CHAPTER
4.2

REGIONAL R&I IN EUROPE

KEY FIGURES

40 %
of jobs are in risk of automation in the West Slovakia region

10 out of 29
European unicorns are located outside of capital regions

27 out of 266
regions account for half of the EU's annual R&D spend on patent applications

3 %
in Hovedstaden (DK) is the highest share of researchers in the number of employed people

What can we learn?

- The **high concentration of R&D activities and agglomeration** effects imply that there are regions with more incentives for R&D investments.
- **Scientific production has become more dispersed** and higher investment in R&D has led to more scientific output from the central and eastern European countries and regions.
- Increasing concentration of economic and innovative activities in capitals and metropolitan areas, on the one hand, and declining industrial or peripheral areas on the other lead to **negative developments in regions with low capacity to exploit innovation**.
- **Upward convergence of economic growth at the regional level is stalling**. While many of the capital regions witnessed fast convergence, other regions have shown little progress and their labour productivity is slowing down. This suggests the **importance of R&I as a new growth engine for innovation-driven productivity growth in less-developed and transition regions**.
- Negative economic developments paired with the impact of globalisation and technological change on disadvantaged groups, i.e. the older and less educated, living in industrial or decaying areas, have led to a set of local economic conditions known as the **geography of discontent**.

What does it mean for policy?

- European innovation policy must place a **greater emphasis on promoting innovation in less-developed and transition regions to trigger economic dynamism** that would increase the competitiveness of the EU as a whole and close the innovation divide.
- Policymakers need to align policies targeted at improving R&I capacities and territorial inequalities with **greater coordination at all levels**. These include aligned R&I policies and Cohesion Policy, together with education and training.
- With substantial variation across EU regions in terms of institutional quality, **improvements in institutional quality and integration of smart specialisation strategies into regional development strategies** would improve the efficiency of R&I programmes, combat corruption and promote innovation.

1. Regional research and innovation systems show signs of convergence

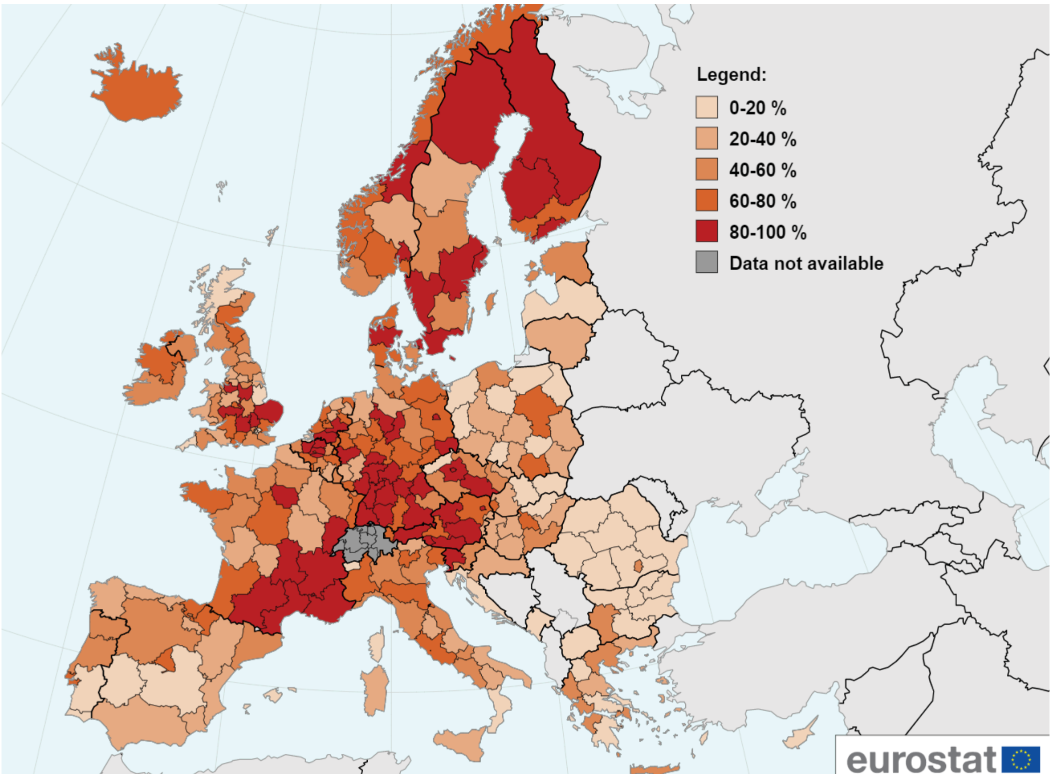
R&D-intensive regions

In general, R&D intensity is high in western and northern Europe with some well-performing regions in other parts of Europe, too. A closer look at the type of expenditure and the spending dynamism reveals specific patterns. As economies become more knowledge-based and dependent on intangible assets, economies and firms achieve large returns on R&D investments which also help to create new and better jobs. However, the latest literature concludes that R&D investment does not trigger the same returns everywhere. The reasons for this include the distance to the technological frontier and the related creation and distribution of new knowledge. The following maps show to what degree the core R&D-performing areas attract and concentrate resources.

R&D investment shows a high concentration of spending in regions with high R&D intensity. Within countries, there is strong concentration (in absolute terms) of R&D expenditure in a few regions, typically capital regions or those with large urban agglomerations. The R&D-to-GDP ratio provides an insight into contributions from public budgets[1] and private actors during the economic cycle. While business R&D trends traditionally depend on business expectations, public R&D is expected to be more counter-cyclical, buffering the effects of economic downturns (OECD, 2014). Currently, the intensity of R&D spending across EU regions varies considerably with highly intensive regions in the west and north of Europe, often as a result of being endowed with headquarters of large tech companies (Figure 4.2-1). As these indicators are related to GDP, eastern European countries showed strong economic growth and many regions also experienced growth in R&D intensity. The absolute amount of R&D expenditure (as well as the number of patents in the region) in eastern Europe as a whole and in many of its regions has clearly increased (Figure 4.2-2). On the other hand, some of the regions with high R&D intensity have continued to expand their R&D expenditure which means the distance to the top-performing regions has not decreased significantly. There are some noticeable exceptions of regions with high absolute amounts of R&D and lower R&D intensity, representing relatively large regions, including, for example Catalunya (ES51), Lazio (ITI4), Lombardia (ITC4), or mid-sized regions with a high GDP per capita (e.g. Southern and Eastern Ireland (IE02). On the other hand, there are (smaller) regions with small absolute amounts of R&D expenditure that are actually very R&D intensive, e.g. Övre Norrland (SE33) and Kärnten (AT21).

1 Data on sectoral R&D expenditure based on sector of performance, hence business spending also includes money coming from public budgets and vice versa.

Figure 4.2-1 R&D intensity (2017 or latest available)[2]



Science, research and innovation performance of the EU 2020

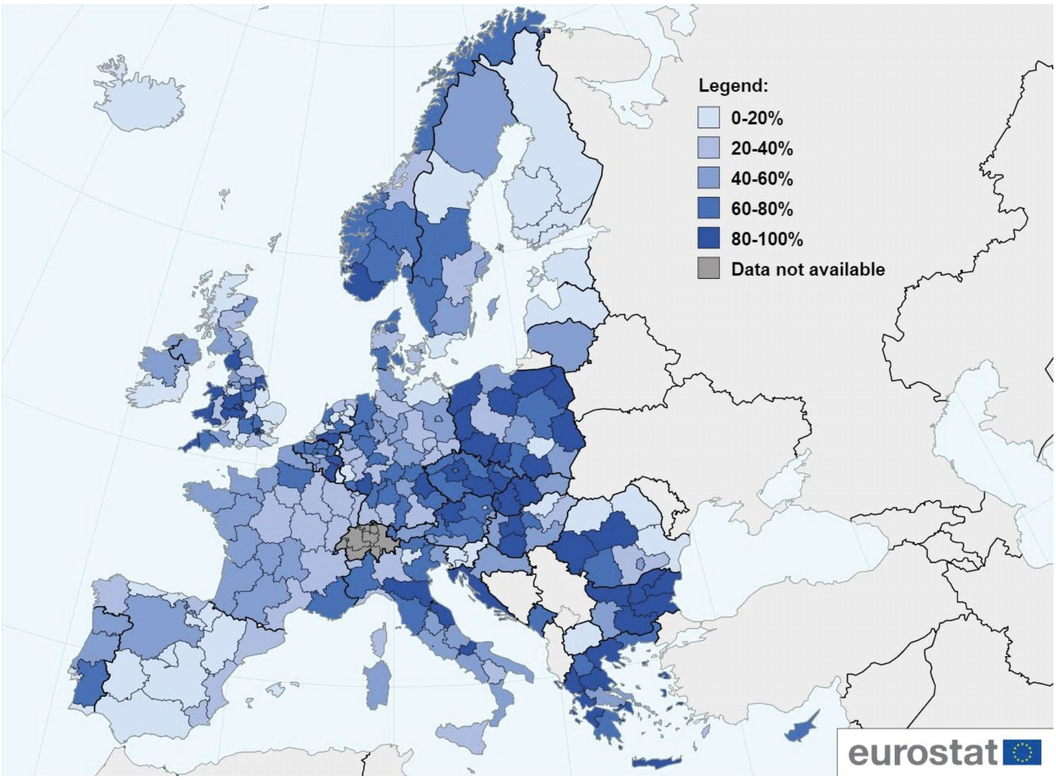
Source: Eurostat (online data code: rd_e_gerdreg)

Note: R&D intensity of UK, IS, NO:2016; BE, IE, LT: 2015; FR: 2013. The maps use NUTS2013 and, where necessary, regional data were matched with NUTS2016 (HU, LT, PL).

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-1.xlsx

2 The maps across this chapter divide regional values of selected indicator into five quintiles according to their performance (0-20% the lowest quintile).

