



# Socio-economic regional microscope series

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## EU regions and the upgrading for the digital age

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European Commission  
Joint Research Centre

Socio-economic regional microscope series  
**EU regions and the upgrading for the digital age**

In this work we use patent data from the European patent office (EPO) to assess the capabilities of EU regions in developing digital technologies especially focusing on those that are more closely related to the digital transformation. More specifically, we measure ICT patents by considering those containing digital codes, as defined by the OECD. The penetration of digital technologies in the development of innovative products is instead captured by the co-occurrence of digital and non-digital codes within patent documents; we call these patents ICT-combining patents.

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# The Socio-economic regional microscope series

The current political and economic challenges faced by the European Union and its Member States call for even more evidence-informed policies. They also require tailor-made policies, developed using highly sophisticated analyses based not only on country-level data, but rather on regional and sub-regional knowledge.

National averages, in particular, bear the risk to present a misleading picture in countries with significant disparities between different regions and areas.

Looking only at national averages can also limit and delay understanding of the differences between regions and cities – identifying leaders and laggards –, as well as prevent the identification of emerging trends in certain socio-economic indicators. Only a detailed analysis of data at regional and local level can bring these insights.

The Joint Research Centre (JRC) of the European Commission has developed the *Socio-economic regional microscope*. It is a new series of short periodical publications which aims to open-up new areas of analysis, and present the stories which can only be told using regional socio-economic data.

Each report presents EU socio-economic indicators according to a data storytelling principle, using a combination of three key elements: data, visuals (maps), and narrative. Each indicator will therefore be represented through maps at regional level (NUTS2), and in some cases even at the NUTS3 and local level.

The *Socio-economic regional microscope* will also show the breadth of the JRC regional analysis in a wide range of research areas: culture, economics, education, energy, healthcare, research and innovation, tourism, etc.

The reports, data and maps are also available on the Territorial Dashboard website of the JRC Knowledge Centre for Territorial Policies, in the *Thematic Analyses* section: <http://urban.jrc.ec.europa.eu/t-board/index.html#/thematic-analyses>.

# Introduction

The development and widespread adoption of digital technologies has changed the way knowledge is generated, used and diffused, bringing profound changes in the functioning of economies and societies and offering new opportunities for countries and regions to upgrade their industrial base. While initially triggered by ICT solutions developed by firms mainly operating in ICT-related sectors, nowadays digital technologies are developed and used in all sectors.

Information and communication technologies (ICT) are at the heart of the ‘Digital Single Market Strategy for Europe’<sup>1</sup> set out by the European Commission (2015) where digitalisation is considered a major leverage for the EU in order to maintain its leading role in a number of industries. The importance of upgrading the industry for the digital age has been further stressed in the communication on ‘A renewed EU Industrial Policy Strategy’<sup>2</sup> (2017). This communication highlighted the importance of a holistic approach favouring the shift of EU industries toward digital technologies while empowering regions to address challenges and cater for their specific transformation needs. Given the potentialities offered by ICT, their adoption and development has been high in the agenda of regional policies aiming at building a cohesive and competitive Europe.<sup>3</sup> Regions’ relevance as spatial and socio-economic entities has gradually become crucial and regional innovation policies for Smart Specialisation (RIS3) represent a key component of the EU cohesion policy 2014-2020. Indeed, technological capacities are not distributed evenly across industries, firms and regions, mainly because of the cumulative nature of innovation and the localized character of spillovers.<sup>4</sup>

In this work we use patent from the European patent office (EPO), as reported in Regpat 2018a, to assess the capabilities of EU regions in developing digital technologies especially focusing on those that are more closely related to the digital transformation.<sup>5</sup> More specifically, we identify ICT patents by considering those containing digital codes, as defined by the OECD.<sup>6</sup> The penetration of digital technologies in the development of innovative products is instead captured by the co-occurrence of digital and non-digital codes within patent documents; we call these patents *ICT-combining patents*.

The objective is to gradually zoom our microscope to assess the specific technological capabilities of regions from a broad to an increasingly detailed characterisation of the phenomenon: 1. *the overall technological capabilities of EU regions (on the right)*; 2. *the ICT specialisation of EU regions*; 3. *the specialisation of EU regions in ICT-combining technologies*; 4. *the dominant industrial application of ICT in EU regions*. For each region, the relative performance across these 4 dimensions may provide insights for a specific regional approach to digital technologies.

The map shows that the leadership in technological development (patent per capita) is mainly concentrated in the central EU, together with Scandinavian regions and some regions in France and the UK. Eastern and Southern regions tend to show lower levels of patenting activity per capita.

