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The Impact of the Green and Digital Transition on Regional Cohesion in Europe

Closing the prosperity gap between regions has always been a key political aspiration of the European Union – and cohesion policy is the primary means to achieve that goal. Europe is currently undergoing a digital and green transition that is drastically changing the way its economy works. How well prepared are regions to capitalise on the twin transition? What impact will it have on regional cohesion in Europe? We find that greening and digitalising the economy will likely widen the gap between rich and poor regions in the European Union.

Europe is undergoing a twin transition of digitalisation and decarbonisation that is drastically changing the way its economy works. This poses critical challenges to the EU's long-standing goal of promoting upward convergence and the treaty-enshrined objective of economic, social and territorial cohesion (Treaty on European Union and the Treaty on the Functioning of the European Union, 2016).

The required adjustments for the twin transition vary greatly between European regions. Local assets such as business clusters and availability of high-skilled labour as well as social fabric play a key role here. What is more, the economic activities that a region specialises in can indicate its potential to benefit from the opportunities offered by the twin transition. More specifically, regions highly adept at embracing digital and green solutions will strongly benefit; regions heavily reliant on agriculture must adjust differently than those dominated by knowledge-intensive services or high-tech manufacturing industries.

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The structural changes emanating from the twin transition could redraw Europe's economic landscape as we know it – and, thus, reshape economic cohesion. Regions prospering today may lose ground tomorrow, while lagging regions may leverage untapped potential and grow above expectations. Current disparities may intensify, vanish, or be complemented by new ones. Either way, policymakers must address the fresh challenges to avoid the EU drifting further apart.

Tracking the likely path of EU cohesion in more informed detail and identifying particularly vulnerable regions are key to combatting centrifugal developments. Until now, only a handful of studies look to the future – and even those focus on a few selected aspects such as the transformation challenges in former coal mining regions. There is no overarching analysis on the (likely) future of economic disparities across European regions.

The aim of our research is to close this gap. We analyse the twin transition's impact on the future economic development of European regions, shedding light on general growth potential and the readiness for the digital and green transition in NUTS 2 regions across the EU27. We provide novel evidence on how European economic prosperity and growth will be distributed in the future and, subsequently, how economic cohesion will develop. We draw up a scoring system to illustrate regions' medium-run growth potential in the digital and green transition, recognising that the results rely on several assumptions and come with a certain degree of uncertainty.

Among others, we assume that national and subnational policy responses for the twin transition will likely be synchronised and promote symmetrical outlooks for regions. At the same time, we evaluate the most likely effects of the transition upon economic convergence – both within and across regions and countries. Past developments have shown that EU cohesion was characterised by a narrow-