Figure 4.2-2 R&D growth (2010-2017 or latest available)



Science, research and innovation performance of the EU 2020

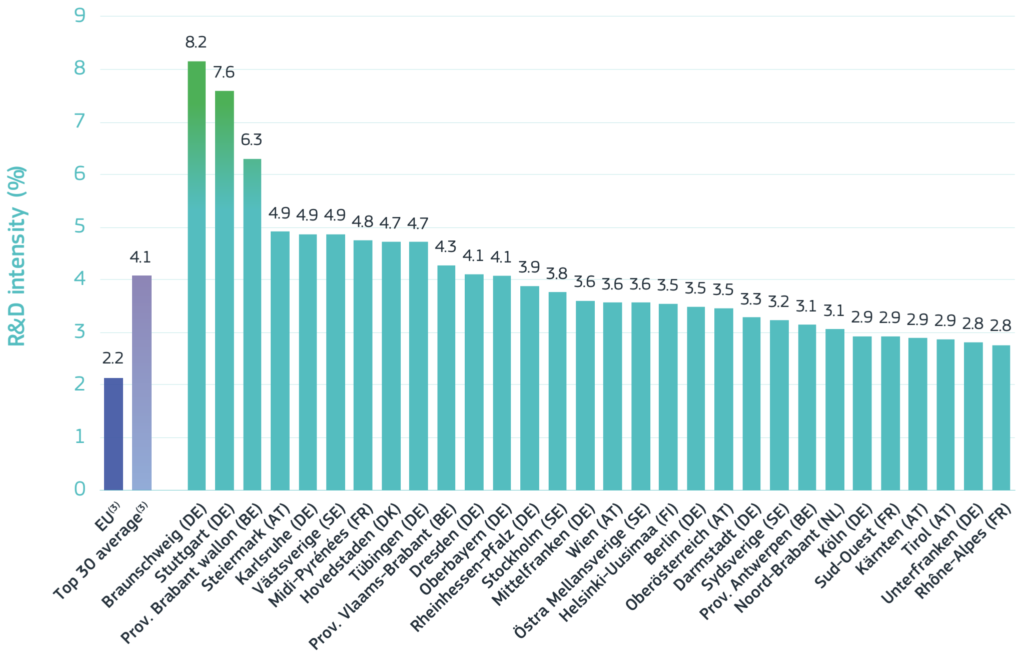
Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat (online data code: rd_e_gerdreg)

Note: Compound annual growth rates calculated NL: 2015-2017; DE, EL, AT, ME: 2011-2017; BE, IE: 2010-2015; UK, NO: 2010-2016; FR:2010-2013; MK: 2015-2017. The maps use NUTS2013 and, where necessary, regional data were matched with NUTS2016 (HU, LT, PL).

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-2.xlsx

The EU's most R&D-intensive regions are all located in western and northern Europe and the degree of concentration confirms the described trends. The average intensity of the top 30 EU regions is more than twice the average intensity of the EU as a whole (Figure 4.2-3). In some cases, the regional R&D intensity is heavily influenced by presence of a single large tech company. An example is Braunschweig, the EU NUTS2 region with the highest R&D intensity, where the biggest European R&D spender Volkswagen has its headquarters.

Figure 4.2-3 The 30 most-R&D-intensive regions[(1)] in the EU - R&D intensity, 2017[(2)]



Science, research and innovation performance of the EU 2020

Source: Eurostat (online data code: rd_e_gerdreg)

Notes: [(1)]NUTS Level 2 regions. [(2)]BE: 2015; FR: 2013. [(3)]EU and top 30 regions' average calculated by DG Research and Innovation.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-3.xlsx

Business and public R&D spending

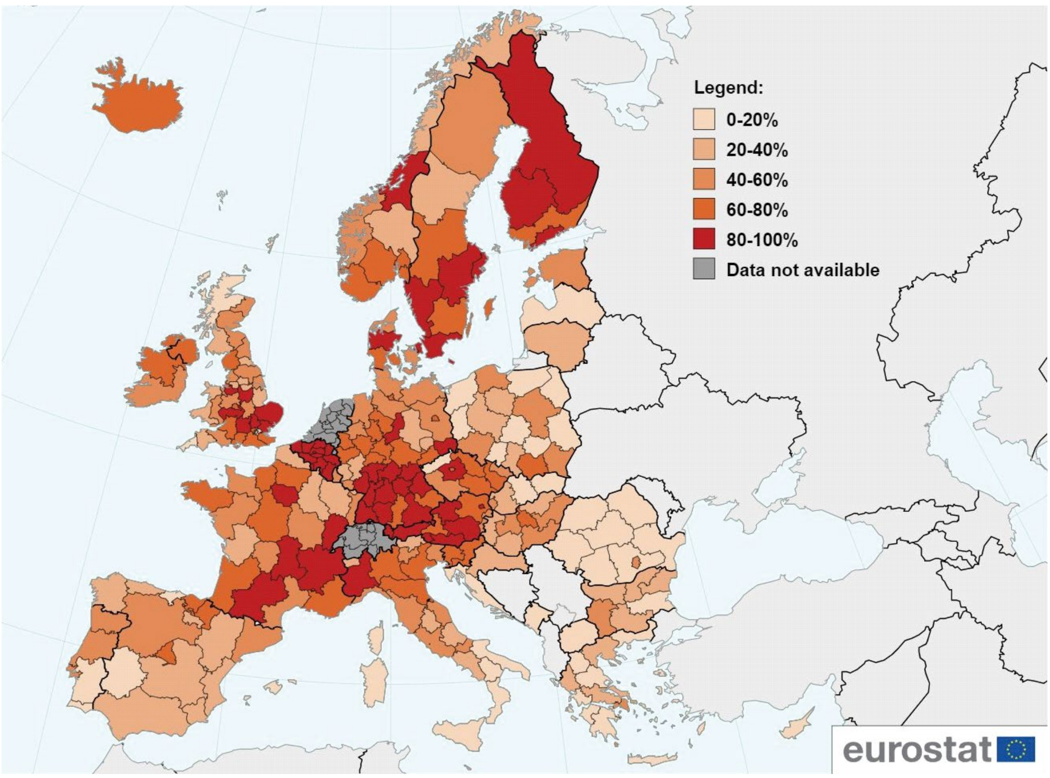
While business R&D expenditure contributes to an increase in R&D intensity in some less-developed and transition regions, overall business R&D expenditure remains heavily concentrated. Business-driven R&D expenditure is expected to play an important role in higher EU competitiveness and job creation (EC, 2014) and to reduce the EU's innovation gap (EC, 2017). Furthermore, the ultimate objective is to accompany the transition of those regions and workers most affected by globalisation and industrial developments and to facilitate their transition to a low-carbon and circular economy (JRC, 2018). Despite certain convergence trends in regions' business R&D intensity, the latest data **suggest a persisting concentration of R&D expenditure in more-developed central locations**. Business R&D expenditure is even more concentrated in more-developed regions with a strong concentration in relatively few internationally active technology companies. Germany, the UK and France contribute to two thirds of total EU business R&D with a strong contribution from the automotive sector in Germany, pharmaceuticals in the UK, whilst France has a relatively balanced sector composition (JRC, 2018)[3]. Currently, more-developed regions represent about 85% of R&D expenditure in the EU, transition regions about 10% and less-developed regions about 5%. One example is Baden-Württemberg, which has about 2% of the EU population but an 8% concentration of the EU's business R&D[4].

3 Among the sample of 1 000 EU top spenders, 899 companies are based in the top 10 Member States, accounting for 97.1% of total R&D. Moreover, the overall performance of the EU 1 000 group is largely driven by the results of companies based in Germany, France and the UK, accounting for 61% of companies, 68% of the total R&D, and 68% of total net sales.

4 The main NUTS2 reference region is Stuttgart DE11 (share of the EU, 2017).

Some upward convergence in R&D expenditure can be observed in many regions in central, eastern and south-eastern European countries (CESEE). Notably, regions such in Czechia, Hungary and Slovakia show an increase in business R&D intensity which seems to be driven by business R&D spending in the automotive and ICT sectors[5] (Figure 4.2-4.). Business R&D intensity in several regions in Greece – where recovery from the severe crisis has set in – is also increasing. In many regions of eastern and southern Europe, R&D expenditure has risen steadily in recent years, linked to a structural shift to more knowledge-intensive activities and expected returns on R&D investment. Although many less-developed regions began to grow from (and were facilitated by) low starting levels, high growth rates brought several regions closer to the performance of frontier regions. Střední Čechy (CZ02), Budapest (HU11) and Warszawski stołeczny (PL91), ranked in the top 20% of business R&D-intensive regions in 2017.

Figure 4.2-4 Business R&D intensity in 2017 or latest available



Source: Eurostat (online data code: rd_e_gerdreg)

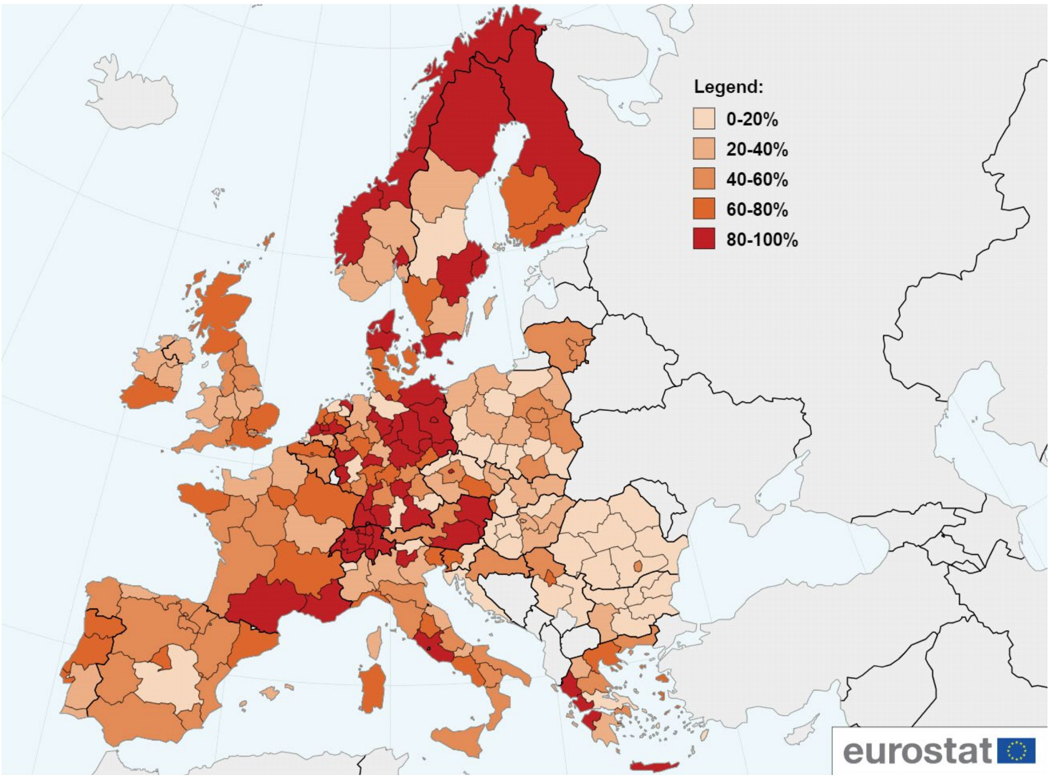
Note: Business R&D intensity of UK, NO: 2016; BE, IE, LT: 2015; FR: 2013. The maps use NUTS2013 level 2 and, where necessary, regional data were matched with NUTS2016 (HU, LT, PL). BE on NUTS1 level, NL data confidential.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-4.xlsx

5 Expenditure in the areas of manufacturing motor vehicles and information technologies represents 36 % of overall business R&D expenditure in Czechia and 33 % in Slovakia.

Public R&D expenditure show similar levels of concentration, with higher rates in regions of Nordic countries. This pattern of innovation-lagging regions that invest less in R&D and of innovation-leaders forging ahead with public R&D spending resembles the earlier observed patterns at the national level (Veugelers, 2014). In particular, Sweden, Germany and Denmark increased their public expenditure on R&D during the financial crisis by a higher degree than in the case of other public expenditures, and this trend seems to persist since then (Figure 4.2-5). In regions that are seemingly too far from the technological frontier and that may have a weak industrial fabric, increasing the R&D effort alone does not always yield greater economic growth. An earlier work identified regions, which failed to achieve economic growth that would be at all proportional to the regions' increases in public R&D investment (Rodríguez-Pose, 2014).