<sup>1</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52015DC0192>

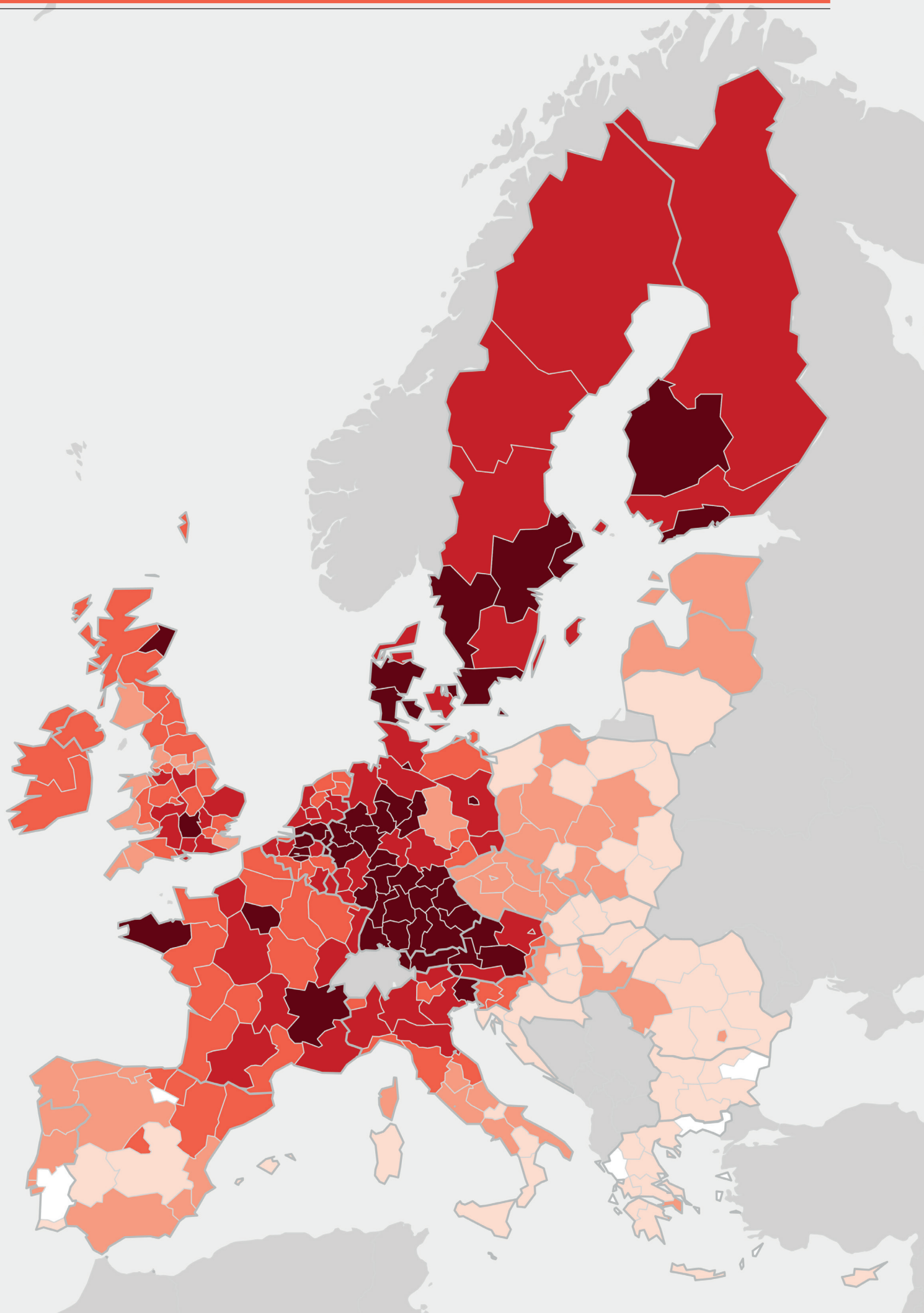
<sup>2</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2017:479:FIN>

<sup>3</sup> For a recent assessment of their economic impact in Europe see: Evangelista R., Guerrieri P., Meliciani V., (2014). *The economic impact of digital technologies in Europe*. Economics of Innovation and New Technology, 23:8, 802-824.

<sup>4</sup> See, for example, Rodriguez-Pose, A., Crescenzi, R. (2008). *Research and development spillovers, innovation system, and genesis of regional growth in Europe*, Regional Studies, vol. 42(1), pp. 51-67.

<sup>5</sup> All regions in this report are defined using the NUTS2 nomenclature, but the London area that is aggregated at the NUTS1 level.