Figure 1

Economic prosperity and economic development in EU NUTS 2 regions
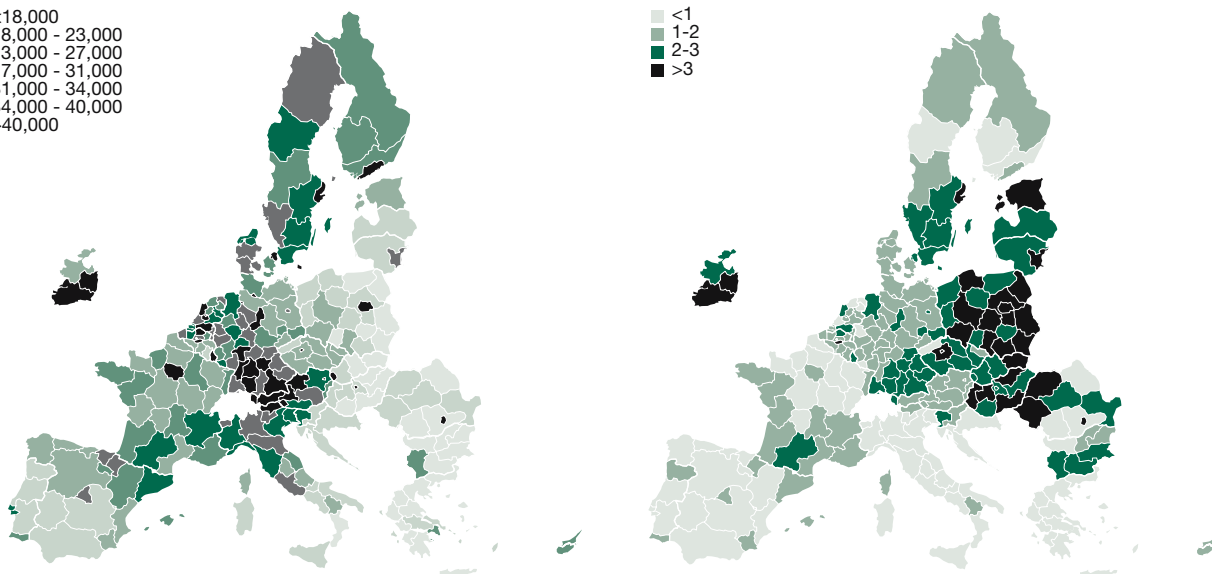
GDP per capita
2019, euros in purchasing power standards
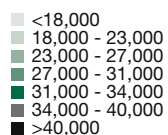
Average annual GDP growth rate
2009 - 2019, in %

Sources: wiiw and Bertelsmann Stiftung illustration based on Eurostat data and authors' calculations.

ing of disparities *across* EU countries and regions, while regional disparities *within* countries tended to increase.

We show that the EU faces the danger of rising regional disparities. While regions in eastern Europe in particular have exhibited prolonged patterns of economic growth in recent decades, their outlook is less bright. Together with southern European regions, which experienced stagnating economic development, their prospects fall below those of their counterparts in western and northern Europe. Thus, we show that the twin transition will accentuate the gap between regions with good and bad economic prospects. We find evidence that the digital and green transition will increase disparities across European regions even further, as the necessary structural changes will be more easily carried out by already highly developed regions located mostly in the European core. Periphery regions will face additional challenges to improving their position.

Economic cohesion across European regions

Status quo

European regions show substantial disparities in economic prosperity, as Figure 1 (left panel) demonstrates. The spread in purchasing power adjusted GDP per capita (2019) rang-

es from slightly over €10,000 in some Bulgarian regions to more than €78,000 in Luxembourg. While in some Bulgarian regions, economic output is only 28% of the EU27 average (€29,900 in purchasing power standards per capita), in Luxembourg, at 254% of the EU27 average, it is well above.

The regions with the lowest per capita income are located in the east of the EU, for example in eastern Poland, Slovakia and Hungary, as well as in Romania, Bulgaria and large parts of Greece. A slightly higher GDP per capita is recorded for southern Italy, Spain and Portugal (outside Lisbon), and the western parts of Poland, Slovakia and Hungary, as well as most Czech regions. Most regions in France as well as eastern Germany have medium GDP per capita levels. The highest levels are recorded for northern Italy, Austria, western Germany, the Benelux countries and Ireland. Notably, capital city regions in all EU member states stand out as the most economically advanced, thanks mainly to specialisation in knowledge-intensive services and therefore high value-added activities. Likewise, regions in western Germany and the Benelux countries known for their industrial focus exhibit high levels of GDP per capita, whereas other industrialised regions, for example in northern France, have both lower GDP per capital levels and lower growth rates.

Over the past decade, the European Union experienced a phase of strong growth in eastern regions (see the right panel of Figure 1). The major driver behind this catch-up was structural change from low value-added to higher value-added activities. The 8th Cohesion Report finds that the strong growth observed in eastern Europe was also due to returns on infrastructure investment and low-cost advantages (European Commission, 2022a). These competitive advantages are starting to disappear; these regions, therefore, need to improve their skill endowments, innovation activities and institutions.