Figure 4.2-5 **Public R&D intensity in 2016 or latest available**

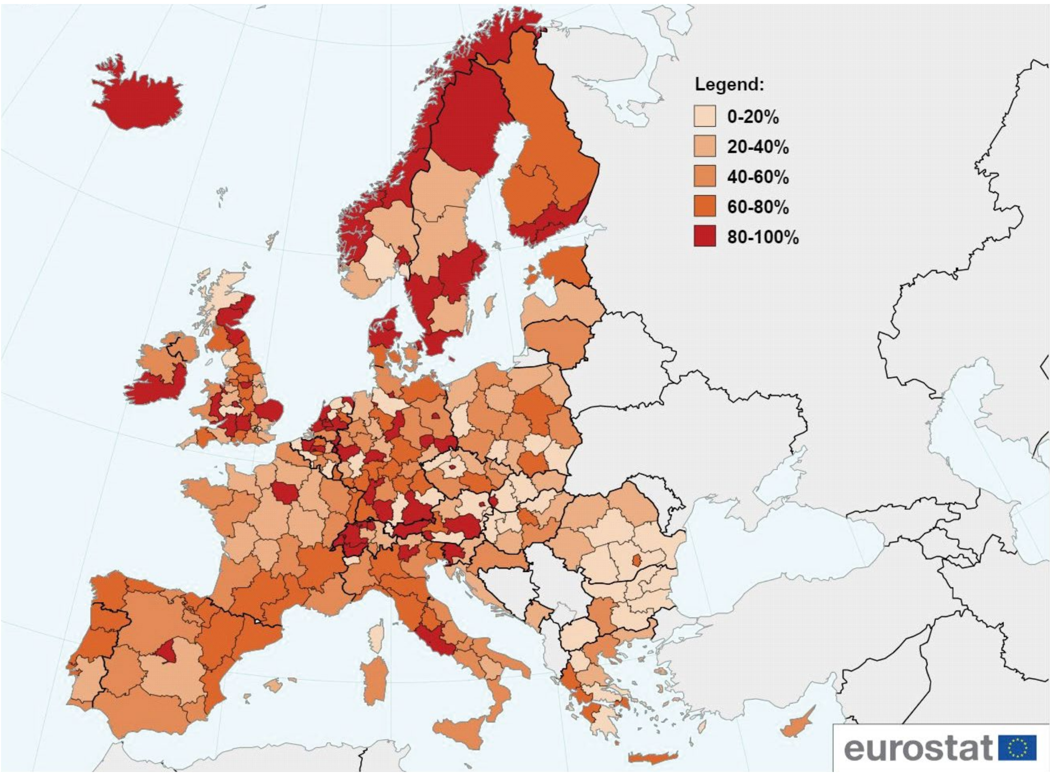


Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Regional Innovation Scoreboard 2019
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-5.xlsx

Scientific publications

Many of the lagging regions, mostly in eastern and southern Europe, have observed an improvement of their performance in scientific output, which indicates improved returns on R&D investment. The map of regional performance in scientific publications per capita shows a relatively dispersed pattern of scientific production across the EU (Figure 4.2-6). However, the picture becomes more concentrated when looking at the regional distribution of 10 % top-cited publications per 1 000 inhabitants. This indicator shows poor performance particularly in regions in eastern Europe[6]. The quality indicator will potentially catch up in the future, as observed in the overall numbers of scientific publications, but the catching-up process may take longer. Currently, the production of high-quality publications is still very concentrated in western Europe with high shares of British and Dutch regions.

Figure 4.2-6 **Share of scientific publications per 1 000 inhabitants**



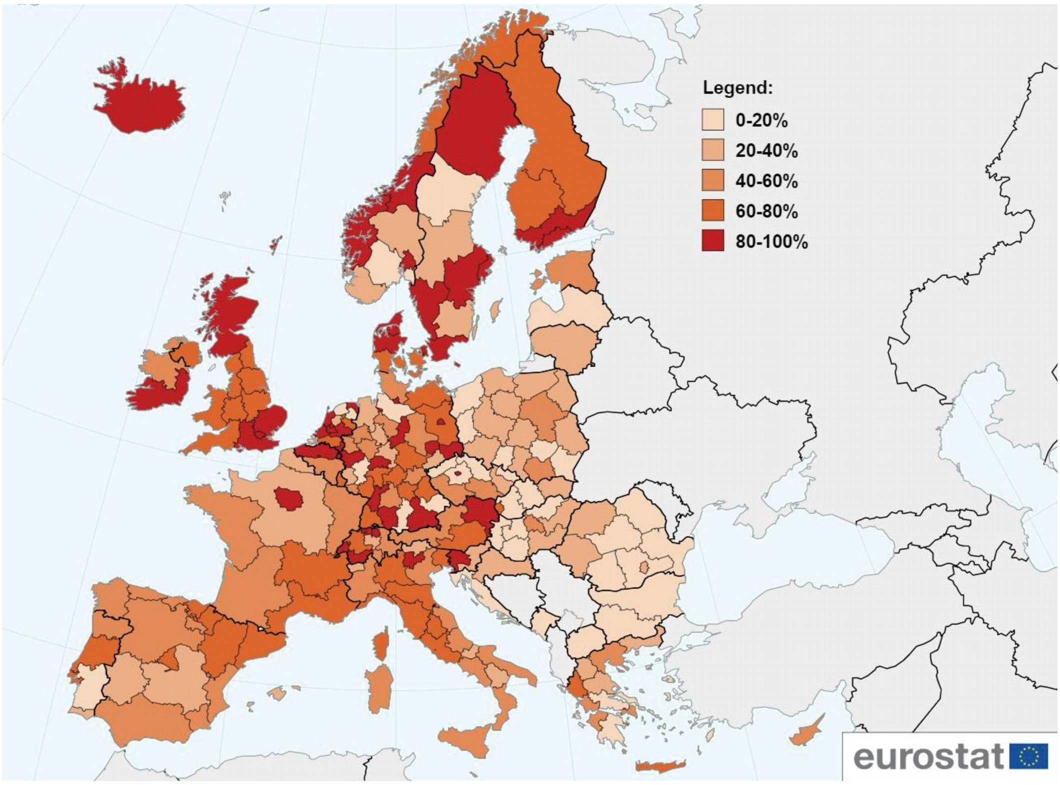
Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on CWTS using data from Web of Science database and Eurostat data

Note: Based on articles and reviews published in the period 2013-2017, covered by the Web of Science.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-6.xlsx

6 Without adjustment per 1 000 inhabitants, the projected concentration of top-10 % publications would increase further.

Figure 4.2-7 Share of top-10% most cited publications per 1 000 inhabitants[(1)(2)]



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on CWTS using data from Web of Science database and Eurostat data

Notes: [(1)]Based on articles and reviews published in 2015, covered by the Web of Science. [(2)]BE, FR, AT at NUTS1 level.

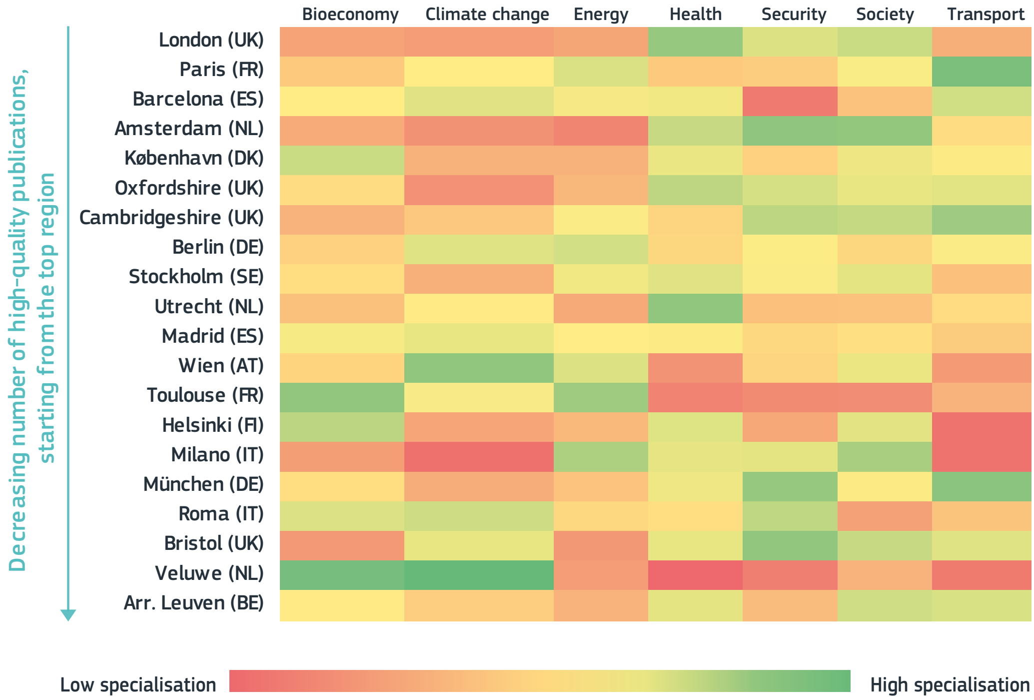
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-7.xlsx

The increasing level of knowledge complexity[7] **suggests that even the metropolitan areas and well-connected regions concentrate specific knowledge**. Figure 4.2-8 is a matrix table of specialisation showing how the regions concentrate specific knowledge relative to other regions and depicts relative patterns of specialisation. The listed regions are ranked by the overall number of their high-quality publications. The matrix columns assess shares of top scientific publications among these regions in the fields of societal challenges compared to the overall European shares[8]. Very few regions, such as Berlin or Madrid, do not show a specific pattern of scientific specialisation. Other regions have their specific focus, such as, for example, Vienna and the Dutch region of Veluwe which perform well on topics related to climate change and environment.

7 Refers to assets for innovation activities in the knowledge economy. See Chapter 2 - Changing innovation dynamics in the age of digital transformation, or earlier publications, such as Westlund, 2006.

8 Societal challenges as defined in the Horizon 2020 Framework Programme.

Figure 4.2-8 Relative specialisation of top regions by societal challenges(1)(2)(3)(4)



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on CWTS using data from Web of Science database and Knowmak project

Notes: (1)Green indicates high specialisation and red indicates low specialisation (share of publications related to the challenge among the publications of the region divided by the share of publications related to the challenge among European publications). (2)Data refers to number of publications that are in the most-cited 10% of publications in 2016. (3)The selected regions present the 20 regions with the highest numbers of scientific publications in the top 10% cited. The regions are ranked by the number of publications (top-down). (4)The ontology for Societal Grand Challenges publications and definitions were developed by the Knowmak project (Horizon 2020 project number 726992).