<sup>6</sup> Inaba, T., Squicciarini, M. (2017). *ICT: A new taxonomy based on the international patent classification*. OECD Science, Technology and Industry Working Papers, 2017/01, OECD Publishing, Paris. Patent documents are classified according to the different areas of technology to which they pertain following the International Patent Classification (IPC) scheme. In their work, Inaba and Squicciarini identify a subset of IPC codes related to ICT technologies.



Patenting activity of EU regions (2011-2015)

● Not available ● Very low ● Low ● Moderate ● High ● Very high

Map 1. Regions are split in five equally populated groups (quintiles, 20%) on the base of patent per capita. Regions in white do not have EPO patents, as reported in Regpat2018a, developed by resident inventors during the period analysed

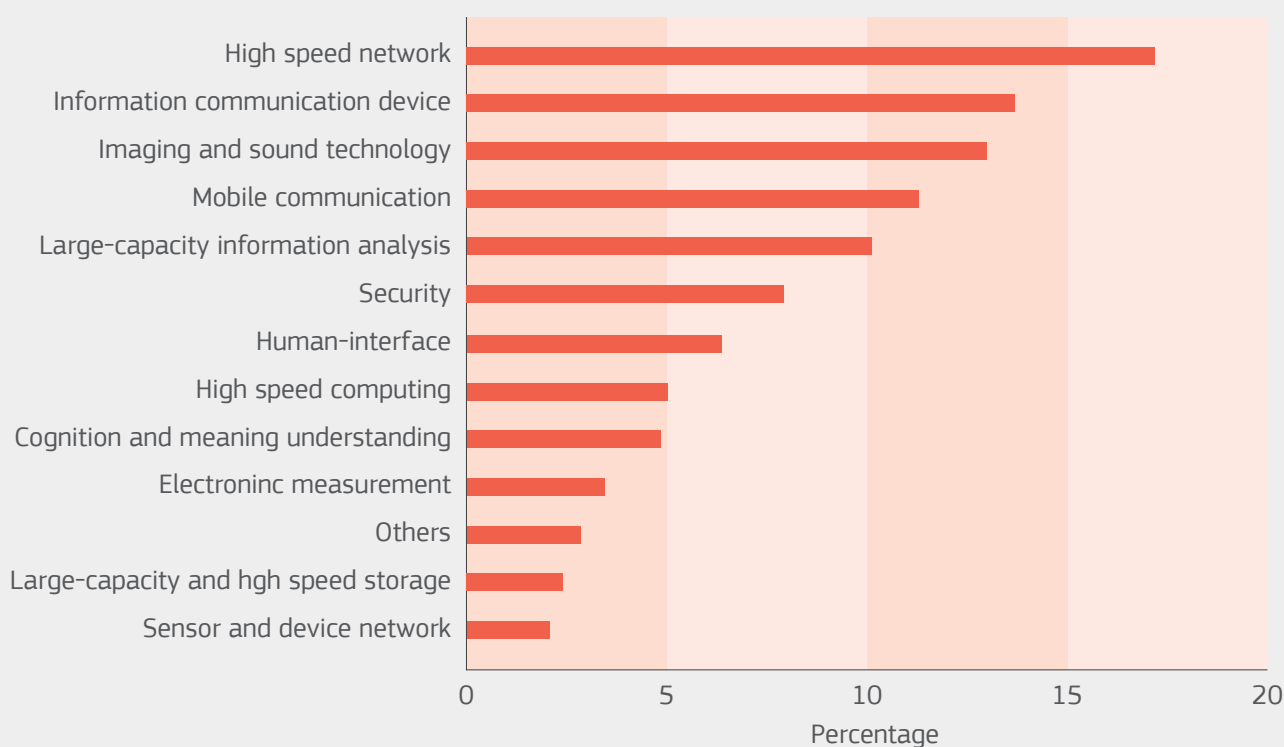
# ICT development in the EU

Overall, EU regions have not increased their relative capacity to create new (patentable) applications in the digital domain between 2006 and 2015.<sup>7</sup> The share of ICT patents over the total patents filed during the period considered is quite stable, fluctuating between 17.5% and 19%. To give a more detailed description of the European technological landscape in ICT, we report in Figure 1 the share of patents in specific technological areas with respect to the total ICT patents by inventors residing in the EU.

The 'Digital Single Market Strategy for Europe' puts emphasis on the fact that the EU should not lag behind other economies in the race for the digital development; a close monitoring of ICT development in the EU to better understand its intrinsic characteristics can help to design a successful European digital strategy. Such strategy should be based on regional competitive advantages in developing ICT technologies and, among these, focus on a specific group integrating ICT and non-ICT components.