In contrast, many of the southern European regions never fully recovered from the 2008/2009 economic and financial crisis, with low to very low economic growth rates over the past decade. The 8th Cohesion Report suggests that those regions fell into a "development trap" that can only be exited with strong public sector reforms, skills upgrading and enhanced innovation potential (European Commission, 2022a).

Potential for economic growth

To determine the economic potential for European regions, we assess five key growth factors – human capital (Becker et al., 2013), institutional quality (Charron et al., 2012), infrastructure (Elburz et al., 2017; Fujita and Thisse, 1996), investment and innovation (Crescenzi and Rod-ríguez-Pose, 2011).

For each region, a joint score based on the corresponding values for each of the five key factors is calculated (Bertelsmann Stiftung, 2022). The regions are grouped by their growth potential within four categories, with pink indicating the regions with the worst potential for economic growth and green being those with the best growth potential. Regions marked in light pink and light green exhibit medium-low and medium-high potential, respectively (see the left panel of Figure 2).

Regions more likely to follow an underlying upward development trend correspond to densely populated metropolitan regions in Europe. Those more likely to face difficulties are located in southern Europe, in particular southern Spain, southern Italy and Greece, as well as at the EU's eastern external borders. In western Europe, regions with medium-high and high growth potential are mostly located next to each other, pointing to potential spillover effects.

Regions specialising in knowledge-intensive services are best placed to experience future growth, *ceteris paribus*. These are often large metropolitan regions, which tend to have the highest innovation potential along with a high-skilled labour force, adequate investments, and high levels of firm dynamics. Moreover, regions specialising in high-tech intensive manufacturing tend to have a better potential for economic growth than other regions (except knowledge-intensive services regions).

By contrast, regions specialising in low-tech intensive manufacturing industries have a comparatively lower growth potential. Agricultural regions have the lowest potential for growth. They are mostly distant from markets, and they lack important agglomeration economies, particularly relevant for innovation activities or participation in (global) value chains. Their overall labour force skills are also lower.

Implications for future cohesion across European regions

Regions which show both high current GDP per capita levels and high growth potentials are pulling ahead, whereas regions with low GDP per capita levels and low potential for economic growth will fall even further behind (see the right panel of Figure 2).

Regions in Greece, southern Italy, Spain and Portugal that exhibited weak economic development in the past are among those with low growth potential. The combination of these factors will increase the spread between them and highly prosperous regions in southern Germany and northern Italy. The result will likely be increasing regional disparities in the medium to long run.

The suggested slowdown of growth in eastern European regions is particularly worrisome. Those that have experienced a prolonged phase of high economic growth now show low potential. This may be a first sign that many of these regions could fall into a development trap, where they remain stuck at income levels below the EU average and lag further behind. This points to a future slowdown or even halt in convergence.

Our findings also point to increasing disparities within countries, in particular in Spain and Italy. The traditional gap in Italy between the lower-income Mezzogiorno and the high-income northern regions such as Lombardy or Emilia-Romagna is likely to grow further. Similarly in Spain, the southern regions of Extremadura and Andalucia are likely to fall behind, while the Basque Country or Catalonia are likely to pull ahead.

Therefore, even without the twin transition, we expect an increase in disparities, both between countries and regions as well as within countries, and, thereby, Europe may well experience a fresh phase of different speeds of economic development plus renewed divergence.