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-8.xlsx

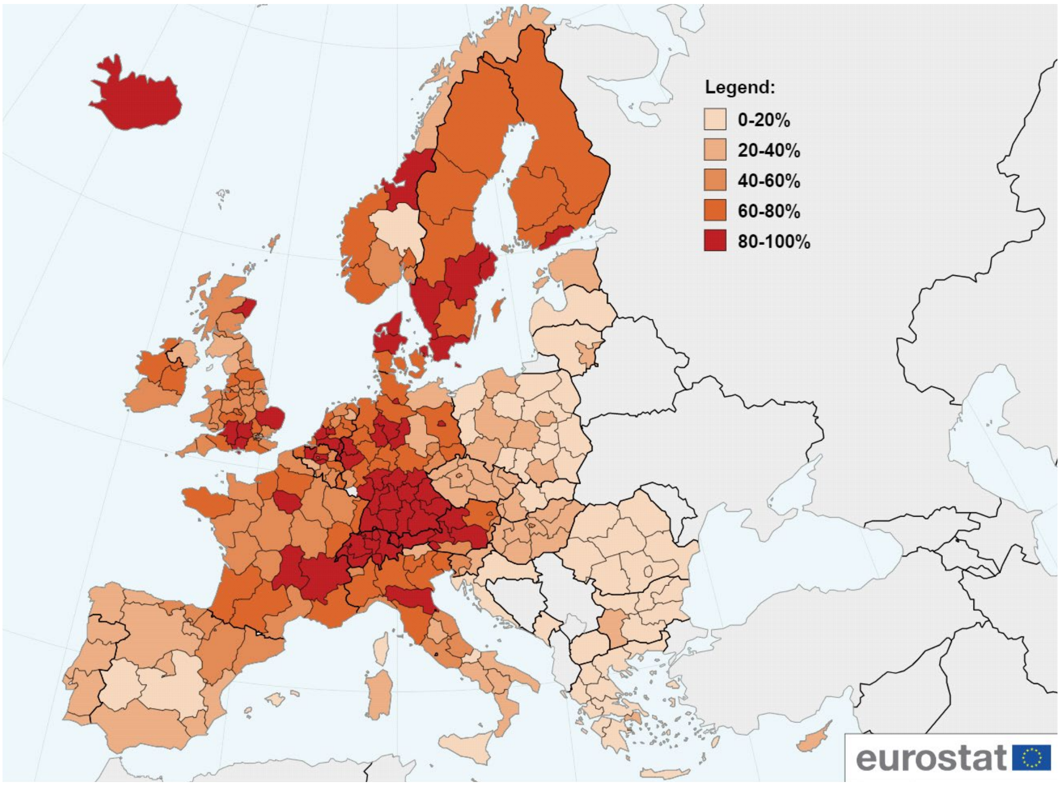
Technological production

The technological output, as measured by patents, is concentrated in regions with a high share of manufacturing and with tech companies' headquarters, such as southern Germany, Austria, Denmark and the Rhône-Alpes region. Furthermore, patenting is concentrated in capital cities (Figure 4.2-9). A high patent output per capita is observed in the Dutch NUTS2 Noord-Brabant (NL41) and Austrian Vorarlberg (AT34).

A look at trends in patent applications across European regions reveals a convergence pattern in the eastern European regions and growth in some southern European regions, too (Figure 4.2-10). Notably, growth in the south concerns regions that belong to the group of laggards. These findings do not confirm an increasing patenting divide but show a dynamic patenting activity instead. Another trend already observed at the national level is the concentration of innovation activities among large companies.

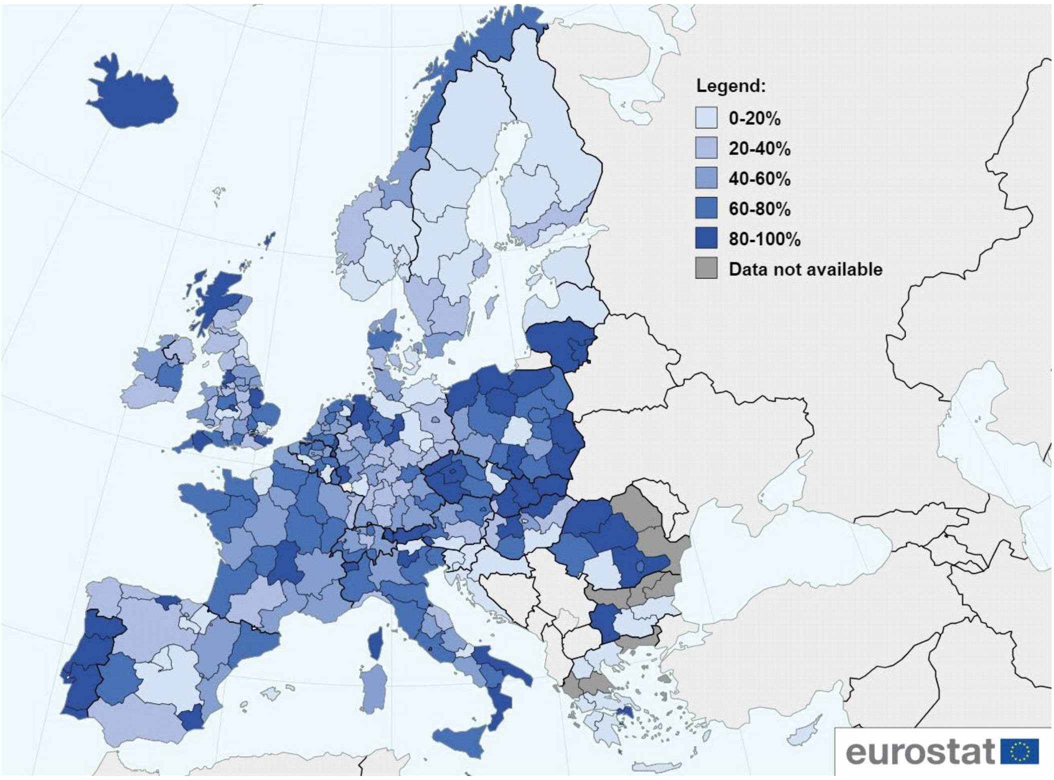
Innovation activity at the regional level, as measured by patent applications, is highly correlated to business expenditure on R&D and shows a similar spatial pattern. Large international technology companies have shifted manufacturing to eastern Europe, which is supposedly also boosting R&D expenditure and IP production in the corresponding regions. Therefore, innovation activities linked to technological production show a broad convergence trend (see more on the patenting divide in Chapter 12 - The research and innovation divide in the EU and its economic consequences).

Figure 4.2-9 **Share of PCT patent applications per 1 000 inhabitants, 2016**



Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit
Note: Data produced by Science-Metrix using data from the REGPAT database.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-9.xlsx

Figure 4.2-10 Growth in PCT patent applications between 2010 and 2016



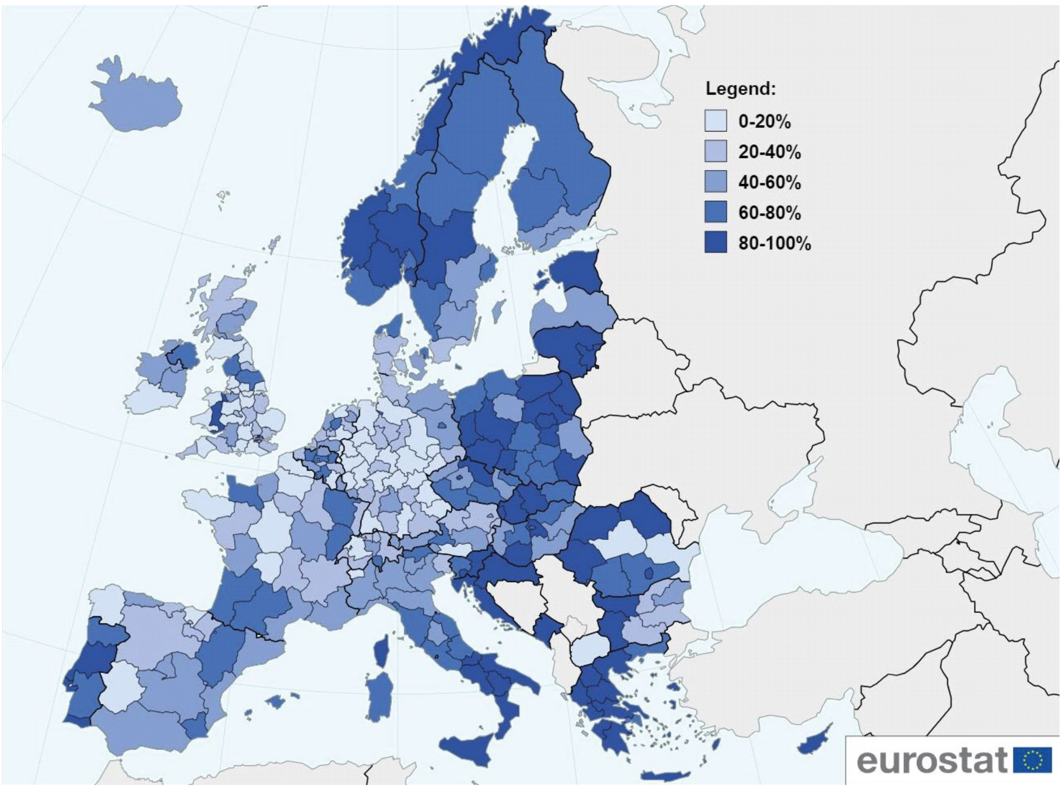
Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit.

Note: Data produced by Science-Metrix using data from the REGPAT database. The highest quintile shows regions with the highest increase from 2010 to 2016.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-10.xlsx

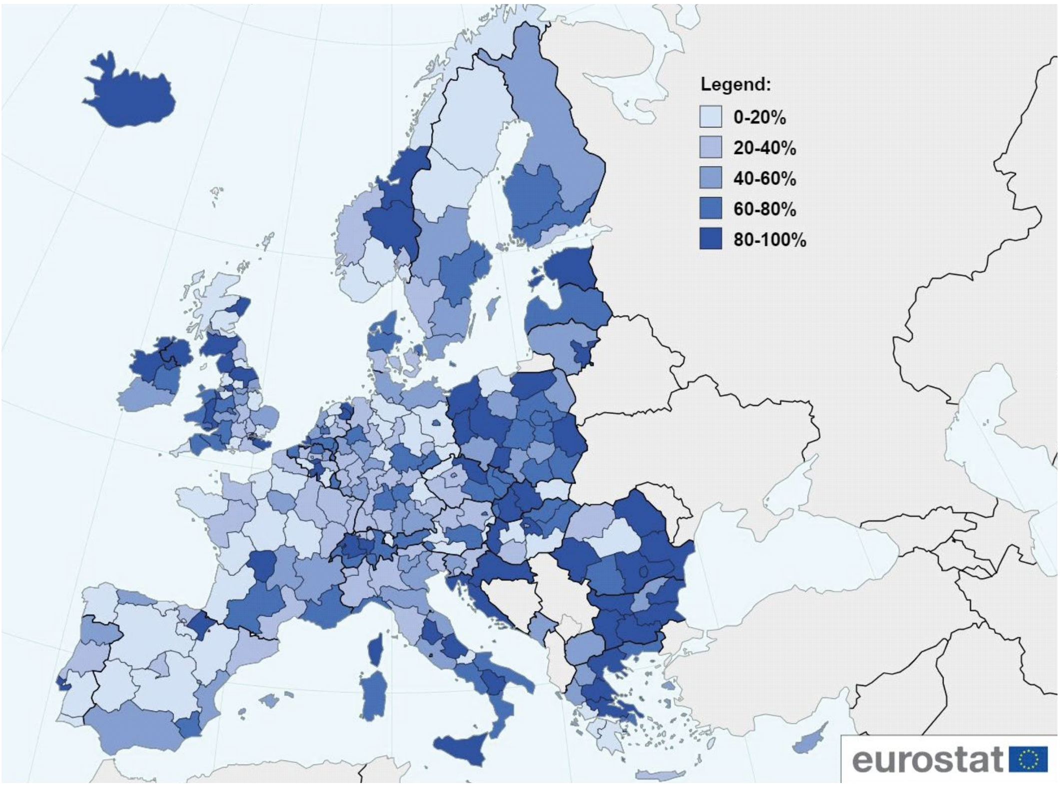
Greater activity in design and trademark applications across Europe reveal emerging convergence trends and examples of local specialisation. A broader perspective on innovation output protected as intellectual property confirms that there is a high concentration and an overlap in the use of patents, designs and trademarks in some regions, but there are also more specialised regions. The emergence of specialisation in less technologically intensive fields covered by designs and trademarks could point to growth in service innovation or design-based innovation in lagging regions. Better performance in designs can be found, for example, in the Polish regions of Małopolskie (PL21) and Wielkopolskie (PL41), while trademarks play a prominent role in Andalucia (ES61) and in many Bulgarian regions (Figures 4.2-11 and 4.2-12). Bulgaria already outperforms the EU average as regards trademarks and design applications per unit of GDP. The changes in design and trademark applications over time show high growth rates in many regions of eastern and southern Europe and imply a catching-up process by some regions.

