (Észak-Magyarország, Nyugat-Dunántúl), the Slovakian regions (Stredné Slovensko and Západné Slovensko), and the Czech (Jihovýchod, Severovýchod, Střední Čechy, and Střední Morava), Polish (Lubuskie, Podkarpacie, and Pomorskie), German (Mecklenburg-Vorpommern, Brandenburg, Sachsen, Sachsen-Anhalt, Thüringen), Italian (Sicily), and Portuguese (Açores) regions. Despite their average

performance in terms of innovation and technological capacities, their abilities to turn this potential into sustained economic development is low.

Finally, “innovative and technological followers” and those “staying economically behind” are characterized by low levels of per capita GDP and poor innovative and technological performance. Even though many of these regions are characterized by relatively good absorption capacities, they have not yet reached the capacity to create knowledge and wealth. Despite their common characteristic in terms of underdeveloped capacities, the degree of dispersion within this group is relatively important. This is the biggest group of regions belonging to this category as it includes all of the remaining EU-10 group regions along with the majority of the southern regions of the EU-15. Given that the degree of homogeneity within this category of regions is by far the lowest compared to the other groups, the performance of these regions should be interpreted with caution. For example, this group contains both national economies (like Latvia and Lithuania), and the poorest regions of Greece, where high-tech patenting activity is practically non-existent and their share in R&D intensities are extremely low. Nevertheless, for all these regions, further efforts to strengthen their innovative and technological capacities are necessary to enhance the rate of their economic catch up.

In summary, economic prosperity is related to the innovative and technological advancement of regions. Table 2.3 shows two extremes. It is very rare to encounter a case where a high per capita GDP is accompanied by poor innovative and technological performance. On the other hand, it is very common that the technological and economic “laggers” always go in pairs.

## **2.5 Spatial Distribution of Technological and Innovative Potential of the EU**

### ***2.5.1 Spatial Concentration of High-Tech Industries in the EU***

The accelerating pace of technological advances and their diffusion through the use of ICT and growing trends towards offshoring and outsourcing raise several questions regarding the spatial allocation of knowledge-based activity across the EU. More specifically, are the industries that emphasize research and innovation more spatially concentrated? Does high-tech employment exhibit different patterns of geographical concentration than high-tech patent concentration does?

The EU countries’ distribution of innovation and knowledge-intensive activities can be evaluated through the use of Gini’s concentration coefficient. The Gini index measures spatial concentration based on the Hoover-Balassa index of revealed comparative advantage, and can be written as (Brulhart 2000):

$$HB_k = \frac{x_r^k}{\sum_r x_r^k} / \frac{\sum_k x_r^k}{\sum_r \sum_k x_r^k}$$

For each country the concentration index is calculated on the basis of the regional share of the country's employment or patents in a given sector  $k$ . The index compares the weight of sector  $k$  in all the other sectors in the region to the weight of this sector in all sectors at the country level. The indexes are calculated for two time periods for the patent activity (2001–2004 and 2005–2007) and just for one time period for the employment activity between 2005 and 2007. The more geographically concentrated the industry, the higher the Gini value. Purely random patterns of geographical dispersion lead to measures of around 0.3. Therefore, clusters within advanced economies with some mobility of factors and firms between regions should reach Gini values of above 0.3 (Solvell et al. 2003). Table 2.4 shows that knowledge-intensive industries are characterized by strong spatial concentration.

High-tech industries tend to be more concentrated than less knowledge-intensive industries, such as industries in which employment is medium high-tech. In general, employment in both types of industries was more concentrated in the smaller EU states than in the larger ones (except Lithuania). The concentrations index in the EU-10 states is higher than in the EU-15 states (except for the Republic of Poland and Lithuania). Among the EU-10 group of countries Malta, Cyprus, Slovakia, Czech Republic, and Slovenia had the highest Gini coefficient concentration in high-tech and medium high-tech employment levels.