Figure 2

General growth potential for EU NUTS 2 regions and regions falling behind and pulling ahead in economic prosperity
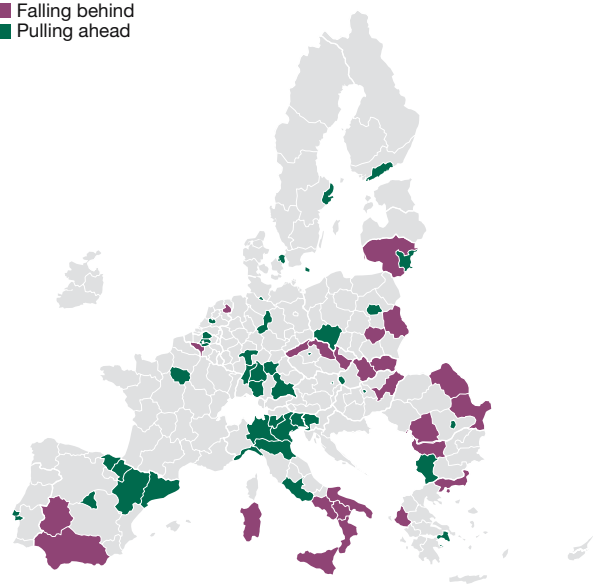
Potential for general economic growth

- Low potential
- Medium-low potential
- Medium-high potential
- High potential
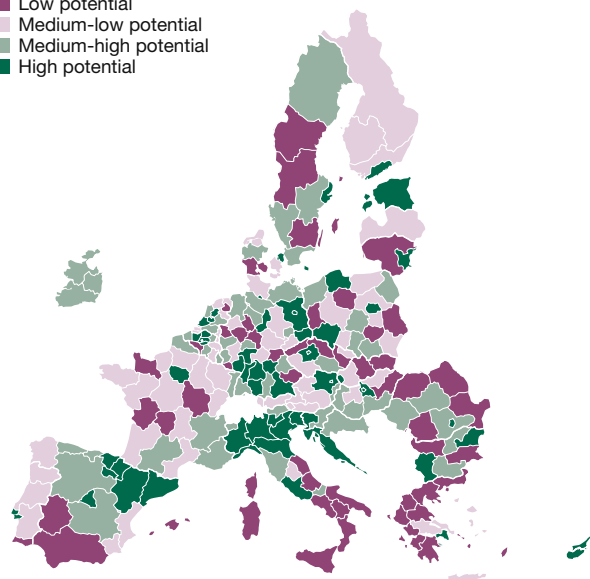
Regions falling behind and pulling ahead

- Falling behind
- Pulling ahead

Notes: The left panel shows the joint score of the five key factors for economic growth (high-skilled employment, institutional quality, infrastructure, investment and innovation), with regions grouped into four categories according to their growth potential (see Bertelsmann Stiftung, 2022 for details on the scoring procedure). The right panel shows regions that are likely to fall behind or pull ahead in their economic development, which is determined by their correlation of general growth potential and current levels of GDP per capita.

Sources: wiiw and Bertelsmann Stiftung illustration based on Eurostat data and authors' calculations.

How the twin transition reshapes European regional economies

Digital transition: New opportunities for regions with skilled labour and infrastructure

Digitalisation is expected to create economic benefits via more efficient and productive ways to generate value added across economic sectors, thereby stimulating growth and job creation.

The EU has set concrete targets for the digital transformation of companies (European Commission, 2021a, 2021b). By 2030:

- at least 75% of enterprises in the EU should have adopted cloud computing services, mass data processing (big data) or artificial intelligence (AI);

- more than 90% of small and medium-sized enterprises (SMEs) should achieve at least basic digital intensity

(adoption of digital technologies like websites, e-commerce, cloud computing, big data or internet access for employees);

- the EU should achieve a doubling of "unicorns"– start-up companies valued at or over US $1 billion – through the expansion of innovative scale-ups in the pipeline and improved access to finance.

The digital transition should transform current business models by introducing ground-breaking technologies and processes such as AI, data analytics, robotics and the Internet of Things (European Commission, 2022b). Equally, digitalisation comes with new skills requirements and calls for policies that strengthen foundation skills, promote lifelong learning and reinforce the link between education, training and the world of work (Morandini et al., 2020).

Critically, the digital transition requires wide-ranging connectivity for people and businesses to access fast and reliable internet, supported by appropriate infrastructure. Here, the EU displays serious disparities: while more than

90% of households have fixed broadband connections in the Netherlands, Cyprus and Luxembourg, less than two-thirds are connected in Finland, Bulgaria, Latvia, Italy and Romania. The picture is more homogenous for businesses (European Commission, 2021c).