The share of ICT in the regional patent portfolios provides a quite different picture with respect to what we previously observed. Regions with a relative specialisation in ICT development are not necessarily those with the highest patenting activity; indeed, there is no correlation among the two indicators.<sup>8</sup> The distribution of regions specialised in the development of ICT technologies is quite scattered and most of the regions with high ICT shares are not among those with intensive patenting activities. An exception is represented by a small number of regions, reported in Table 1.

**Distribution of ICT patents across specific technology areas in the EU (2015)**



**Figure 1.** Distribution of ICT patents across specific technology areas in the EU (2015). Source: own computation on Regpat 2018a data.

<sup>7</sup> However, it should be considered that software is not patentable at EPO (while it is at the United States Patent and Trademark Office).

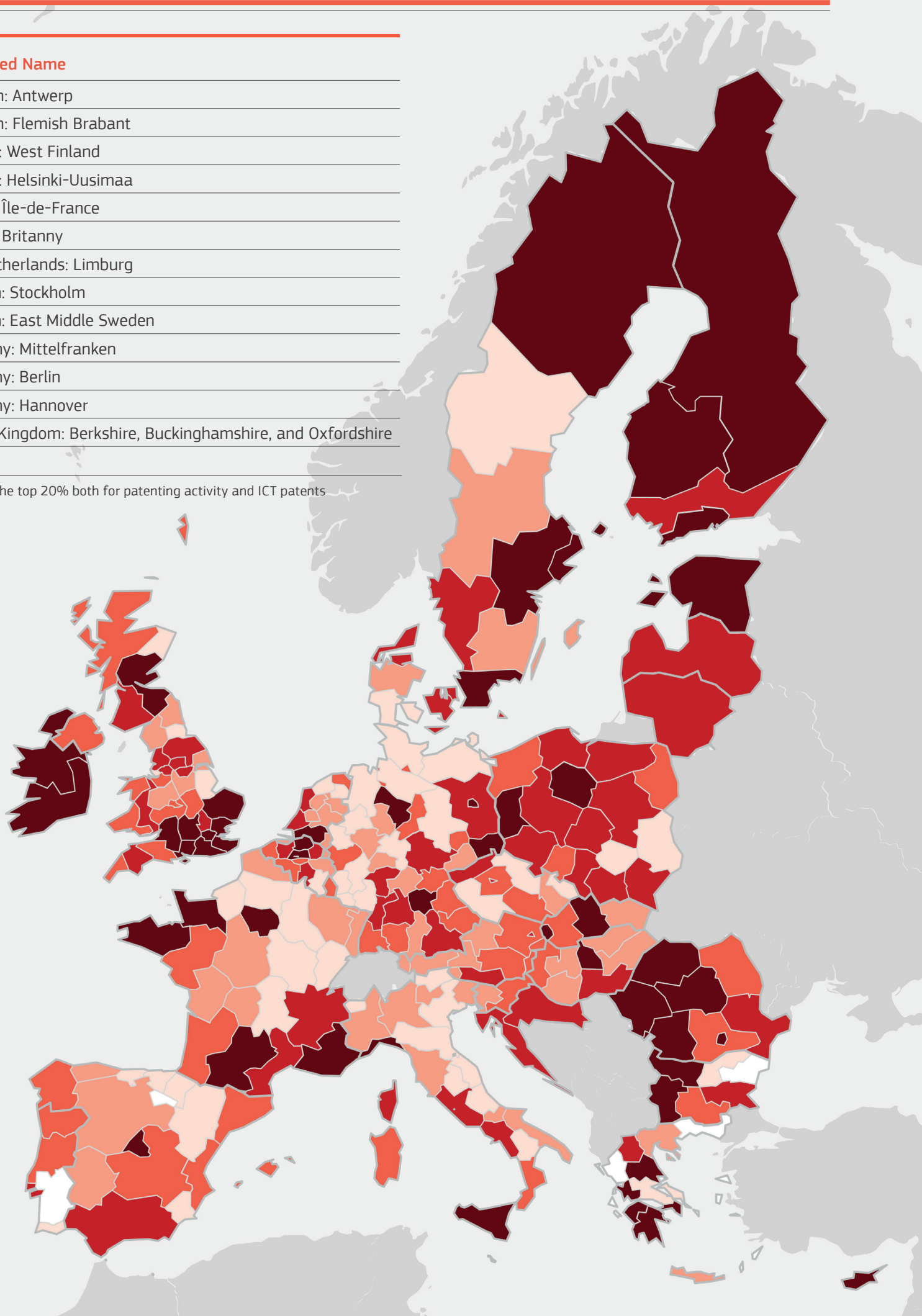
<sup>8</sup> The Spearman correlation coefficient is close to zero and equal to 0.002.