High-tech employment is the least concentrated in the southern states of the EU and in more recent EU Member States. The levels of concentration approximate to random geographical dispersion were observed for Spain (0.38), Greece (0.20), and Portugal (0.39). For Lithuania, Poland, and Estonia the Gini coefficients for high-tech employment were lower than 0.6. This relatively low level of spatial concentration in high-tech industry employment can be explained by the small share of high-tech manufacturing in total employment, intra-regional economic disparities within these countries, as well as their administrative devolution (Lithuania and Estonia are considered as single regions at NUTS 2 level). Therefore, the mechanisms based on economies of scale and agglomeration externalities will matter less for these regions.

In all the EU Member States, concentration of high-tech patents is extremely high. Changes in Gini coefficients between 2001–2004 and 2005–2007 were small for every state, implying small changes in concentration; however, there was a slightly increasing trend for Belgium, Finland, Portugal, Slovenia, Malta, and Estonia. Going into details of the spatial concentration of high-tech industry in the EU requires more detailed study of the six basic groups of high technology: aviation; computers and automated business equipment; communication technology; lasers; micro-organisms and genetic engineering; and semiconductors.

The biggest concentration of the *Aerospace industry* (NACE Rev 1.1 codes 35.3 Manufacture of aircraft and spacecraft) is located in three EU countries – Germany, France, and the UK – and accounts for 80 % of the EU's value added, 72 % of

**Table 2.4** High-tech patents and employment Gini coefficients in EU Member States in 2005–2007

Country	High-tech employment	Medium high-tech employment	Knowledge-intensive services	High-tech patents		
				2002–2007	2001–2004	2005–2007
Austria	1.12	0.95	0.84	0.92	0.92	0.91
Belgium	0.61	1.01	1.05	0.92	0.90	0.92
Germany	1.47	1.61	1.01	0.91	0.90	0.92
Denmark	0.79	0.93	1.17	0.93	0.92	0.93
Spain	0.38	0.73	0.88	0.93	0.91	0.93
Finland	1.80	0.87	1.32	0.86	0.83	0.88
France	1.00	0.87	1.03	0.90	0.88	0.91
Greece	0.20	0.37	0.58	0.93	0.95	0.90
Italy	1.05	1.15	0.94	0.92	0.92	0.91
Portugal	0.39	0.55	0.61	0.93	0.88	0.94
Sweden	0.81	0.98	1.34	0.89	0.87	0.90
United Kingdom	0.86	0.82	1.13	0.89	0.87	0.90
Estonia	0.96	0.53	0.83	0.87	0.85	0.92
Czech Republic	1.42	1.55	1.08	0.93	0.93	0.92
Cyprus	–	–	0.59	1.09	1.20	0.95
Hungary	1.15	1.08	1.05	0.92	0.90	0.91
Slovakia	1.49	1.40	0.96	0.96	0.95	0.95
Slovenia	1.03	1.44	1.03	0.92	0.86	0.95
Lithuania	0.54	0.35	0.71	0.96	0.96	0.95
Latvia	–	–	0.83	1.45	1.29	1.43
Malta	1.66	0.61	0.90	1.93	3.86	1.43
Poland	0.52	0.83	0.90	0.92	0.90	0.91

Source: own estimations

employment, and 94 % of total R&D spending (Hollanders 2006). Space activities account for less than 10 % of the activities in the aerospace industry. Most innovative activity in the aerospace industry takes place in the following top 20 regions: French (Midi-Pyrénées, Île de France, Provence-Alpes-Côte d'Azur Rhône-Alpes, Haute-Normandie), German (Niedersachsen, Hamburg, Bayern, Baden-Württemberg, Bremen, Nordrhein-Westfalen, Schleswig-Holstein), UK (South West, South East, East of England, West Midlands, East Midlands), Spanish (Com. de Madrid), Swedish (Östra Mellansverige), and Denmark. Meanwhile, the five regions of Midi-Pyrénées, Île de France, Niedersachsen, Hamburg Bayern, and Baden-Württemberg, contribute to the totals by having over 50 % of all patents in this group of regions, with respect to the average number of patents in 2003–2007. As for the EU-10 areas of Cyprus, Lithuania, Közép-Magyarország, and Mazowieckie, they account for the total number of European patent applications of this group. Although the industry's direct economic weight is relatively small, with percentages of 1.0 % in terms of employment, and 1.5 % for value added in terms of total manufacturing (Eurostat 2006), the industry's indirect impact is much



more significant. The industry is home to staff with key skills and possesses key technologies in different fields such as electronics, software, telecommunications, materials, and, more recently, market related and managerial fields.

