CHAPTER 13

THE GREEN AND DIGITAL TWIN TRANSITION ACROSS EU REGIONS*

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Summary

The recovery from the COVID-19 pandemic provides an opportunity to accelerate the green and digital transformation and to strengthen social cohesion to make the EU economy more resilient and sustainable. Using data of the 2021 EIB Investment Survey (EIBIS), this chapter shows that firms in the EU's cohesion regions tend to invest less in digitalisation and in green measures than firms in non-cohesion regions. At the same time, firms in cohesion regions express greater concerns about the current impact of climate change on their business. They need to reassess their operating environment, innovate and adapt. Accelerating the EU's green and digital transformation will also require a policy framework that fosters climate-related and digital innovation at the technological frontier. Using patent data, we show that the EU is a global leader for patenting activities at the crossroads of digital and green technologies. We also find that cohesion regions have a relatively high share of patents in these technology domains: they hold fewer patents overall than non-cohesion regions but have a strong focus on green and digital innovation. As the potential for technological advancements in these areas accelerates, the EU will be well-placed to maintain its lead, but this will require significant investment across EU regions.

1. Introduction

Europe faces a choice. The recovery from the coronavirus pandemic provides an opportunity to accelerate the green and digital transformation and to strengthen social cohesion to make the EU economy more resilient and sustainable. Yet there are also serious risks. Due to the uncertainty created by the COVID-19 pandemic, many firms cut investment activities in 2020, postponing their plans to adopt advanced digital technologies and climate-related measures.

Much is at stake. Europe's future prosperity depends on advancing in digitalisation and keeping its lead position in climate change. The aim is to foster a more competitive and smarter Europe, by creating an inclusive environment that incentivises firms across the EU to invest in the twin green and digital transition.

Support for economic, social and geographical cohesion has been an integral part of the EU from the very start. EU integration drove economic convergence, reduced regional and social disparities and created opportunities for many people, but challenges remain. The pandemic's impact was not felt evenly across Europe, and regions are rebounding at different speeds. Increasing digitalisation and the greening of the economy will bring profound structural change. Europe risks becoming more unequal once the pandemic has receded. A process of re-adjustment awaits firms and regions that lag behind.

Using data from the 2021 EIBIS, this chapter shows that EU's cohesion regions (less developed and transition regions) have a lower share of firms that invest in digitalisation and in green measures than non-cohesion regions. At the same time, firms in cohesion regions express greater concerns about the current impact of climate change on their business. They need to reassess their operating environment and innovate and adapt. They have to invest to become more digital and to tackle physical

and transition risks from climate change. This will help ensure their survival and future competitiveness in a new, greener and more digital environment.

Accelerating the EU's green and digital transformation will also require a policy framework that fosters climate-related and digital innovation at the technological frontier. Using PATSTAT data, we find that the EU is a global leader for patenting activities at the crossroads of digital and green technologies. We also show that non-cohesion regions hold a large number of patents in these domains. At the same time, cohesion regions have a relatively high share of patents in these technology domains: they hold fewer patents overall but are strongly specialised in green and digital innovation.

As the potential for technological advancements in these areas accelerates, the EU will be well-placed to maintain its lead, but it can take nothing for granted. European policymakers will have to do everything it takes to ensure that this dominant position is not rapidly lost. The strong position of the USA and China in the development of new technologies in most digital fields could make it difficult for Europe to remain on top in the areas in which it currently excels. The European Green Deal and the EU's Digital Strategy are the cornerstone of the recovery plan for Europe. Combined with the national recovery and resilience plans, the initiatives present a unique opportunity to transform the EU economy and make it greener, more digital and more innovative.

The remainder of this chapter is organised as follows. The next section introduces the two different sources of data that we use: EIBIS on the adoption of digital technologies and climate related measures and PATSTAT on innovation in green and digital technologies. Using EIBIS data, the third section identifies corporate green and digital profiles based on firms' current use of advanced digital technologies and their investments to tackle climate change. Green and digital firms tend to perform better but they also report facing different obstacles to investment than firms that are not green or digital. In the fourth section, we show that there is a high focus on innovation at the crossroads of digital and green technologies across Europe, but we also highlight that Europe's pole position risks being overtaken. The last section concludes with policy implications for the green and digital recovery from the COVID-19 crisis.

2. Data

EIBIS is an annual survey that gathers qualitative and quantitative information on investment activities by non-financial corporates, their financing requirements and the difficulties they face. Every year since 2016, the survey has collected data from more than 13 000 businesses located in all EU countries, the United Kingdom and, since 2019, the USA. The focus of this chapter is EU cohesion and thus relies only on data for the 27 EU countries. Using a stratified sampling methodology, the survey is designed to be representative at the level of the country, sector (manufacturing, construction, services and infrastructure) and firm-size class (micro, small, medium and large) [1].

EIBIS also gathers qualitative information on firms' adoption of digital technologies and their investments to tackle the impact of climate change. This chapter identifies green-digital firm profiles based on two dimensions:

- the current adoption of the state-of-the-art digital technologies;
- investments to tackle the impacts of weather events and to reduce carbon emissions.

The survey thus provides us with unique information on the adoption of digital technologies and green investments in the EU.

EIBIS data are collected in a consistent manner and with the same methodology for a large number of firms across different countries, making it possible to carry out a comparative analysis of investment activities in diverse institutional settings.

As economic convergence lies at the heart of the EU, the goal of this chapter is to compare different regions, and to analyse where their firms stand when it comes to digitalisation and investments to tackle climate change. In section 4, we also use Worldwide Patent Statistical Database (PATSTAT) data on patenting activities in the development of new green and digital technologies across different EU regions. In the following, we refer to NUTS2 regions with incomes above the EU average as 'more developed' or 'non-cohesion' regions, to those with GDP per capita between 100% and 75% as 'transition' regions, and to those with incomes below 75% as 'less developed'[2].

The patent data used in this chapter are sourced from PATSTAT, a patent statistics database held by the European Patent Office (EPO) and developed in cooperation with the World Intellectual Property Organization (WIPO), OECD and Eurostat. Since 2006, PATSTAT's raw patent data are collected from more than 100 regional and national patent offices worldwide. Amongst others, PATSTAT contains information on technological domains related to the patents[3].