Digitalisation can increase productivity, create new employment and improve society's well-being by opening up new ways of working, learning, interacting and accessing public services such as healthcare. But it has stronger economic effects in more developed regions, as less developed ones are more digitally constrained due to the concurrent requirement to switch from labour-intensive to more capital-intensive technologies. There, digitalisation should be accompanied by an upskilling of the labour force (to avoid labour market supply and demand mismatches), considerable investment in ICT infrastructure, and high-quality governance and policymaking.

Digitalisation prompts sectors to introduce more complex production methods, which may go hand in hand with a higher demand for high-skilled workers or the substitution of labour by machines. A recent study conducted for the European Commission reveals that "without proactive convergence measures, the effects of digital innovation would likely be distributed unevenly between member states, due to their industries' varying readiness to adopt disruptive technologies, and to supply it domestically" (European Commission, 2020a).

Digitalisation means a potentially higher enterprise churn rate because innovative new companies enter the market as others drop out. Similarly, "old" jobs are lost while new jobs with different qualification profiles are created. Companies and jobs may well be lost in regions different from those where new ones are created, thereby deepening disparities between EU regions and countries. The adaptability of labour markets, as well as their productivity and efficiency are thus key factors for a successful digital transition.

Green transition: Regions differ in the effort needed to achieve climate neutrality

The EU has the ambitious goal to "increase the greenhouse gas emissions reduction target for 2030 to 55 per cent" with the aim of becoming a climate-neutral economy by 2050 (European Commission, 2020b). Although emissions have been decreasing in the past decade, there is substantial variation at the national and regional levels. Some member states and regions have a long way to go to reach those 2030 and 2050 goals. The European Commission has therefore proposed a range of initiatives, laws, financial resources and other instruments under the European Green Deal that address emission reductions in all key economic sectors, including agriculture, energy, transport and industry.

In total, €600 billion from the NextGenerationEU Recovery Plan and the EU's seven-year budget (Multiannual Financial Framework) are expected to finance the delivery of the European Green Deal. Local and national policymakers will introduce more extensive measures to reduce emissions and end reliance on fossil fuels in the coming years. Given regional differences in energy and greenhouse gas intensity, sectoral specialisation, mobility patterns and housing stocks, the impacts of the green transition are expected to vary greatly.
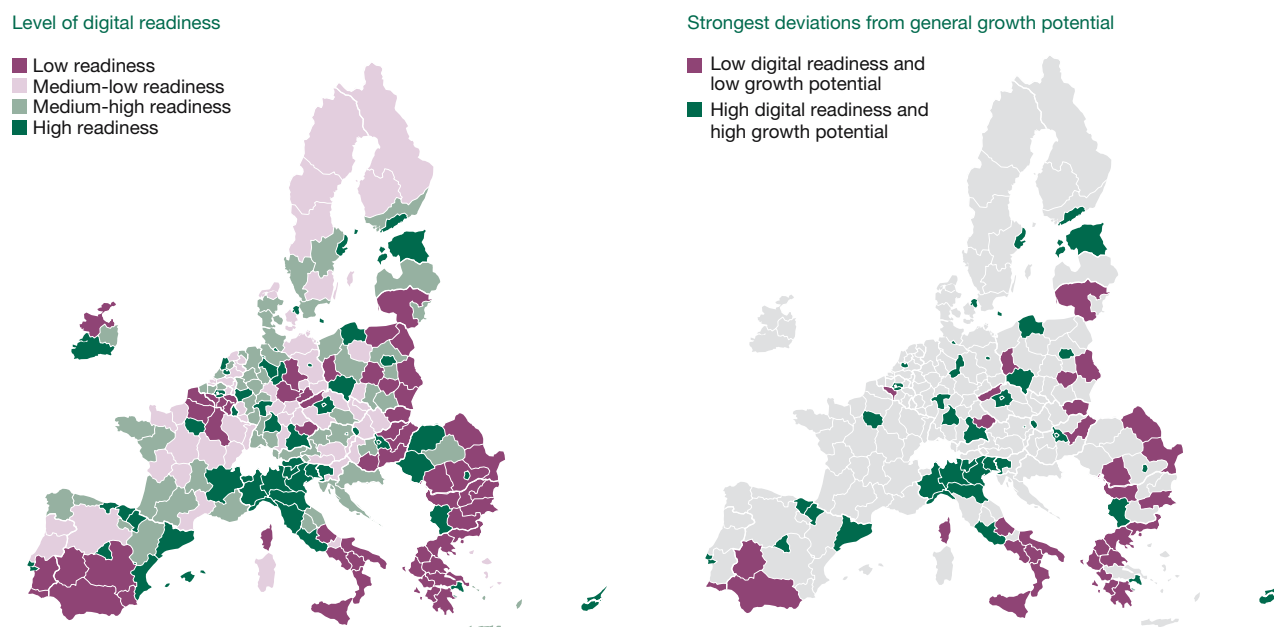
The most relevant sectors for reducing greenhouse gas emissions are energy industries, i.e. public electricity and heating plus petroleum refining. They account for 24% of all EU emissions in 2019, followed by the transport sector (22%) and buildings and manufacturing industries (both around 11%). Together, these four sectors emit around 70% of all EU greenhouse gases (European Commission, 2022c).