The *Biotechnology industry* (NACE Rev 1.1 codes 24.4 Manufacture of pharmaceuticals, medicinal chemicals and botanical products) employs approximately 100,000 people (year 2006) in total, of which most work in SMEs. However, the exact figures on its contribution to employment or the number of companies involved in biotech-related activity are unknown. Many of these companies are only partially active in biotechnology so not all companies may be covered by the relative statistical surveys. The pharmaceutical industry employs 615,000 people. Around 15 % of the total number of high-tech patent applications relates to the “microorganism and genetic engineering” (Bio4EU study, JRC/IPTS 2007). The industry is highly research intensive, with almost half of its employees involved in R&D functions; therefore, it relies strongly on interaction with universities and depends heavily on their science-based research.

Geographically speaking, innovative activity in biotechnology fields is dispersed around the EU regions, however it remains clustered around major universities, which specialize in biotechnological research. Broadly, the top 20 regions of the EU-15 and EU-10 account for 61 % and 2 % of EU patent applications in the biotechnology industry, respectively (2007). In terms of the top 20 patenting EU regions, based on the accumulated number of patent applications in the 2003–2007 period, the following regions are taking the lead: German (Bayern, Nordrhein-Westfalen, Baden-Württemberg, Hessen, Berlin, Niedersachsen, and Rheinland-Pfalz), French (Île de France and Rhône-Alpes), Denmark, UK (East of England and South East London), and Belgium (Vlaams Gewest and Rég. Wallonne), Dutch (Zuid-Holland and Zeeland Gelderland), Italian (Lombardia), and the Spanish capital (Comunidad de Madrid). Amongst them Bayern, Nordrhein-Westfalen, Baden-Württemberg, Hessen, Berlin, Île de France, Denmark (Medicon Valley, located around Copenhagen and the Skaane Region), East of England, and Vlaams Gewest regions produce roughly 50 % of all patent applications for this group of EU regions. The best performing EU-10 regions in terms of patenting activity include those that contain capital cities within them, for example Mazowieckie (Warsaw), Praha, Közép-Magyarország (where Budapest is located), Észak-Alföld, and Slovenia. These regions take the first five places of the top 20 ranking (based on the accumulated number of patents in 2003–2007) and produce over 45 % of all patent applications for this group of EU regions.

The *Communication industry* (NACE Rev 1.1 codes 32 Manufacture of radio, television, and communication equipment and apparatus) employs approximately 3.6 million people (as of 2007) in the EU, of which 1.16 million work directly for telecommunication service operators. The four largest member countries (Germany, UK, Italy, and France) account for almost 80 % of the telecommunications value added in the EU. Employment in the communication technology industry in the EU-10 dropped between 1995 and 2004 as a result of the late phase of transition (privatization of big state-owned companies) (Havas 2006). However, since their accession to the EU in 2004 employment increased again, particularly in

Hungary and Poland. These two countries have one of the biggest communication technology clusters in the EU, employing some 10 % and 5 %, respectively, of the total number of people employed in the manufacture of radio, television, and communication equipment (Eurostat 2005).

Geographically, the group of the top 20 patenting regions of the EU-15 in this industry is concentrated in the German (Bayern, Baden-Württemberg, Nordrhein-Westfalen, Niedersachsen, Hessen, and Berlin), French (Ile de France, Bretagne, and Rhône-Alpes), Swedish (Stockholm and Sydsverige), Finnish (Etelä-Suomi and Länsi-Suomi), Dutch (Noord-Brabant and Zeeland), UK (South East, South West, and East of England), Belgian (Vlaams Gewest), and Danish (North Jutland) regions. These regions account for 71 % of the total number of EU patent applications in the communication industry.