1 The sector classification in EIBIS is based on the NACE classification of economic activities: manufacturing: group C; construction: group F; services: group G (wholesale and retail trade) and group I (accommodation and food services activities); infrastructure: groups D and E (utilities), group H (transportation and storage) and group J (information and communication). The firm size classes in EIBIS are: micro (5-9 employees); small (10-49 employees); medium-sized (50-249 employees); large (250 employees).

2 NUTS2 refers to the Nomenclature of Territorial Units for Statistics. NUTS2 regions are the basic regions for EU regional policies. According to regions' income classification, the availability of co-financing from EU funds differs, with poorer regions having the possibility to receive more financial support.

3 The data sourced for this chapter and the classification of technological domains were produced in collaboration with the Centre for Research and Development Monitoring (ECOOM) in Belgium.

2.1 Adoption of digital technologies

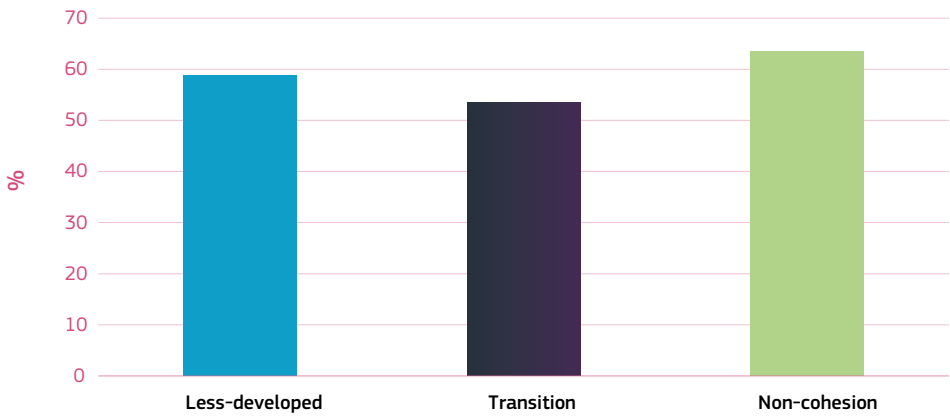
The COVID-19 crisis has led to wider recognition of the importance of digital transformation. Until recently, the implementation of advanced digital technologies was considered an important contributor to market success and usually associated with the most innovative and modern companies. The pandemic, however, has made the digital transformation an integral part of many firms' survival. Digitalisation turned out to be indispensable to prevent business disruption, organise work remotely and improve communication with customers, suppliers and employees (EIB, 2021).

Firms in non-cohesion regions tend to be more digital. In 2021, 63% of firms in non-cohesion regions implemented at least one advanced digital technology, compared to only 53% of firms in transition regions and 59% in less-developed regions (Figure 1)[4]. Significant differences in digital adoption also exist across firm size classes: large firms digitalise faster across all regions.

2.2 Investments to tackle the impacts of weather events and the process of reduction in carbon emissions

Firms in non-cohesion regions are taking clearer steps to tackle the physical and transition risks from climate change (Figure 2). Specifically, EIBIS asks firms if they have already invested or if they plan to invest in the next 3 years to tackle the impacts of weather events and to deal with the process reducing

Figure 13-1: Adoption of digital technologies (% of firms), by cohesion region



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021), firms in EU-27

Note: The figure is based on a survey asking firms to answer questions on the use of four different digital technologies in their business. A firm is identified as digital if at least one advanced digital technology was implemented in parts of the business. The state-of-the-art digital technologies considered are different across sectors. Firms in manufacturing are asked about the use of: (a) 3D printing; (b) advanced robotics; (c) internet of things (IoT); (d) big data analytics and artificial intelligence (AI). Firms in construction: (a) 3D printing; (b) drones; (c) IoT; (d) virtual reality. Firms in services: (a) virtual reality; (b) platforms; (c) IoT; (d) AI. Firms in infrastructure: (a) 3D printing; (b) platforms; (c) IoT; (d) AI.

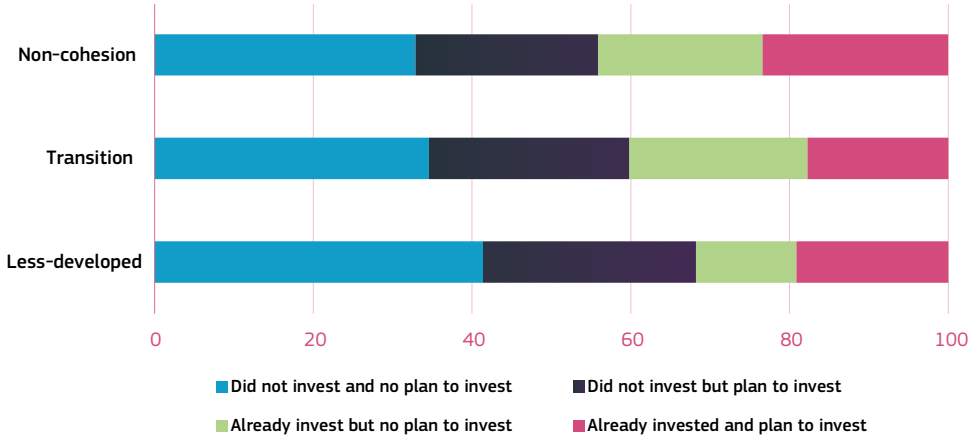
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-1.xlsx

4 All figures relying on EIBIS data are weighted using value added to make the sample of firms representative of the economy.

carbon emissions. 44% of firms in non-cohesion regions have already invested in green measures, compared to 40% in transition regions and 32% in less-developed regions. Less-developed regions have the highest share of firms that neither invested nor plan to invest to tackle the impacts of climate change.

At the same time, firms in less-developed regions are more likely to report that climate change currently has a major impact on their business than firms in the other regions. Firms in transition regions are more likely to assert that climate change has a minor impact, and firms in non-cohesion regions are more likely to say that climate change has no impact at all (Figure 3). Climate change and the related changes in weather patterns include, for example, higher temperatures, more rainfall or extreme climate events, such as such as droughts, flooding, wildfires or storms. Overall, most firms consider that this currently has an impact on their business.