Hence, the green transition is a particular challenge for regions specialised in carbon-intensive industries such as coal mining, fossil fuel production, steel, basic chemicals (ethylene and ammonia) and cement. Those sectors will have to undergo the most dramatic changes to become carbon neutral, either through the introduction of alternative energy sources or new production technologies, or both. But a key problem for economic growth is that these changes require investment in new, greenhouse gas-reducing capital stock without necessarily a concomitant rise in potential output. Thus, these industries will incur significant costs that – should these environmental investments crowd others out – could dampen growth.

Furthermore, the green transition will disproportionately burden less developed regions when it comes to the transportation sector and increasing energy efficiency in the housing sector. First, in less developed regions these sectors are on average more energy intensive than in more developed regions. Thus, replacement and renovation requirements emerge as stricter conditions for the former. Second, their capacity to invest in greenhouse gas-reducing technologies is lower. Less developed regions may therefore need to invest a higher share of their GDP in the green transition to reach similar goals as their more developed peers. Where investment is crowded out, comparatively fewer funds will be available for other productive investments. This reduces their medium- to long-run growth potential and catch-up prospects.

Figure 3

Readiness of EU NUTS 2 regions for the digital transition leading to deviations in economic growth potential and regions with strongest deviations from general economic growth potential caused by the digital transition

Level of digital readiness

- Low readiness
- Medium-low readiness
- Medium-high readiness
- High readiness

Strongest deviations from general growth potential

- Low digital readiness and low growth potential
- High digital readiness and high growth potential

Notes: The left panel shows the joint score of the five key factors for digital readiness (labour productivity, internet access, business sophistication, life-long learning and labour market efficiency), with regions grouped into four categories according to their digital readiness (see Bertelsmann Stiftung, 2022 for details on the scoring procedure). The right panel shows regions with low (high) potential for economic growth further lowered (increased) by the digital transition in pink (green).

Sources: wiiw and Bertelsmann Stiftung illustration based on Eurostat data and authors' calculations.

Assessing the impact of the twin transition on European cohesion

We assess the readiness of regions for the digital and green transition using selected key factors. By adding up the general potential for economic growth and the levels of readiness of regions, we analyse the future landscape of economic growth and prosperity in Europe and its implications for economic cohesion.

Deviations in economic growth potential caused by the digital transition

The readiness of regions for the digital transition is assessed using five key factors that capture different dimensions of the digital transition – labour productivity, internet accessibility, business sophistication (European Commission, 2021b), lifelong learning and labour market efficiency (European Parliament Research Service and Kiss, 2017).