<sup>9</sup> For compatibility reasons, we use the pre 2016 NUTS classification for France.



NUTS	Extended Name
BE21	Belgium: Antwerp
BE24	Belgium: Flemish Brabant
FI19	Finland: West Finland
FI1B	Finland: Helsinki-Uusimaa
FR10	France: Île-de-France
FR52 <sup>9</sup>	France: Brittany
NL41	The Netherlands: Limburg
SE11	Sweden: Stockholm
SE12	Sweden: East Middle Sweden
DE25	Germany: Mittelfranken
DE30	Germany: Berlin
DE92	Germany: Hannover
UKJ1	United Kingdom: Berkshire, Buckinghamshire, and Oxfordshire

Table 1. Regions in the top 20% both for patenting activity and ICT patents



Share of ICT patents for EU regions (2011-2015)

● Not available ● Very low ● Low ● Moderate ● High ● Very high

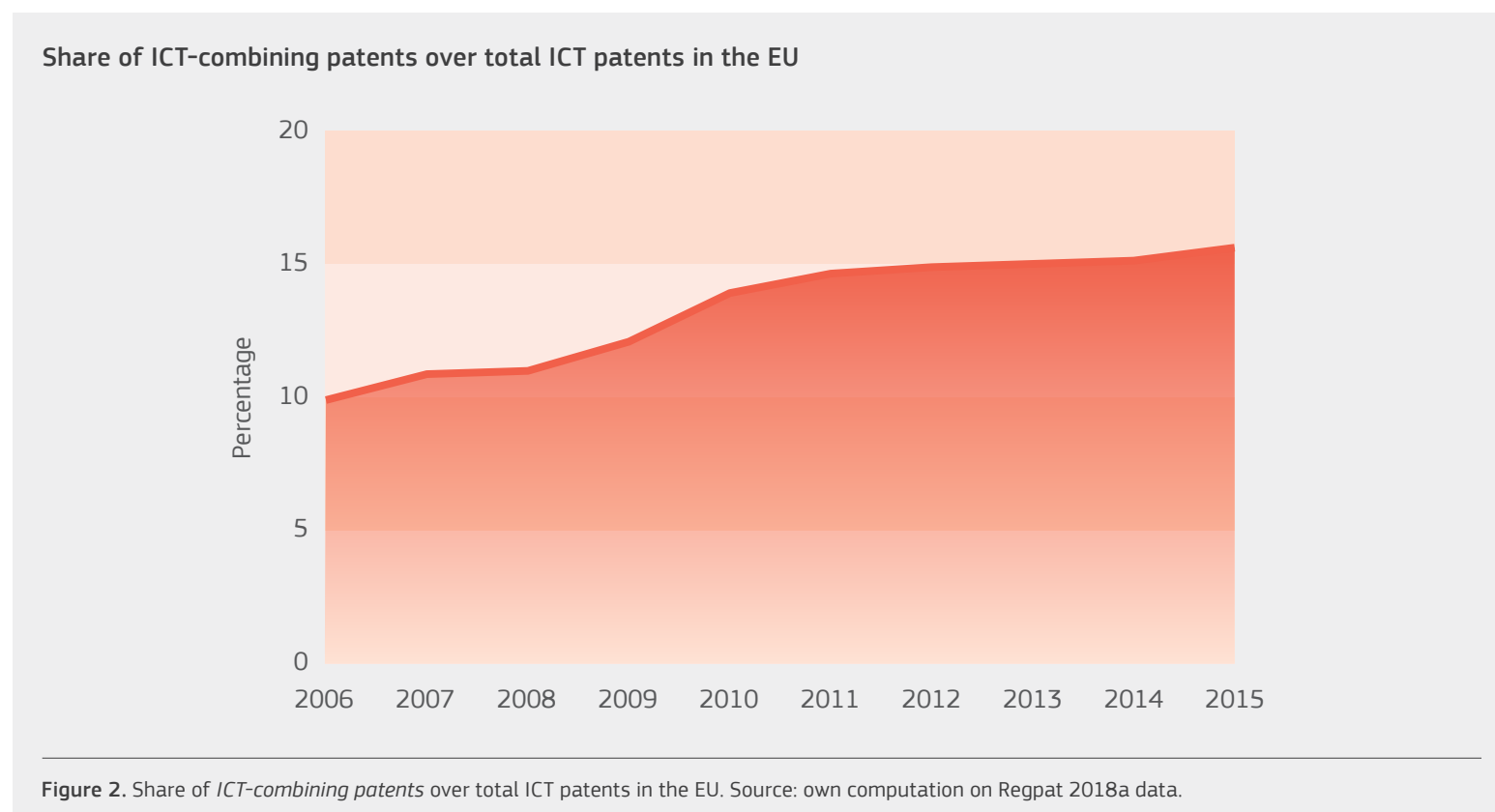
Map 2. Regions are split in five equally populated groups (quintiles, 20%) on the base of the share of ICT patents. Regions in white do not have enough EPO patents from resident inventors to compute meaningful shares. Source: own computation on Regpat 2018a data.