Figure 4.2-11 **Growth in trademark applications between 2010 and 2018**



Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit
Note: Data produced by Science-Metrix using data from the EUIPO database. The highest quintile shows regions with the highest increase from 2010 to 2018.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-11.xlsx

Figure 4.2-12 Growth in design applications between 2010 and 2018



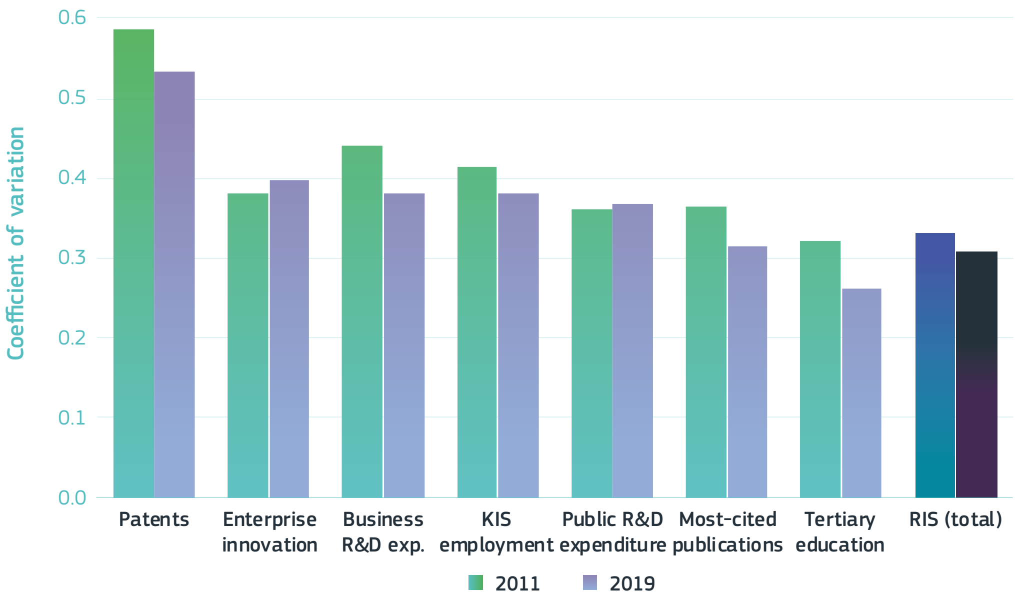
Science, research and innovation performance of the EU 2020
Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit
Note: Data produced by Science-Metrix using data from the EUIPO database. The highest quintile shows regions with the highest increase from 2010 to 2018.
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-12.xlsx

2. Technological output remains concentrated

The Regional Innovation Scoreboard (RIS) results show a convergence in R&I performance across the EU for the period 2011-2019. Nevertheless, a group of low-performing regions has barely improved and has slowed down the convergence process. The dispersion of regions in terms of innovation performance declined between 2011 and 2019[9]. Performance increased in two thirds of the regions (159 out of 238) but decreased in one third (79 regions). The share of regions that improved was 55 % in the innovation-leader category, 64 % in the strong-innovator category and 80 %, the highest share, in the moderate-innovator category. However, only 45 % of regions within the modest-innovator category improved and several regions in this category showed significant negative growth rates.

The RIS convergence trends confirm that R&I output linked to business shows significant gaps (e.g. patents) or lack of convergence (e.g. enterprise innovation). Figure 4.2-13 depicts in nutshell some of the trends described earlier. Tertiary attainment and top scientific publications are at the frontier of the convergence process, although some other indicators show persistent differences. a more detailed look at Regional Innovation Scoreboards would enable a better understanding of these indicators and regional developments.

Figure 4.2-13 Regional convergence of key R&I components in the EU (coefficient of variation), 2011 and 2019



Science, research and innovation performance of the EU 2020

Source: DG Regional and Urban Policy based on Regional Innovation Scoreboard

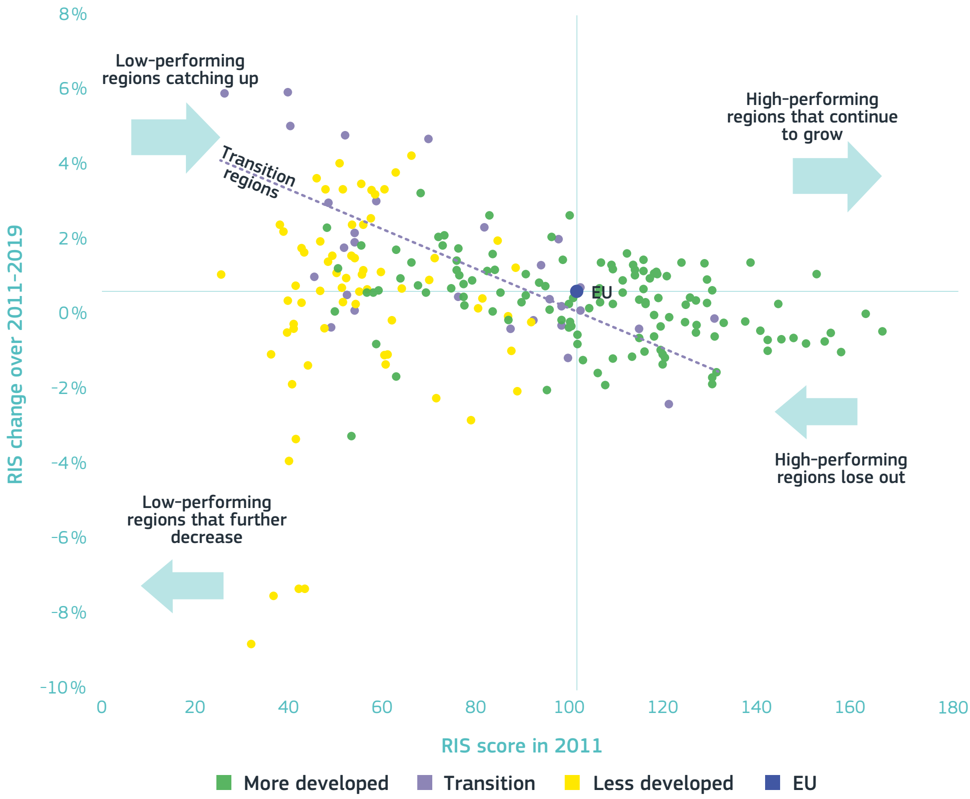
Note: The coefficient of variation (CV) is the ratio of the standard deviation to the mean, which shows the extent of variability of data in a sample in relation to the average value. The higher the coefficient of variation, the greater the level of dispersion around the mean.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-13.xlsx

9 The coefficient of variation of the regional scores was 0.314 in 2011 and 0.300 in 2019.

The overall R&I performance and convergence pattern differ according to the level of economic development, with a stronger convergence pattern in transition regions. The so-called transition regions, reaching 75-90% of the EU's average GDP, showed a convergence trend with a higher catch-up of low performers in this group and a declining rate of growth with higher levels of R&I performance. The performance of less-developed regions is influenced by a group of low-performing regions where performance has deteriorated significantly over the last decade (Figure 4.2-14). The majority of low-developed regions are in the CESEE countries and are considered to be moderate or modest innovators. Their poor digital capacities together with certain other bottlenecks, such as low R&D investment, could hinder higher absorption of current and future innovations. This issue, coupled with some skills gaps and underdeveloped innovation systems, could perpetuate their poor ability to transform R&D investment into scientific and technological capacity and might further restrict the region's potential to boost its economic growth from an improved innovation performance.

Figure 4.2-14 Regional convergence as measured by the European Regional Innovation Scoreboard, regions by level of economic development



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Regional Innovation Scoreboard 2019 and 2011

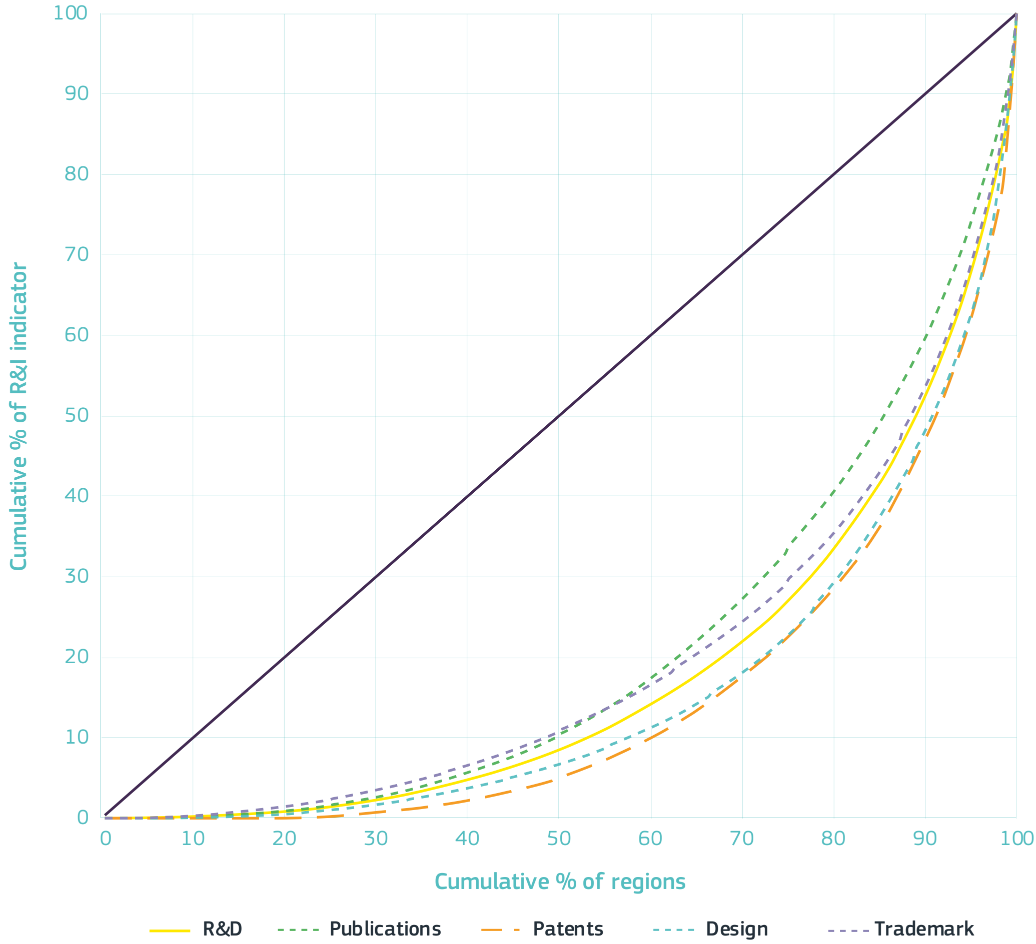
Note: The level of regional development refers to the GDP per capita of each region, measured in purchasing power parities (PPS) and calculated on the basis of EU figures for the period 2007-2009, and relates to the average GDP of the EU for the same reference period.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-14.xlsx