Figure 13-2: Climate investment behaviour (% of firms) by cohesion region



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Source: EIB Investment Survey (EIBIS, 2021), firms in EU-27
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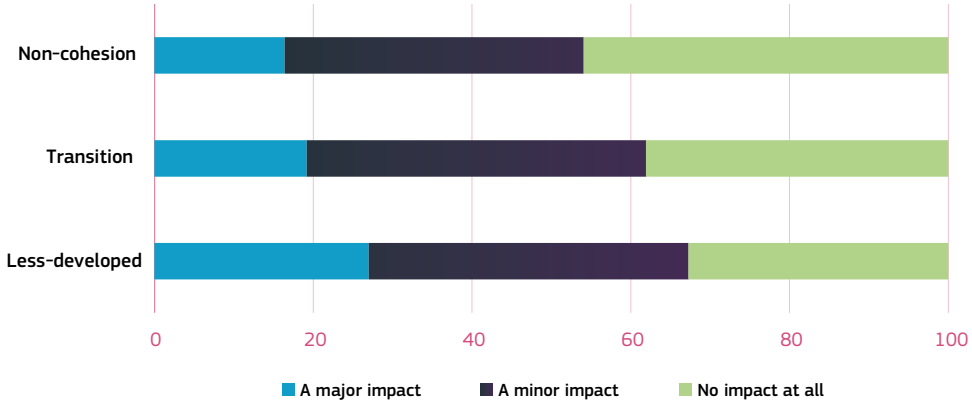
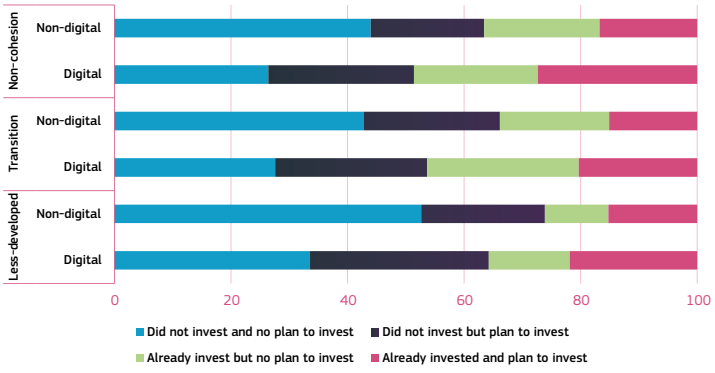
Figure 13-3: Current impact of climate change on business (% of firms) by cohesion region



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021), firms in the EU-27
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-3.xlsx

Figure 13-4: Climate investment behaviour (% of firms) by digital intensity and cohesion region



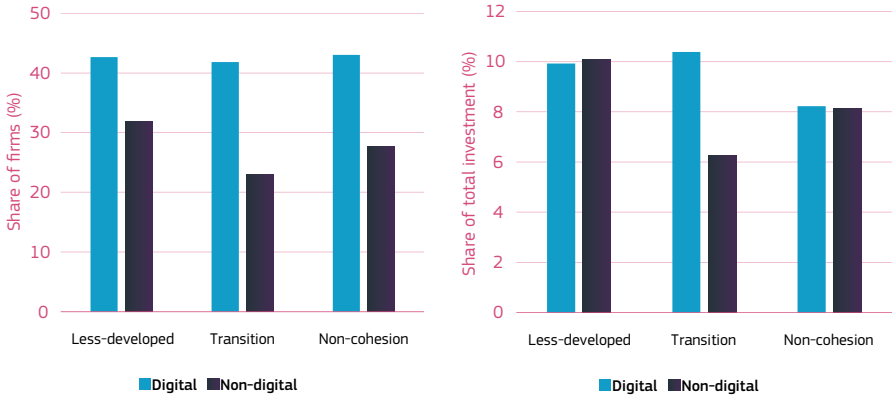
Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021), firms in the EU-27
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-4.xlsx

Digital technologies will be key enablers of the green transition under the European Green Deal that will transform the EU into a modern, resource-efficient and competitive economy (European Commission, 2019). We find that digital firms are more likely to take clear steps to tackle the physical and transition risks from climate change. In addition, digital firms are more likely to report having already invested but also having further plans to invest in green measures, a pattern that holds across all regions (Figure 4).

Furthermore, digital firms tend to invest more in measures to improve energy efficiency. However, the incidence and intensity of investment in energy efficiency are not only associated with firms' digital status but also with the region in which they are located (Figures 5a and 5b). The gap between non-digital and digital firms in energy-efficiency investment is most pronounced for firms in transition regions.

Figure 13-5: Firms investing in measures to improve energy efficiency (% of firms) and share of total investment allocated to these measures (% of total investment) by digital intensity and cohesion region



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021)
Note: A firm is identified as digital if at least one advanced digital technology was implemented in parts of the business.
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-5.xlsx

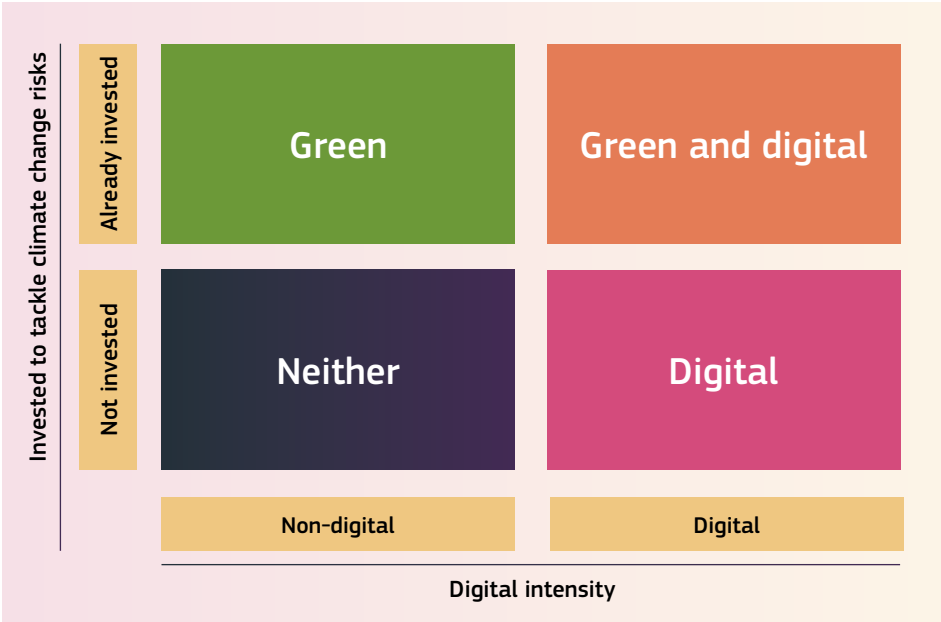
3. The green and digital corporate categories

The previous section has identified significant differences in digital and green investments across firms and regions. The next step is to understand which firms are forging ahead with digital and green adoption and which firms are falling behind. To this end, we classify firms into four profiles based on their green and digital investment activities (Figure 6).