## What about combining ICT with non-ICT components?

We now zoom in on the patents combining ICT technological codes with codes pertaining to other technologies, the *ICT-combining patents*. This subset of ICT patents is better suited to measure the EU regional capacity in developing new technological solutions for the industrial modernisation keeping them at the forefront of the industrial transformation process. In doing so, we focus on the knowledge generation process of, rather than the adoption of, new technologies.<sup>10</sup>

The share of *ICT-combining* over total ICT patents increased steadily during the last decade, with the share increasing from 10% to above 15%. The EU seems to have moved its knowledge production towards those digital technologies with a more pervasive role for the industrial transformation. Of course, this last result can also in part be due to a general increase of the importance of ICT in the production of new technologies. Further analyses may disentangle whether this is part of a general global trend or represent the emergence of a ‘European way’ to digital technologies.

Again, zooming further with our microscope, we uncover other specificities. Regions relatively specialised in the production of *ICT-combining patents* tend to have a high patenting activity, but a low ICT specialisation.<sup>11</sup> The three indicators capture different aspects of regions’ technological capabilities and by combining them it seems possible to design specific regional profiles. Despite the higher correlation, also in the case of *ICT-combining patents* the number of regions ranking in the top 20% both with respect to ICT-combining shares and overall patenting activity is quite limited. As reported in table 2, only 10 regions belong to this category. Interestingly, there is no region in the EU ranking among the 20% top performers in all three dimensions.