Regional performance is affected by the capacity of regions to ride the undergoing innovation wave by producing, diffusing and adopting technologies which change the way we produce and compete globally. The high concentration of R&I activities and agglomeration effects imply that regions where these investments are located have an initial advantage, while those regions at the periphery need to rethink their economic growth model in order to position themselves better in global value chains. As long as these developments prevail over the benefits of knowledge spillovers, tailored R&I policy is needed to promote territorial cohesion and inclusive growth (see more on policy design in Chapter 12 – The research and innovation divide in the EU and its economic consequences), as well to manage the related social, economic and political consequences of widespread discontent (Dijkstra et al., 2018).

Despite overall convergence trends among European regional R&I systems, there is still a strong concentration in technological output. Patenting activity together with design applications show higher regional concentration than the numbers of scientific publications and less technologically demanding trademarks (Figure 4.2-15). The graph below shows that 70 % of regions hold a share of around 28 % of publications compared to only 18 % of patent applications. An increase in scientific output has narrowed the gap in scientific publications relative to the scientific leaders in Europe. In order to boost the overall performance of the R&I system, European regions have to increase the production of knowledge at the frontier while their business partners must reach high adoption rates. a weak technological innovation characterised by a focus on innovation in the service sector, along with an innovation activity in the low-tech and medium-tech manufacturing sector would not equip countries and regions well for the digital transformation. It is the complexity of technological developments and the novelty of business models that often restrict firms from becoming more innovative and thus hinder their competitiveness. The increasingly digital economy, characterised by 'winner-takes-all' dynamics, hampers the stronger uptake of innovations across companies, sectors and regions.

Figure 4.2-15 Regional concentration of R&I components[1]



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat, Science-Metrix based on EIPO database, Patstat, Web of Science

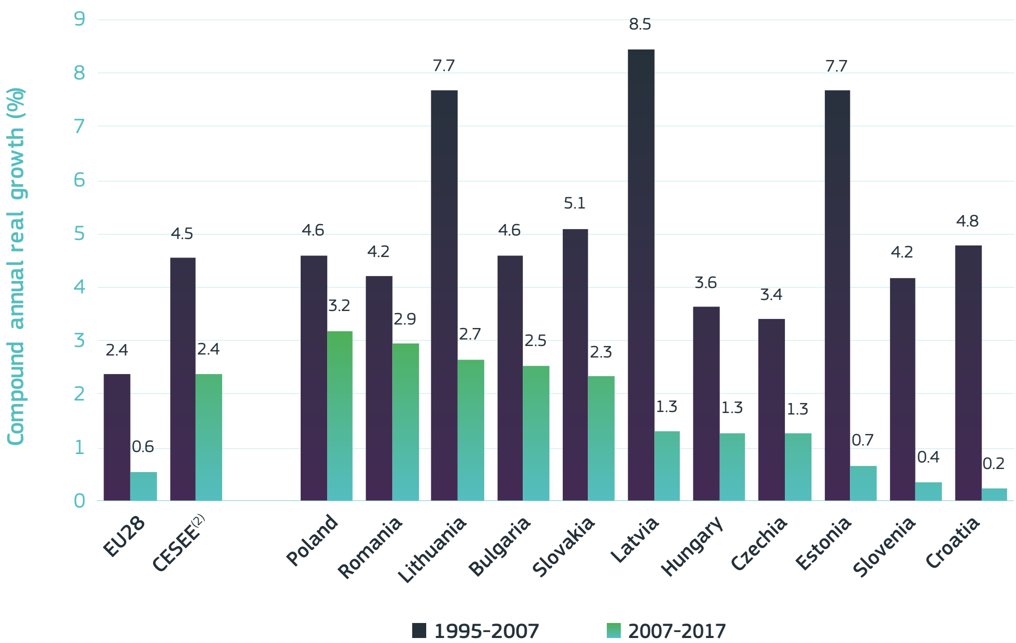
Notes: [1]Cumulative percentage shares within European NUTS2 regions. [2]Data refers to R&D investment in 2015, scientific publications in period 2013-2017, patent applications in 2014 and design and trademark applications in 2018.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-15.xlsx

3. Stronger innovation could boost regional productivity and economic growth

Over the last two decades, the EU has shown convergence in economic output with many poorer countries catching up. However, the trajectory of economic convergence is changing as central and eastern European countries continue to converge more slowly and southern countries are falling behind. New Member States with a lower initial GDP per capita (in relative terms) have exhibited a higher speed of convergence towards the EU average. In the post-crisis decade, economic growth in CESEE countries slowed down and was mainly associated with slower TFP growth (Alcidi et al., 2018). On the contrary, the position of some southern Member States with an initially higher GDP per capita has deteriorated in relation to the EU. Four countries that were below the EU average in 2000 (Greece, Cyprus, Spain and Portugal) did not manage to keep pace with it and their relative position deteriorated (Figure 4.2-16).

Figure 4.2-16 GDP per capita[1] - compound annual real growth (%), 1995-2007 and 2007-2017



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat and DG Economic and Financial Affairs data

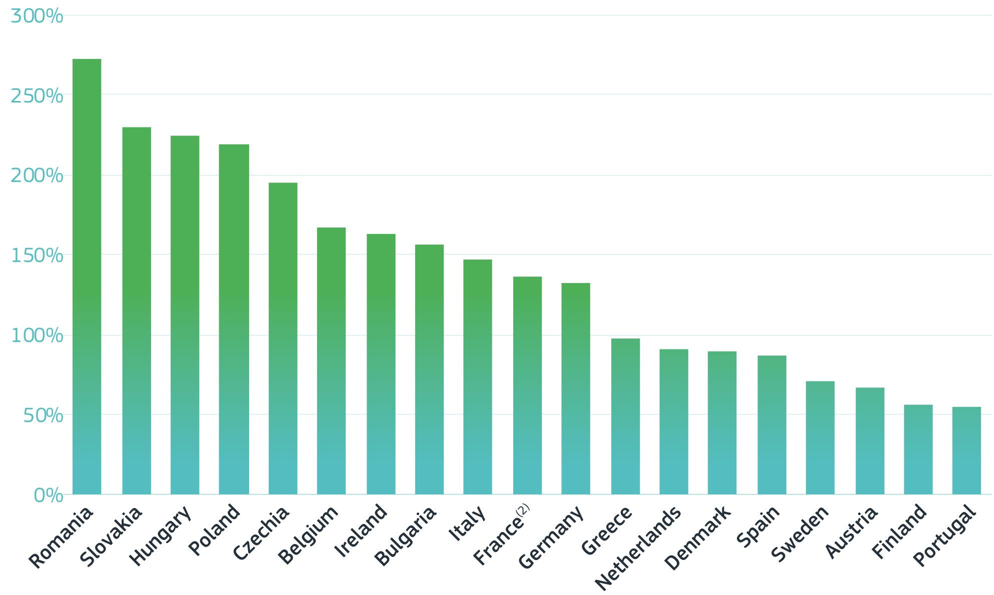
Notes: [1]GDP per head of population in PPS€ at 2005 prices and exchange rates. [2]CESEE: BG+CZ+EE+HR+LV+LT+HU+PL+RO+SI+SK.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-16.xlsx

While trends at the national and regional level suggests that poorer Member States and regions have been converging towards a higher level of GDP per capita since 2000, there has been an increasing divergence within many countries. In terms of the growth rate of GDP per capita, convergence at the regional level has been particularly strong in Bucharest and Bratislava, enabling them to surpass the national growth rates. At the same time, these strong growth rates also contribute to inequalities within countries at the regional level (Figure 4.2-17).

These exceptionally high regional growth rates reveal that country aggregates contain different patterns at regional level. This is the case in many central and eastern European countries, where capitals are accelerating the convergence process while the rest of the country lags behind. On the other hand, some regions have performed below their national average. Such regions are also among Greek, Italian and Spanish regions which suggests that that some of these underperforming regions either remained poor or became even poorer relative to the EU.

Figure 4.2-17 GDP per head of population[1] – the difference between the highest and the lowest NUTS2 regional values as% of the lowest value in 2017[3]



Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Eurostat data

Notes: (1)GDP per head of population in current PPS€. (2)French NUTS2 regions Guadeloupe, Martinique, Guyane, La Réunion and Mayotte not included in the calculation. (3)HR, CY, LV, LT, LU, MT, SI excluded due to low number of NUTS2 regions.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-17.xlsx

Labour productivity growth has been stronger in those regions that have traditionally lagged behind. Nevertheless, slower productivity growth over the last 10 years, notably in some less-developed and transition regions, explains the slowdown in the convergence process (Figure 4.2-18). Within the less-developed regions, there is a tendency for stronger growth rates in regions that started from lower levels, reflecting the convergence process. Nevertheless, despite their strong growth rates, all less-developed regions show levels of labour productivity that remain below the EU average (except Basilicata region in Italy)[10]. Over the last two decades, labour productivity growth rate has been higher in the low-developed regions (mainly CESEE) than in the EU. However, since the onset of the global financial and economic crises, several countries in the region have experienced low levels of labour productivity growth – in some cases, such as Slovenia and Hungary, labour productivity growth was even lower than the EU average. Regional productivity went through the same development and, after a convergence period, notably in the period 2000-2009, progress came to a halt after the crisis and there has only been a slight increase in divergence since 2013.

There is a mixed evidence on productivity growth in the European metropolitan and capital regions[11,12]. Capital regions in the east of the EU show the fastest productivity growth, while productivity has been shrinking in capital cities across the centre and south of the EU. Productivity growth in capital regions was notably slow in southern Europe (EL, PT, IT, ES) and in centrally located EU countries (AT, DE), where it fell between 2010 and 2017.