- green and digital firms that have already invested to tackle the impacts from climate change and have implemented at least one digital technology in parts of the business (see also Figure 4);
- digital firms that have implemented at least one advanced digital technology in parts of the business but have not yet invested to tackle the impacts from climate change;
- green firms that have already invested to tackle the impacts from climate change but have not adopted advanced digital technologies;
- neither green nor digital firms that have neither invested to tackle the impacts from climate change nor adopted advanced digital technologies (listed in note to Figure 1).

The share of green and digital firms is higher in non-cohesion regions (31 %) than transition regions (25 %) and less-developed regions (21 %). In addition, the share of firms that are neither green nor digital is higher in transition and less-developed regions than in non-cohesion regions (Figure 7).

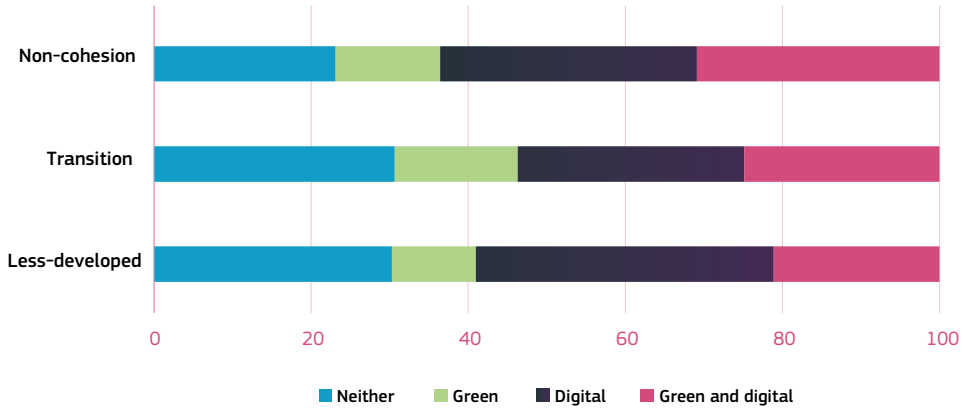
Figure 13-6: **The four green and digital corporate profiles**



Science, Research and Innovation Performance of the EU 2022

Source: authors' elaboration
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-6.xlsx

Figure 13-7: Green and digital corporate profiles (% of firms) by cohesion region

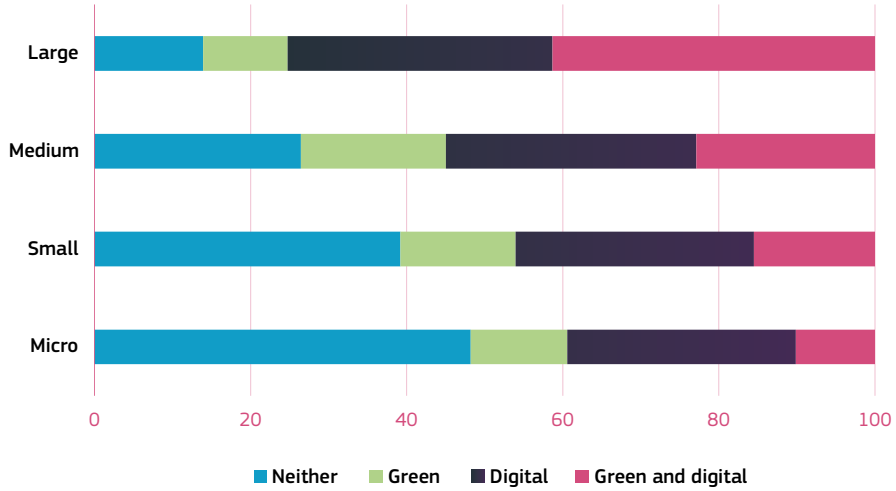


Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021)
Note: See note to Figure 6 for the definition of corporate green and digital profiles.
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-7.xlsx

Larger firms are more likely to be both digital and green than small ones (Figure 8). While only 10 % of micro firms and 16 % of small firms are green and digital, this share increases markedly for medium-sized (23 %) and large firms (41 %). Furthermore, micro firms are least likely to be both digital and green in the less developed regions. The relationship between firm size and green and digital activities can be explained by the fact that the adoption of these technologies involves high fixed costs and can be risky. Costs and risks are easier to bear if they are spread over larger revenue streams.

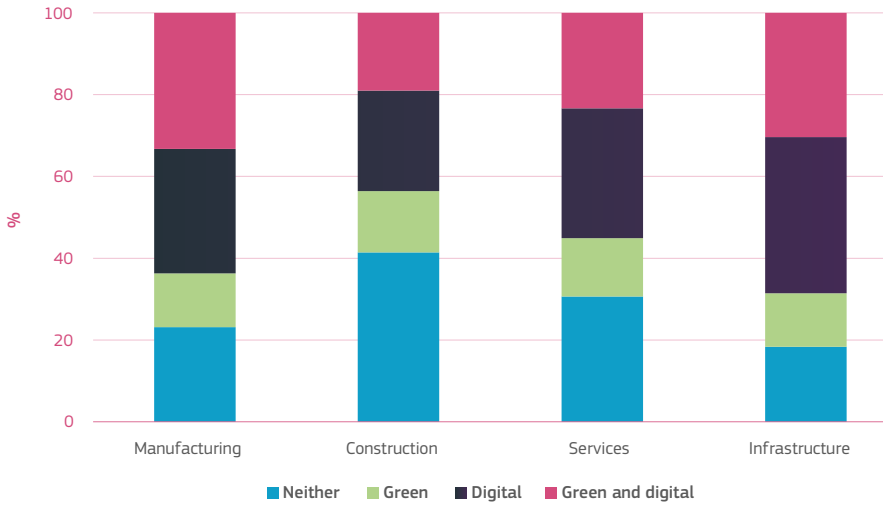
Figure 13-8: Corporate green and digital profile (% of firms) by firm size



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021)
Note: See note to Figure 6 for the definition of corporate green and digital profiles.
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-8.xlsx

Figure 13-9: Corporate green and digital profile (% of firms) by sector



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021)

Note: See note to Figure 6 for the definition of corporate green and digital profiles.

Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-9.xlsx

The manufacturing (33 %) and infrastructure (30 %) sectors have a higher share of firms that are green and digital (Figure 9). This may be partly explained by the greening of the transportation sector. At the same time, the construction sector has a particularly high share of firms that did not invest in green measures or digital technologies (41 %), followed by the service sector (31 %).

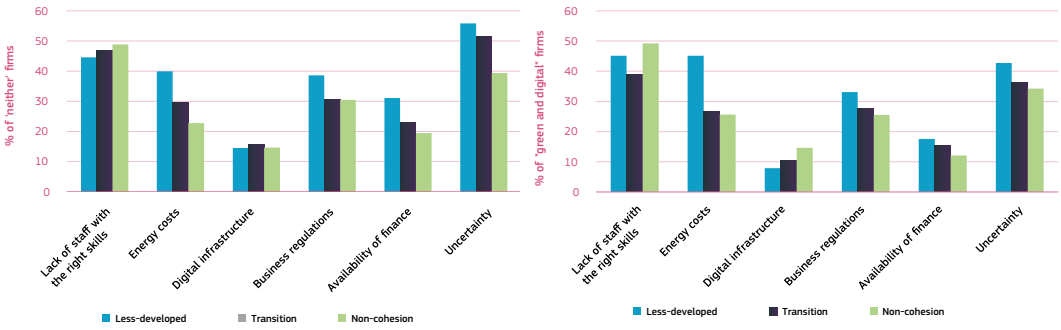
3.1 Obstacles to investment in the EU

EIBIS survey data also allow us to look at the different barriers firms perceive when thinking about investment decisions. Identifying barriers to investment activities that specifically impedes firms that are not green or digital is relevant to develop policies that will help move these firms away from their 'neither' status. Similarly, identifying the obstacles faced by firms in different regions will allow EU policymakers to accelerate investment in the green and digital transition.

The availability of staff with the right skills is the most important constraint to corporate investment in the EU, with 46 % of EU firms reporting it as major obstacle. Uncertainty about the future appears to be the most important obstacle for 'neither' firms in transition and less-developed regions. Business and labour market regulations are second-order major impediments.

When focusing on differences between different profiles, and in particular between firms that have not invested in either green or digital and firms that invested in both, we observe marked differences in the perception of major obstacles to investment. First, firms that are neither green nor digital complain more often that barriers are a major impediment (Figure 10a), compared to firms that are digital and green (Figure 10b). The difference is largest for uncertainty, where 45 % of 'neither' firms report it as a major obstacle compared to 35 % of green and digital firms. Similarly, the availability of finance is more often reported as a

Figure 13-10: Major obstacle to investment (% of firms)



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021)

Note: See note to Figure 6 for the definition of corporate green and digital profiles.

Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-10.xlsx

major impediment for firms falling in the neither category than for green and digital firms (22 % vs 13 %, respectively). Furthermore, this barrier seems to be greater in less-developed regions than in non-cohesion regions.

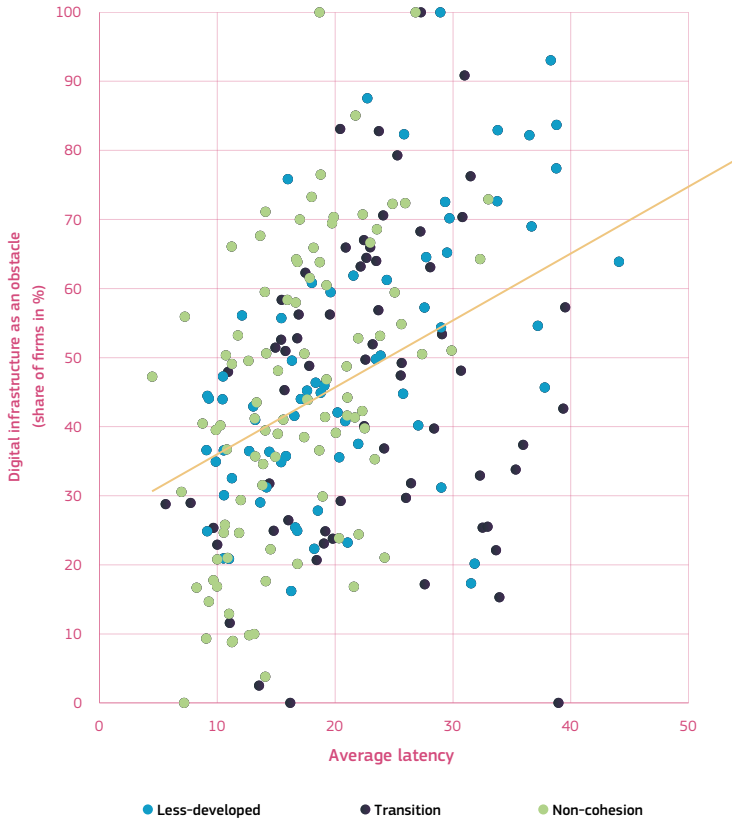
A large share of EU firms consider access to digital infrastructure as an obstacle to investment. However, the assessment varies significantly across regions. For example, firms operating in regions with low average latency (a proxy for good connection) tend to have higher rates of digital adoption (EIB, 2022). At the same time, they also have a lower share of firms complaining about digital infrastructure (Figure 11). This indicates that many EU regions have the potential to unlock investment in the digital transformation of businesses by making access to faster broadband speeds more widespread. The operating environment can have an impact on firms' decisions to become greener and more digital.

3.2 Firm performance and employment along the green digital grid

It is worrisome that a large share of European firms have not invested in the green and digital transformations as this could have long-term negative consequences for the economy. The pandemic has led to major changes in the nature and organisation of work, with implications for firm productivity, employment, wages and investment. This section explores a range of firm performance indicators along the green digital grid. For ease of exposition, we focus on firms that have not invested in either green or digital and firms that invested in both. The analysis is based on correlations and does not necessarily imply causation.