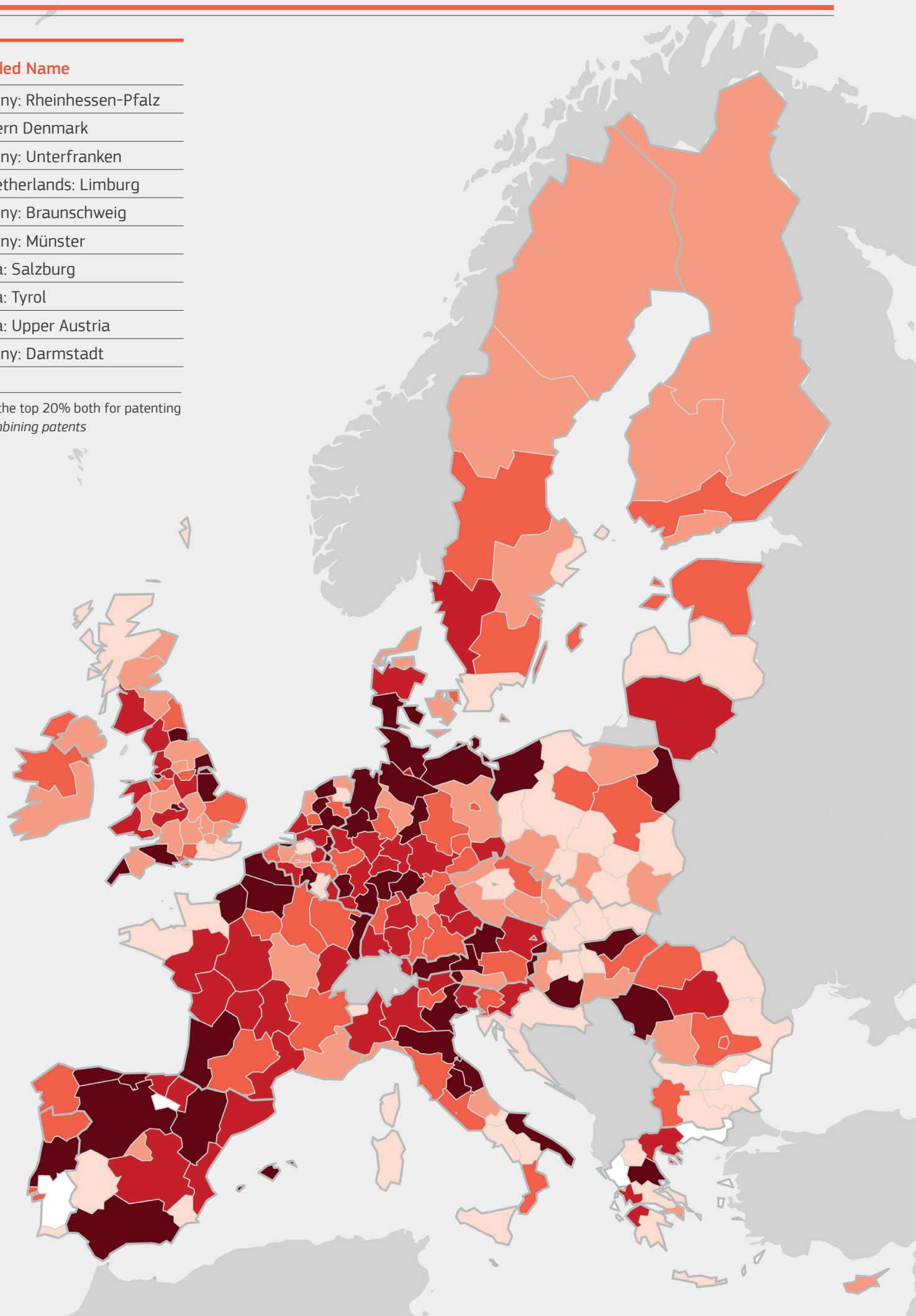


<sup>10</sup> Of course, the adoption of new technologies may also bring productivity improvements and sustain competitiveness. However, here we are more interested in the output of the research and development efforts of European actors. Moreover, the lack of comparable data on the acquisition and usage of ICT technologies in the EU limit the possibility of performing EU wide comparisons of ICT adoption.

<sup>11</sup> In particular, the share of *ICT-combining patents* correlates negatively with the share of ICT patents, Spearman correlation coefficient = -0.342, but positively with the total applications per capita, Spearman correlation coefficient = 0.295.

NUTS	Extended Name
DEB3	Germany: Rheinhessen-Pfalz
DK03	Southern Denmark
DE26	Germany: Unterfranken
NL42	The Netherlands: Limburg
DE91	Germany: Braunschweig
DEA3	Germany: Münster
AT32	Austria: Salzburg
AT33	Austria: Tyrol
AT31	Austria: Upper Austria
DE71	Germany: Darmstadt

Table 2. Regions in the top 20% both for patenting activity and ICT-combining patents



Share of ICT-combining patents of EU regions (2011-2015)

Not available
  Very low
  Low
  Moderate
  High
  Very high

Map 3. Regions are split in five equally populated groups (quantiles, 20%) on the base of the share of ICT-combining patents. Regions in white do not have enough EPO patents from resident inventors to compute meaningful shares. Source: own computation on Regpat 2018a data.

## Which link between ICT and other components?

Finally, regions can have different capabilities and face different opportunities in developing technologies for industrial applications. In particular, they can show relative advantages in developing ICT applications for specific industrial purposes.

We therefore look at the dominant linkages at the regional level. For each region we calculate the most frequent combination of ICT with technologies classified under other sections.<sup>12</sup> For each section, we report in table 2 the share of EU regions having it as the dominant linkage.

In general, EU regions show the highest shares on ICT patents combined to the section B of the IPC classification scheme, a section grouping machineries, transport and material related technologies (46.8%). However, different specialisation patterns emerge with some regions showing dominant ICT combinations in other technological areas. In particular, a relevant number of regions develop digital technologies combined with technologies in section A, a section spanning from health to agriculture (20.8%). Sizeable minorities combine ICT with sections C (chemistry and metallurgy) and F (mechanical engineering, lighting, heating, weapons and blasting).