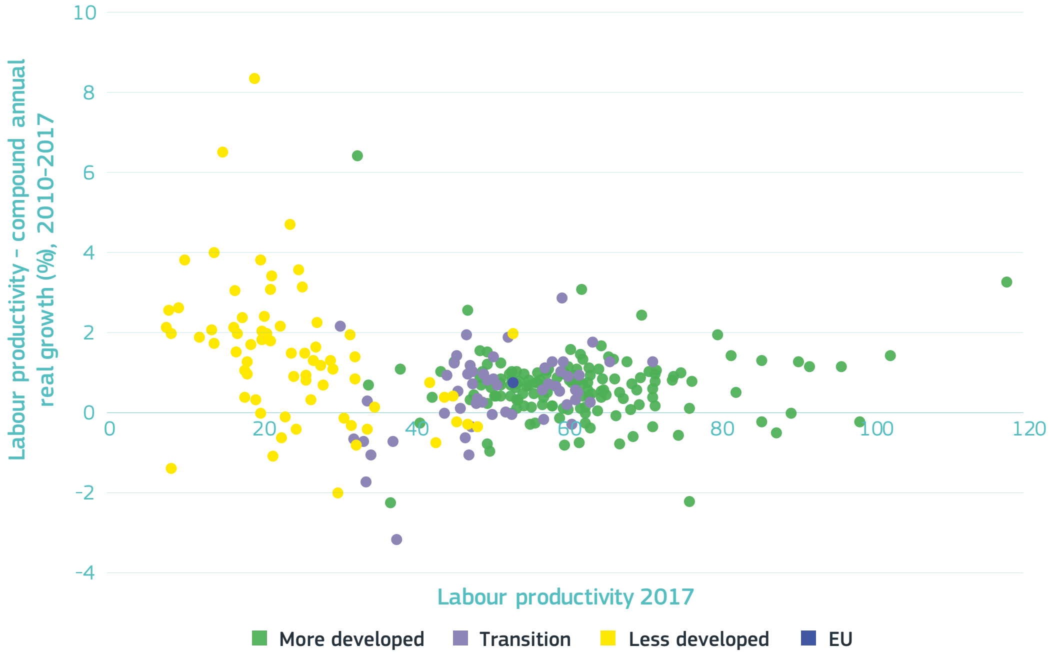
The potential of leading (superstar) cities and regions that benefit from agglomeration economies and have access to the intangible assets and human capital required by the increasing complexity of innovation is likely to gain in importance. The overall productivity growth in the United States has slowed considerably, accompanied by a stark gap between the high productivity of the relatively few metropolitan areas with very high shares of innovation industries and those without them (Atkinson et al., 2019). The European mapping of most specialised areas in innovation industries and the presence of large local innovation sectors that spur metro-wide productivity requires closer examination. From the initial observations, low and declining productivity growth in the service sector and a shift from industry to services contribute mainly to dampening down productivity growth in capital regions and other regions with large cities.

10 The region of Basilicata has 0.57 million inhabitants but is home to a plant in Melfi where Fiat invested EUR 1 billion to boost production. This plant, with 8 000 employees, plays a big part in Basilicata's economy and is responsible for the recent boost in the region's economic output.

11 Labour productivity calculations based on output-weighted average Eurostat data for capital regions and other regions with cities with over 0.5 million inhabitants, for the period 2010-2017.

12 Metropolitan regions are NUTS3 regions or a combination of NUTS3 regions which represent all agglomerations of at least 250 000 inhabitants.

Figure 4.2-18 **Labour productivity (GVA per person worked), 2017 and compound annual growth 2010-2017**(1)(2)(3)



Science, research and innovation performance of the EU 2020

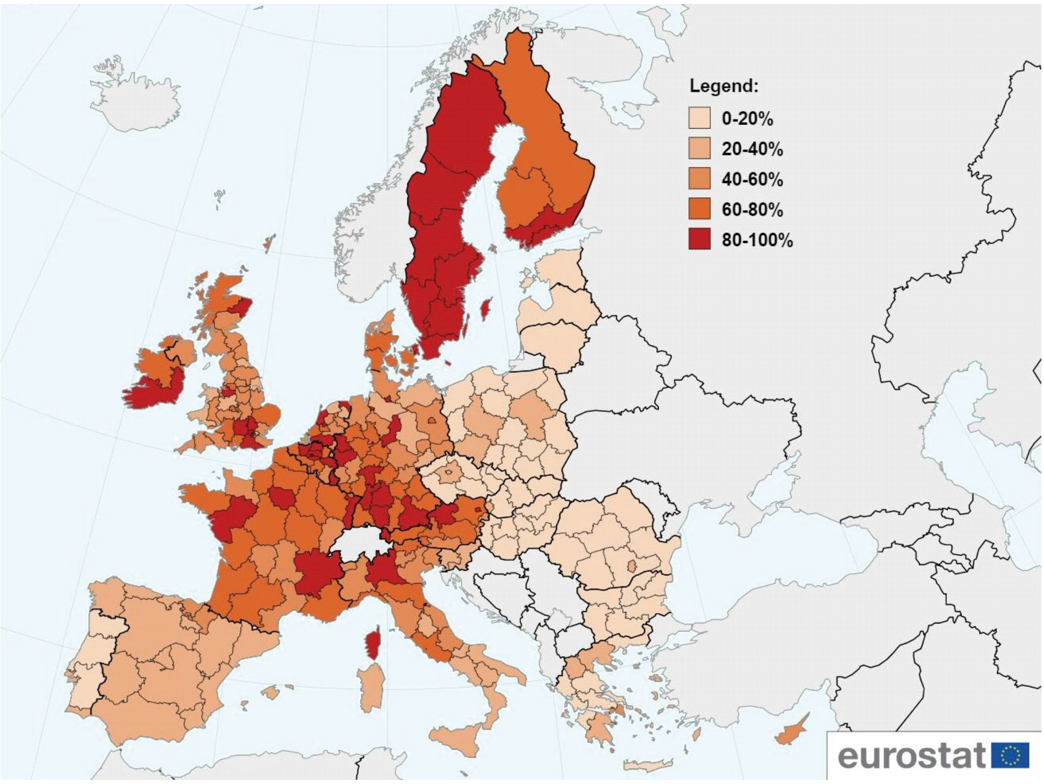
Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on DG for Regional and Urban Policy data

Notes: (1)EL+PL regions labour productivity value 2016 and growth 2010-2016. (2)French NUTS2 regions divided by level of development according to Eurostat 2017 calculations, not including Régions ultrapériphériques. (3)Data includes regions from United Kingdom.

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-18.xlsx

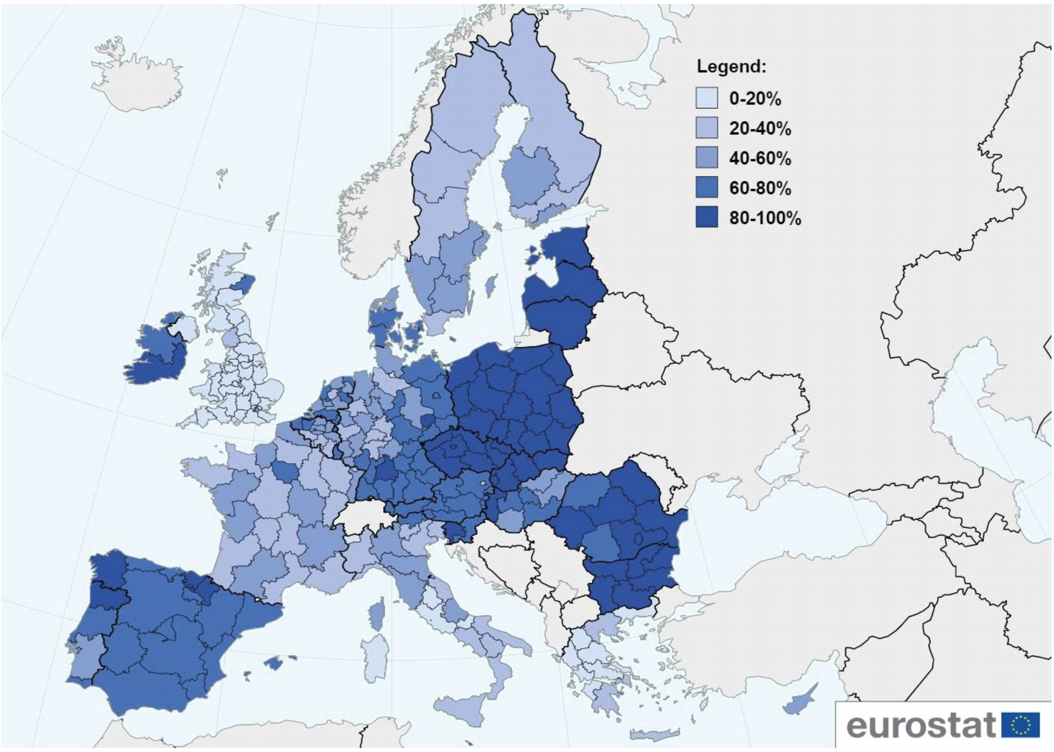
Lower labour productivity growth rates reflect the stagnation, or even the decline, in TFP growth over the last decade. Economic growth and social prosperity rely on the ability of an economy to mobilise all available resources while boosting productivity growth. TFP is arguably the best predictor for long-term economic growth and reflects an economy's overall efficiency and ability to work more smartly and produce higher value-added products and services. There is a clear divide in total factor productivity among regions in the eastern and southern part of the EU and the rest (Figure 4.2-19). Most of the regions in the eastern part of Europe have shown high growth rates during the last two decades. However, at the same time, many regions in the south of Europe, notably in southern Italy and Greece, have been falling behind in total factor productivity growth.

Figure 4.2-19 Total factor productivity in the EU28, 2015



Source: European Commission, DG Employment, Social Affairs and Inclusion
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-19.xlsx

Figure 4.2-20 Total Factor productivity growth in the EU28 between 2005 and 2015



Science, research and innovation performance of the EU 2020

Source: European Commission, DG Employment, Social Affairs and Inclusion

Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-20.xlsx

For more developed economies, boosting TFP growth is closely associated with the ability to foster innovation creation and diffusion. Although there are many factors explaining TFP growth, ranging from how institutions function and the rule of law (see more on institutional quality in Chapter 8 - Framework Conditions) to better infrastructure or high levels of education, TFP growth in high-income countries and regions is typically supported by a high level of technological advancement and innovation. Business enterprise R&D (BERD), as a proxy for innovation capacity, is highly correlated with TFP for high-income regions, whose prosperity rely on the ability to innovate (Figure 4.2-21).

More focus on R&I-driven growth and innovation diffusion would support productivity growth. As many less-developed (located predominantly in central and eastern European countries)[13] and transition regions approach higher levels of prosperity, avoiding a 'middle-

13 According to Regulation 1303/2013, the classification of regions into three categories shall be determined on the basis of how the GDP per capita of each region, measured in purchasing power parities (PPS) and calculated on the basis of EU figures for the period 2007-2009, relates to the average GDP of the EU for the same reference period.

income trap' will require a new growth model based on innovation. This growth model will need to be based on new innovation activities that move beyond the traditional drivers of economic growth in the regions. The emigration of skilled labour and insufficient home-produced innovation create risks for the sustainability of the convergence process in less-developed regions, making the case for building up innovation capacity. Without counteraction, the underdeveloped regional innovation systems, skills gap and poor institutional quality will undermine the growth potential of these lagging regions (EC, 2017b).