Being green and digital has clear upsides. Green and digital firms tend to be more productive across all regions in Europe

Figure 13-11: Internet quality and share of firms mentioning digital infrastructure as an obstacle (in %)



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021) and European Data Journalism Network (2021)

Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-11.xlsx

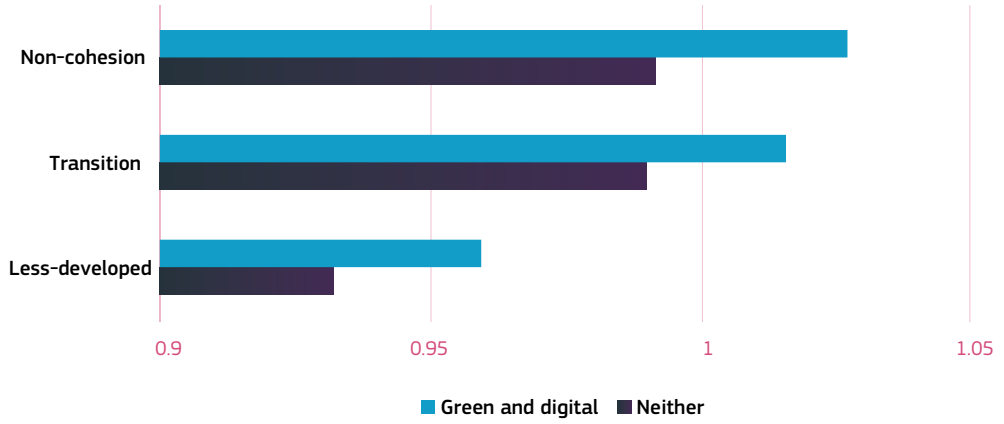
(Figure 12)[5]. The productivity premium for green and digital firms compared to 'neither' firms that do not invest in green or digital measures is significant in all regions.

As argued by many economists, digitalisation can have an impact on shifting demand for skills, leading to job polarisation (Acemoglu and Autor, 2011; EIB, 2018; Acemoglu and Restrepo, 2020). By comparing the current number of employees with the number of employees in the same firm a year ago, Figure 13 highlights that firms forging ahead with the green and digital transformation are more likely to have increased employment compared to before the pandemic[6]. At the same time, those that neither invested to tackle climate change nor to adopt advanced digital technologies were more likely to downsize.

5 All the associations discussed in this chapter – such as the association of green and digital investment with firm performance, employment, training or wages – also hold in multivariate regression analysis, controlling for potential factors that might confound the analysis, such as size, sector and region of the firms.

6 Across all profiles, about one in two firms reported that sales decreased due to COVID-19. The drop in sales has been more severe for firms that invested in neither digital nor green than for firms that invested in both digital and green. However, the association of employment growth with green and digital investment also holds in multivariate regression analysis controlling for impact of COVID-19 on firm sales, firm size, sector and region of the firms.

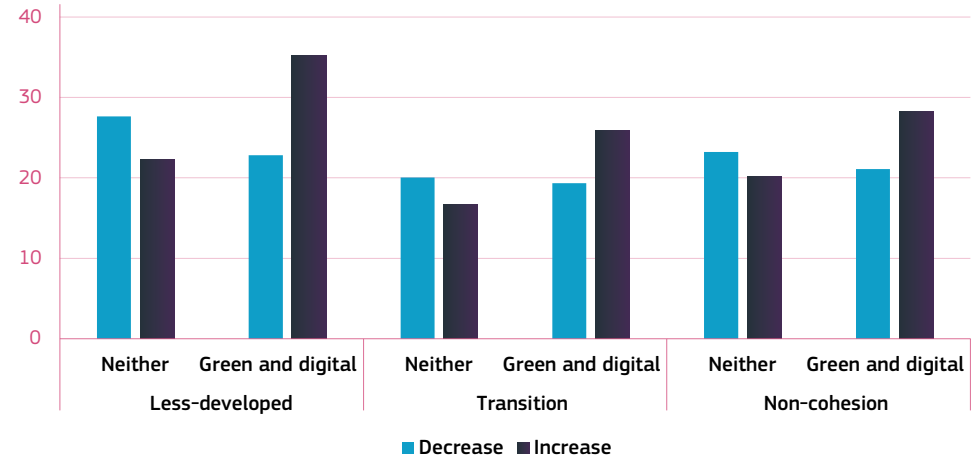
Figure 13-12: Median labour productivity (index, EU average=1) by cohesion region



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021)
Note: See note Figure 6 for the definition of corporate green and digital profiles.
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-12.xlsx

Figure 13-13: Employment growth (% of firms) by green digital profile and cohesion region



Science, Research and Innovation Performance of the EU 2022

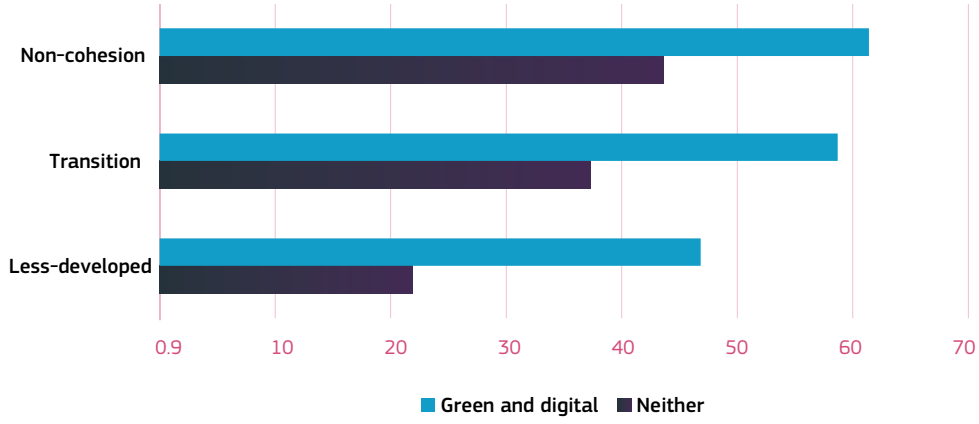
Source: EIB Investment Survey (EIBIS, 2021)
Note: See note Figure 6 for the definition of corporate green and digital profiles.
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-13.xlsx

In addition, firms undertaking structural transformation through green measures and digital technologies invest in training workers.