## Key messages to retain

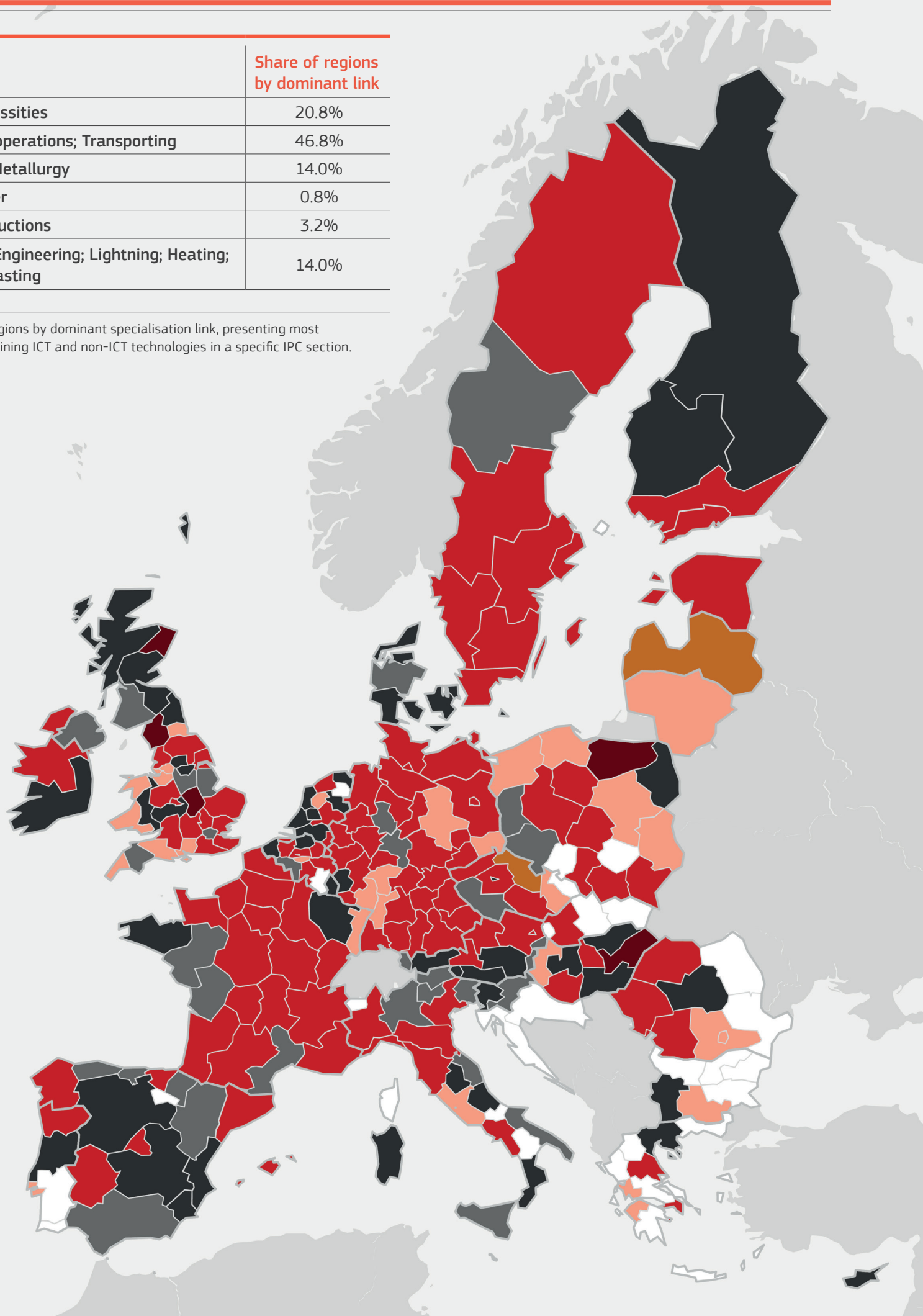
- ICT development in EU regions has been relatively stable over the last years.
- European regions have rather differentiated specialisation with respect to ICT technologies.
- Regions relatively specialised in the production of *ICT-combining patents* tend to have a high patenting activity (innovation leaders), but a low ICT specialisation.
- The development of ICT and ICT-combining technologies and products may involve different regional capabilities and open different windows of opportunity.
- While the EU missed the first 'ICT revolution', it can benefit from the development of those technologies at the heart of the industrial digital transformation.

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<sup>12</sup> We exclude section G and H because most of the ICT technologies are classified in these two sections.

IPC Sections	Share of regions by dominant link
A - Human Necessities	20.8%
B - Performing operations; Transporting	46.8%
C - Chemistry; Metallurgy	14.0%
D - Textile; Paper	0.8%
E - Fixed Constructions	3.2%
F - Mechanical Engineering; Lightning; Heating; Weapons; Blasting	14.0%

Table 3. Share of regions by dominant specialisation link, presenting most of the patents combining ICT and non-ICT technologies in a specific IPC section.



Dominant linkages between ICT and other components in EU regions (2011-2015)

- A - Human Necessities
- B - Performing operations; Transporting
- C - Chemistry; Metallurgy
- D - Textile; Paper
- E - Fixed Constructions
- F - Mechanical Engineering; Lightning; Heating; Weapons; Blasting
- Not available

Map 4. Non-ICT technological section most commonly combined with ICT in the region. Regions in white do not have enough EPO patents from resident inventors to compute a meaningful figure. Source: own computation on Regpat 2018a data.



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