The share of the EU-10 in the number of patent applications in the EU within the communication technology industry is very small. The top 20 regions of the EU-10 account for some 2 % of the total number of EU patent applications to EPO in the communication industry. Half of the total number of patent applications for this group of regions is located in Hungarian Közép-Magyarország and the Polish Lubuskie and Podkarpackie regions. The communication industry can potentially play a crucial role in industrial specialization and thus, for regional development in these regions. The Hungarian Közép-Magyarország region significantly outperforms all the other EU-10 regions in terms of patent activity.

The *Computer industry* (NACE Rev 1.1 codes 30 Manufacture of office machinery and computers) employs some 1.6 million people in the EU, of which 140,000 are employed in the EU-10 (9 %). Germany employed almost 26 %, UK 16 %, Italy 10 %, and Ireland 8 % of the total labor force in this industry for 2008. The Czech Republic is the only country from the EU-10 group of members that contributes significantly to employment in this industry – 6 % of total employment (Eurostat 2008). Overall, the computer industry is prospering in the EU. For example, in 2007, the number of people employed in the software industry and computer services was over 51 % higher than it was when compared to 1999. High growth in the number of computer services has taken place, for instance, in Austria, Hungary, Spain, Ireland, The Netherlands, and Slovakia. Large firms (with more than 250 employees) are more common in the manufacture of office machinery and computers (NACE 30), and produce most of the sector's value added and R&D output.

The top 20 regions from the EU-15 and EU-10 groups account for 76 % and 0.8 %, respectively, of the EU-25's total number of patents in this industry. Most of the EU-15's innovation activity in this industry is concentrated in the following top 20 regions: German (Bayern, Baden-Württemberg, Nordrhein-Westfalen, Niedersachsen, Hessen), Swedish (Sydsverige), French (Ile de France and Provence-Alpes-Côte d'Azur, Rhône-Alpes, Bretagne), Finnish (Etelä-Suomi and Länsi-Suomi), Dutch (Noord-Brabant and Zeeland), Belgian (Vlaams Gewest), the UK (South East, East of England, London, South West), and the Italian (Lombardia) regions. The share of new Member States in EU patent applications within computer technology is very small. The top 20 regions from the EU-10

account for 0.8 % of the total number of EU patent applications in the computer industry. Over half of the patent applications for the top 20 EU-10 regions are located in the Hungarian (Közép-Magyarország), Czech (Praha), and Polish (Mazowieckie) regions, as well as in Slovenia, Cyprus and Estonia.

The EU *Semiconductor industry* (NACE Rev 1.1 codes: 32 Manufacturing of radio, television and communication equipment and apparatus) shows strong growth in automotive electronics, industrial and medical equipment, wireless communication, and consumer electronics. In 2008 the industry employed 215,000 workers and contributed to generating approximately 10 % of the EU's value added.<sup>2</sup> The top 20 regions of the EU-15 account for 90 % of all EU patent applications in the semiconductor industry. Most innovation activity in this field is concentrated in the German (Bayern, Baden-Württemberg, Nordrhein-Westfalen, Hessen, Sachsen, Berlin, Rheinland-Pfalz, Thüringen), French (Rhône-Alpes, Île de France, Prov. Alpes-Côte d'Azur), Dutch (Zeeland and Noord-Brabant), UK (South-East and East of England), Austrian (Steiermark), Belgian (Vlaams Gewest), Italian (Lombardia and Sicily), and Finnish (Etelä-Suomi) regions, sites of the largest silicon semiconductor design clusters in Europe.

The top 20 EU-10 regions account for roughly 2 % of EU patent applications in the semiconductor industry. Most of the innovation activity in this industry is done by Poland's Mazowieckie region, the Czech Republic's Jihovýchod and Střední Morava regions, Slovakia's Bratislava region, and smaller states of the EU-10 (such as Estonia, Lithuania, Slovenia, Cyprus, and Malta).