Presumably this is also to prepare their workforce for the future by improving their green and digital skills. The firms leading the green and digital transition invest more often in employee training compared to firms that do not invest in green or digital (Figure 14). The variation across regions may also be related to the incidence of teleworking and the ability to deliver training online, which often proved difficult, particularly for smaller firms (OECD, 2021). Furthermore, green and digital firms tend to pay higher wages on average to their employees (EIB, 2022)[7].

The digital transformation frequently goes hand in hand with the automation of routine jobs. However, this automation often comes at the expense of demand for low- and medium-skilled jobs. On the other hand, to use digital technologies, firms need to have a pool of qualified personnel with the right skills. While digitalisation can disrupt employment and tasks, the jobs created by green and digital firms often appear to be relatively well paid.

Figure 13-14: Firms investing in training (in %) by green and digital profile and cohesion region



Science, Research and Innovation Performance of the EU 2022

Source: EIB Investment Survey (EIBIS, 2021)
Note: See note Figure 6 for the definition of corporate green and digital profiles.
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-14.xlsx

7 The association of wages with digital and green investment also holds in multivariate regression analysis controlling for labour productivity, firm size, sector and region of the firms.

4. Green and digital innovation

Investments to tackle the impact of climate change and the adoption of digital technologies should also go in hand with innovation at the technological frontier. An increasing number of companies are developing new technologies in these areas as they try to seize new opportunities in the fast-changing digital and economic environment.

The development and diffusion of technologies that generate environmental benefits are, by now, acknowledged to be crucial for green growth. It is evident that the challenge of climate change cannot be tackled without technological advances, and progress must be made in a variety of sectors (Aghion et al., 2019). Investing in environmentally friendly technologies and supporting innovation in the private sector are clearly stated ambitions of the European Green Deal (European Commission, 2019).

If digital technologies are properly employed, they could play an essential role in tackling environmental challenges, for example by improving food production with precision agriculture or by reducing energy consumption. Digital technologies can also be instrumental in monitoring climate change and facilitating the much-needed shift towards a circular economy. They can foster more sustainable supply chains. The cloud, in combination with mobile data and social media, can take products or even entire industries fully online. Moreover, 3D printing creates opportunities for manufacturing goods locally, leading to quicker turnaround on product designs and development (Lacy and Rutqvist, 2015). Recent reports convincingly document that the ICT sector and its recent digital advances are contributing to growing energy consumption, but that the net benefits of the sector outweigh the costs (GeSI, 2019; IPCC, 2021).

The EU is one of the main players in new technologies developed to tackle climate change. The EU has many climate change-related patents and is far ahead of the USA and China. However, Europe's climate-change innovation is stagnating and has even been declining in recent years (Figure 15a). In China and the USA, there even seems to be a persistent negative trend in the share of patents that are dedicated to climate change. This seemingly stands in stark contrast with the strong need for the development of new technologies in this area. In a way, the share of green patents (out of all patents applied for in a given year) reflects the specialisation of an economy in the development of new green technologies.

The rate of development of green technologies not only shows a large divergence across the globe, but also within Europe. In line with firm-level investments to tackle the impacts of climate change, non-cohesion regions are leading the way for green innovation, as reflected in the number of green patents applied for (Figure 15b). Nevertheless, the picture is a little more nuanced when looking into the share of patents dedicated to green technologies across regions. While non-cohesion regions are still frontrunners, the share of green patents in transition and less-developed regions follows the non-cohesion pattern very closely. Overall, while absolute innovation levels are clearly lower in cohesion regions, the focus on green technology development is comparable. This indicates that market players realise the importance of technology development in these areas, albeit at a different scale.

The EU needs to play a more prominent role in developing new digital technologies. In terms of digital innovation activities overall, as measured by the number and share of patent applications, the EU is lagging behind the USA and China

Figure 13-15: Climate change patents, 2009 to 2019

Science, Research and Innovation Performance of the EU 2022

Source: PATSTAT data prepared in collaboration with ECOOM

Note: The dotted lines show the number of green patents (right axis); the solid lines show the percentage share of green patents in the total portfolio of domestic patents (left axis). The left panel shows Patent Cooperation Treaty (PCT) data, while the right panel shows EPO patent applications. In order to assess the performance of Europe in green innovation, we build on the methodology of Haščič and Migotto (2015) to classify the patented inventions.

Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-15.xlsx

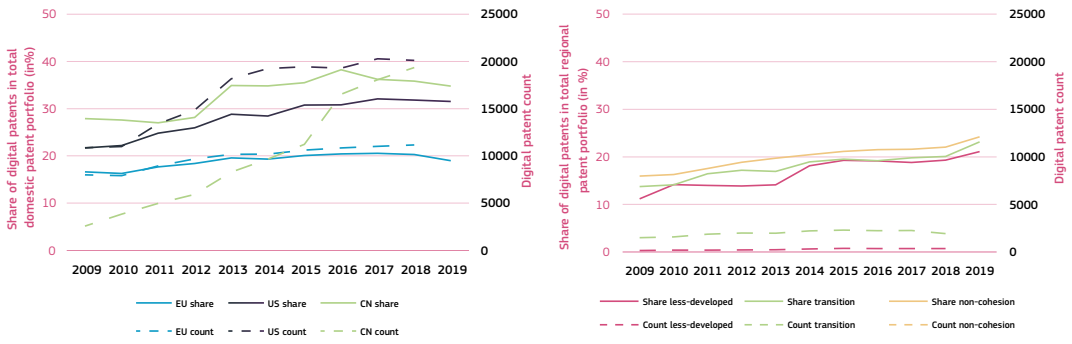
(Figure 16a). While the share of digital patents in the total patent portfolio has remained relatively stable in the EU since 2012, the US share has increased over time, widening the EU-US gap in digital innovation. In addition, over the past 15 years, China has doubled its share of digital patents, reflecting its increased focus on developing new digital technologies. This suggests that, compared to the EU, the USA and China have accelerated investments in digital innovation over the past decade.

Within the EU, digital innovation continues to be mainly driven by non-cohesion regions (Figure 16b). Nevertheless, also in the digital domain, the focus, or relative share of patenting, does not differ much across regions. Furthermore, this patent share dedicated to the development of digital technologies appears to have been increasing everywhere.