The group of some less-developed and mainly transition regions is immediately associated with the risk of falling into a 'middle-income trap'. With higher productivity and wages, they become less attractive for labour-intensive or low-skilled activities. These regions show the lowest GDP growth, mainly because they are neither very low cost nor particularly innovative or productive. This implies that the transition regions[14] are not innovative enough to compete with the most-productive and developed regions of Europe and the world, while their cost levels are too high to compete with low-cost, less-developed regions (EC, 2017a).

Figure 4.2-21 **Total factor productivity - compound annual growth, 2004-2014 business R&D intensity, 2005**[(1)(2)]

Science, research and innovation performance of the EU 2020

Source: DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on DG EMPL and Eurostat

Notes: [(1)]Based on data for 243 European NUTS2 regions. [(2)]Data for Croatia not available.

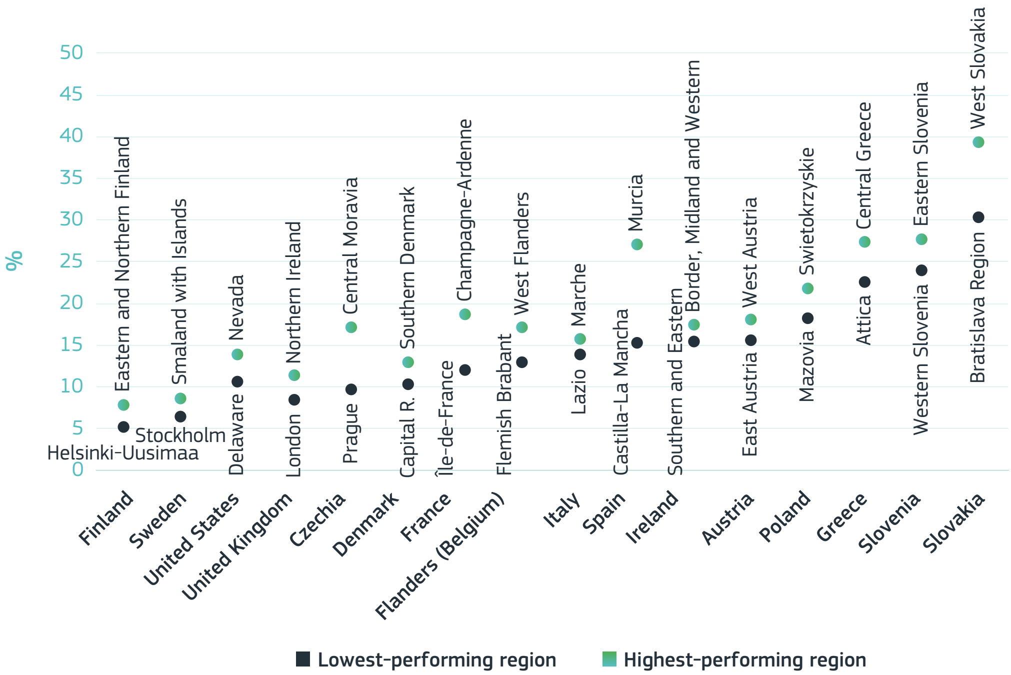
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-21.xlsx

14 As the classification of regional income groups differs, the 'Seventh report on economic, social and territorial cohesion' refers to the medium-income group of regions with a GDP per head of 75-120% of the EU average.

Economic activity and innovation have become more concentrated in core cities and regions, which could potentially lead to a less economically and socially cohesive Europe. These internal divergences are most apparent in the growing gap between capitals and metropolitan areas where most economic and innovative activities are concentrated, on the one hand, and the declining industrial and peripheral areas, on the other hand, experiencing skilled emigration and less resilience to change. If left unmanaged, technological change is likely to widen these divergences, as shown by the most recent evidence (European Commission, 2017a; Iammarino et al., 2018).

As has been happening over the last decade, a 'geography of discontent' is emerging, with increasing distrust being shown towards political and democratic institutions. This is mainly driven by the dissatisfaction of those who are most affected by the negative impact of technological change, i.e. the older and less educated, living in industrial or decaying areas (Iammarino et al., 2018). The perceived risks are of concern as technological developments can contribute to the displacement of some current jobs, while many of the emerging and future jobs require a special set of conditions, as described above.

Figure 4.2-22 Share of jobs at high risk of automation across regions, 2016



Source: OECD - Job Creation and Local Economic Development 2018, based on Nedelkoska and Quintini (2018) and national Labour Force Surveys (2016)
Stat. link: https://ec.europa.eu/info/sites/info/files/srip/2020/parti/chapter42/figure-42-22.xlsx

Jobs are increasingly becoming concentrated in a smaller number of capital or metropolitan regions. The large regional differences and concentration of new jobs in capital regions favour imbalances in employment developments. In Finland, Denmark and Ireland, more than 80% of net job creation between 2006 and 2016 took place in the capital region (OECD, 2018). Many of the new jobs were created in new industries, e.g. the number of jobs in the ICT sector for the period 2010-2017 increased by 72% in Bucharest, 31% in Berlin and 27% in Stockholm[15]. Although the 6% share of ICT employment across EU capital regions remains small compared to approximately 25% in retail and services[16], there are structural changes that will require targeted efforts to create an attractive environment for highly skilled jobs and growing industries across the regions. The transfer of skills and knowledge from mature industries often enables the emergence of new industries, but in cases of more radical technological change, the new industries draw directly from R&D (Storper et al., 2015).

To find out more, see Chapter 12 - The research and innovation divide in the EU and its economic consequences.

Summary of Andrés Rodríguez-Pose's Chapter 12 - The research and innovation divide in the EU and its economic consequences

This contribution looks at **the economic consequences of the R&I divide across EU regions** and highlights the policy challenge they represent. It reviews the theoretical factors behind current levels of territorial polarisation, maps the current state of this divide and presents an econometric approach to identifying the effects.

The core of the argument is that **R&D investment alone does not trigger the same returns on investment everywhere because of several factors**. These are linked to the cost of technology accessibility in different places, the distance to the technological frontier, positive externalities from larger and denser regions, the quality of local institutions, and hampered knowledge sharing.

Many of these factors disadvantage the less-developed regions in their efforts to broaden their innovation capacities with the aim of unleashing greater economic activity and growth. Nevertheless, most of the R&D growth in less-developed regions has been in the higher education sector, which has led to a substantial improvement in scientific output. The chapter discusses how to improve the efficiency of investment in R&I systems and strengthen innovation-driven economic growth.

In its conclusions, the chapter not only diagnoses the situation but also suggests elements of innovation policy for less-developed regions. These aim at **closing the innovation divide between more- and less-developed areas in the EU and increasing the EU's competitiveness** through a stronger role for innovation as a trigger of economic dynamism.

15 Employment by economic activity in NUTS2 regions. Estonia and Malta show even higher increases in ICT jobs.
16 Wholesale and retail trade, transport, accommodation and food service activities.

4. Conclusions

Economic dynamism and productivity growth often depend on the implementation of structural policies, which do not take regional conditions into account. This implies an important role for further **place-based policies to boost underutilised regional potential and strengthen regional innovation systems**. To deliver on this ambitious innovation agenda, policymakers must align policies targeted at improving R&I capacities and territorial inequalities with **greater coordination at all levels**. These include R&I policies and Cohesion Policy, together with education and training implemented through a broad range of instruments.

European policies must put **greater emphasis on promoting innovation combined with more focus on the local context** to trigger economic dynamism in less-developed regions. An ambitious innovation agenda at the regional level should not focus solely on comparing performance with more-advanced regions but must embed local issues. Place-based approach in promoting innovation, especially the diffusion and commercialisation of existing innovation in lagging regions, is essential and should be supported in line with the specificities of each region and its current or possible comparative advantages as mapped in 'smart specialisation strategies'. Effective public support for innovation must understand the specificities of both the national and regional innovation systems and build on these. Furthermore, the substantial variation across EU regions in terms of institutional performance calls for **improvements in institutional quality**. The local authorities play a major role in well-tailored innovation strategies as well as in the efficiency of R&I programmes, combating corruption and tackling market failures such as the weak take-up of technology.

Policy in lagging regions can contribute to **improving economic competences**, especially managerial competences in firms, including internal processes and organisational structure, and **building technological capacities**, for example, by supporting technology transfer. The **reinforcement of local R&D capacities** and **pursuit of radical innovation** can be targeted by a mix of initiatives, such as **public procurement for innovation** on the demand side or dedicated supply-side measures.

5. References

Alcidi, C., Ferrer, J., Di Salvo, M., Musmeci, R. and Pilati, R. (2018), Income Convergence in the EU: a Tale of Two Speeds, CEPS Policy Contribution.

Atkinson, R.D., Muro, M. and Whiton, J. (2019), The Case for Growth Centres, Brookings and Information Technology & Innovation Foundation.

Dijkstra, L., Poelman, H. and Rodríguez-Pose, A. (2018), The geography of EU discontent, Working Papers, DG Regio working papers.

European Commission (2014), For a European Industrial Renaissance, Commission Communication, COM(2014) 14 final.

European Commission (2017), Investing in a smart, innovative and sustainable Industry. a renewed EU Industrial Policy Strategy, Commission Communication, COM(2017) 479 final.

European Commission (2017a), Seventh report on economic, social and territorial cohesion, Publications Office of the European Union, Luxembourg.

European Commission (2017b), Competitiveness in low-income and low-growth regions. The lagging regions report, Commission Staff Working Document, SWD (2017) 132 final.

Filippetti, A., Gkotsis, P., Vezzani, A., Zinilli, A. (2019) How to survive an economic crisis? Lessons from the innovative profiles of EU regions. European Commission, Seville, Spain, JRC115664.

Iammarino, S., Rodríguez-Pose, A. and Storper, M. (2018), Regional inequality in Europe: evidence, theory and policy implications, *Journal of Economic Geography*, 19(2), 273-298.

Joint Research Centre (2018), For a transformative industry and innovation strategy, IRITEC Briefs Series, Issue 5.

OECD (2014), Science, Technology and Industry Outlook 2014, OECD Publishing, Paris.

OECD (2018), Job Creation and Local Economic Development 2018: Preparing for the Future of Work, OECD Publishing, Paris.

Rodríguez-Pose, A. (2014), Leveraging research, science and innovation to strengthen social and regional cohesion. Policy Brief by the RISE group, EUR 27364 EN, Publications Office of the European Union, Luxembourg.

Storper, M., Kemeny, T., Makarem N.P. and Osman, T. (2015), The rise and fall of urban economies: lessons from San Francisco and Los Angeles, Stanford University Press, Stanford.

Veugelers, R. (2014), Is Europe saving away its future? European public funding for research in the era of fiscal consolidation. Policy Brief by the RISE group, EUR 27363 EN, Publications Office of the European Union, Luxembourg.

Westlund, M. (2006), Social Capital in the Knowledge Economy, Springer, Heidelberg.