Finally, the *Lasers and optical technologies industry* (NACE Rev 1.1 codes 33 Manufacture of medical, precision and optical instruments, watches and clocks) employs around 300,000 people (2010).<sup>3</sup> In addition, the jobs of more than two million employees in the EU's manufacturing sector depend directly on photonic products. The European photonics industry is dominated by SMEs, which makes the industry both more adaptable to change and more sensitive to international market fluctuations that may take place.

The largest contributors to the EU's value added in precision instruments were Germany (34 %), the UK, France, and Ireland. Among the newer EU Member States, where precision instruments contributed to a more-than-average extent to manufacturing, were two of the Member States that joined in 2004: Malta and Slovenia (the latter in terms of employment).

The top 20 EU-15 regions account for 77 % of EU patent applications in the lasers and optical technologies industry. A major part of innovation activity in this industry is clustered around the German (Bayern, Baden-Württemberg, Nordrhein-Westfalen, Berlin, Rheinland-Pfalz, and Thüringen), French (Île de France, Rhône-Alpes, and Bretagne), UK (South East, Scotland, East of England, and South West), Dutch (Zeeland and Noord-Brabant), Italian (Lombardia), Belgian (Vlaams Gewest), Austrian (Vorarlberg), Danish, and Irish regions.

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<sup>2</sup> Sustainable semiconductor manufacturing in Europe – the future of the industry, Position Paper of the European Metalworkers' Federation (EMF), June 2010, <http://ec.europa.eu/enterprise/sectors/ict>

<sup>3</sup> [www.optik-photonik.de](http://www.optik-photonik.de)

The share of EU-10 Member States in terms of EU patent applications in the communication technology industry is very small. The top 20 EU-10 regions account for some 2 % of the total number of EU patent applications in the lasers and optical technologies industry. Most of the innovative activity for this group of EU countries is located in Lithuania, Slovenia, and within the Hungarian (Dél-Alföld) and Polish (Mazowieckie, Dolnośląskie, Podkarpackie, and Wielkopolskie) regions.

## 2.6 Summary and Conclusion

Three decades after the accession of the southern Member States to the EU and almost a decade after the accession of the Central and East European countries to the EU, there are still big wealth disparities within and across its Member States, with the former growing faster than the latter ones. Regions with GDP per capita largely above the European average extend from the UK South of England to the Benelux, western Germany, and western Austria, and end in the northern part of Italy. Nonetheless, within these countries, regions with the highest GDP per head over the past years have been Inner London, Brussels, and Luxembourg, followed by Hamburg, Île de France, Wien, Uusimaa, and Stockholm. Most regions belonging to the new Member States as well as the southern European periphery, including the Portuguese, Spanish, southern Italian, and Greek regions, are characterized by relatively low levels of GDP per capita.

A common feature of regions with high GDP per capita is their high technological and innovative potential. The opposite trend in turn was observed in the poorer regions. The latter shows that the technology gap provides a fundamental potentiality for lagging behind regions to catch up. Yet, factual catch up is only possible if the regions lagging behind develop sufficient technological infrastructure to improve knowledge absorption, transfer, and diffusion capacities. In some regions, such as EU-10 countries' regions, RISs are not in place yet. These regions are generally characterized by relatively low business R&D intensities. For these regions, absorption capacity is embodied mainly in university labs and government-led research centers. Capital regions and larger agglomerations have greater potentials for knowledge diffusion because of the relatively better communication infrastructure and population density. It is therefore not surprising that the Bratislava, Közép-Magyarország, Praha, and Mazowieckie regions are among the technological, innovative, and economic leaders amongst the EU-10 group of regions.

From a dynamic point of view, all the EU regions performed well. As a result, the gap between the richest and poorest EU regions has, in fact, narrowed since 2000. In the context of the "technological gap" and endogenous growth theory, it is important to understand what role knowledge spillovers and technological change played during the past decade in the growth and catching up of the EU regions.



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