While the EU is not ahead in digital innovation overall, a different picture emerges when looking into certain subdomains where digital could play a major role. One important example is the contribution of digitalisation to the development of climate-related technologies. The EU is currently a global leader in innovation that combines digital and green applications (Figure 17a). A similar picture emerges when looking at the extent to which digital technologies are cited in green patents, showing that Europe is also more likely to adopt already existing digital technologies in its green innovations. At the same time, in recent years, patenting that combines green and digital technologies seems to have stabilised. That slow down should be a wake-up call for policymakers, as the transition will rely on green and digital innovations.

Once more, the diverse nature of the different regions is apparent in the patent data, with non-cohesion regions leading the way (Figure 17b). Not only do these regions have more patent applications, they also have a consistently higher share of patents in digital and green than the other regions.

Figure 13-16: Digital patents, 2009 to 2019



Science, Research and Innovation Performance of the EU 2022

Source: PATSTAT data prepared in collaboration with ECOOM

Note: The dotted lines show the number of digital patents (right axis); the solid lines show the percentage share of digital patents in the total portfolio of domestic patents (left axis). The left panel shows PCT data, while the right panel shows EPO patent applications. The digital patent classification used in this chapter is based on a classification of Industry 4.0, published by the European Patent Office (EPO, 2017).

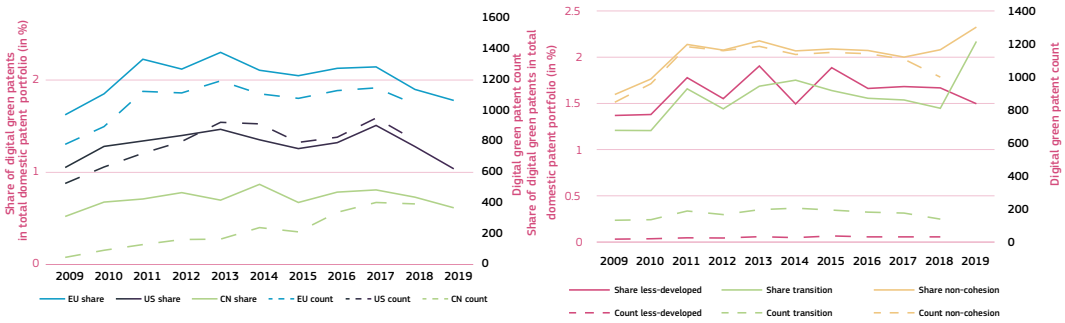
Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-16.xlsx

Europe's main strengths in green and digital technologies lay in the domains of environmental management and transportation. The EU co-develops many digital innovations within these green domains. The digitalisation of the transport sector is an integral part of the European Green Deal. Even before its announcement, the European Commission pinpointed digitalisation as a priority. In addition, while Europe is lagging behind in most sectors for digital innovation and digital adoption as shown above, the transportation sector is following a different pattern and seems to enjoy a strong head start (EIB, 2022). The EU is well ahead of the USA in Industry 4.0 patents for vehicle applications, despite trailing in many other areas.

The EU is particularly strong in innovation related to electrification and energy efficiency (EIB, 2022). Compared to the USA and China, the EU has seen the highest increase in patenting in these domains compared to other regions over the past decade. A large number of innovations are needed in these domains given that energy-intensive industries, together with the transport and mobility sector, dominated and accounted for almost half of the total emissions in 2018.

What is more, digital technologies are also intensively co-developed, with innnovations focusing on carbon capture, utilisation and storage (CCUS). While the overall development of innovations in this area is moving at a relatively slow pace, the most recent IPCC (2021) report puts this type of technology at the heart of its proposed solutions to tackle the impacts of climate change. The IEA (2021) also stresses the importance of similar technologies. Of course, technological development is still required at a much larger scale to make this technology commercially viable. Digital technologies are expected to help smooth this process.

Figure 13-17: Patents related to both climate change and digital, 2009 to 2019



Science, Research and Innovation Performance of the EU 2022

Source: PATSTAT data prepared in collaboration with ECOOM

Note: The dotted lines show the number of digital-green patents (right axis); the solid lines show the percentage share of digital-green patents in the total portfolio of domestic patents (left axis). The left panel shows PCT data, while the right panel shows EPO patent applications.

Stats.: https://ec.europa.eu/assets/rtd/srip/2022/figure-13-17.xlsx

5. Conclusion

The pandemic has accelerated the digital transformation for many EU firms, but policymakers should be concerned that the COVID-19 crisis may exacerbate a divide across firms and regions. They need to ensure that the opportunities of the transition to a greener and more digital economy can be realised across the EU and that the benefits are broadly shared. The political and regulatory environment will have to become more investment friendly to encourage transformative investments.

To help lagging regions to catch up, basic infrastructure also needs to be upgraded and to become more climate-friendly. This will require significant investment across the EU, especially in transition and less-developed regions. Finance and capacity gaps need to be narrowed in lockstep to maximise the impact of financial support for cohesion. Joint action to support cohesion together with the green and digital transition will be key to boost the resilience of the EU economy looking ahead.

The limited availability of skills also stands out as an obstacle to the firms driving the green and digital transition experience in particular – and most often in less developed regions. Similarly, there are also large differences in the level of employee training across firms. While the pandemic took its toll on training investment, firms that are green and digital were more likely to grow and to invest in their workforce. This indicates resilience but also that they are building the capacity to drive changes looking ahead.

In spite of its persistent lag in digital innovation, the EU is a leader in the development of climate related technologies. As the potential for technological advancements in these areas accelerate, the EU will be well-placed to maintain its lead for technologies at the crossroads of green and digital. But nothing should be taken for granted. European policymakers will have to do everything it takes to ensure that this dominant position is not rapidly lost. The strong position of the USA and China in the development of new technologies in most digital fields could make it difficult for Europe to remain on top in the areas in which it currently excels.

The twin digital and green transition represent a major economic opportunity for the EU. The European Green Deal and the EU's Digital Strategy are the cornerstone of the recovery plan for Europe. Combined with the national recovery and resilience plans, the initiatives present a unique opportunity to transform the EU economy and make it greener, more digital and more innovative.

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