All five key factors are combined in a single joint digital readiness score (see Bertelsmann Stiftung, 2022 for more
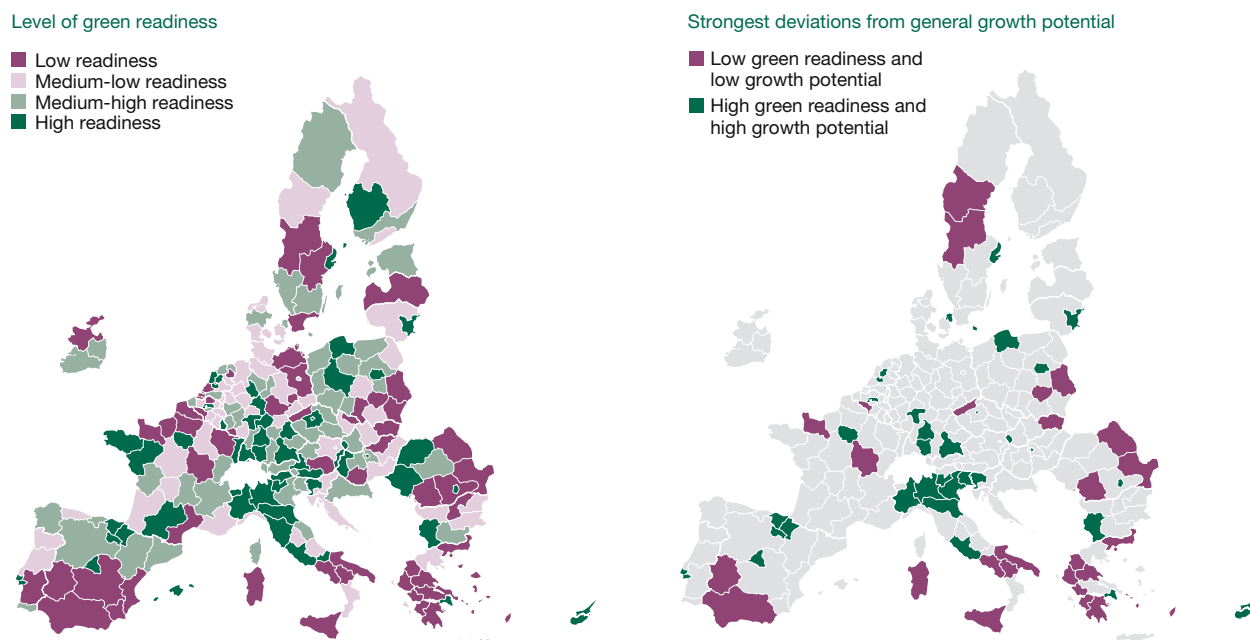
details). Regions with a high (low) level of digital readiness are expected to have a higher (lower) potential for economic growth than we assessed above. The results are shown in Figure 3.

Regions with a higher readiness for the digital transition are mostly urban and metropolitan, while those with lower readiness are located in eastern (in particular Poland, Hungary, Bulgaria and Romania) and southern Europe (in particular Spain, Italy and Greece). Regions in northern Europe are more likely to be better positioned.

Metropolitan regions that specialise in knowledge-intensive services show the highest potential to benefit from the digital transition as they tend to enjoy better technical infrastructure. They also offer more opportunities to engage in the digital economy owing to a strong business environment and highly flexible and vibrant labour markets. In contrast, industrial regions tend to benefit less as their potential for developing new digital products and services is lower. Rural regions specialised in agriculture are expected to benefit the least from digitalisation.

Figure 4

Readiness of EU NUTS 2 regions for the green transition leading to deviations in economic growth potential and regions with strongest deviations from general economic growth potential caused by the green transition

Level of green readiness

- Low readiness
- Medium-low readiness
- Medium-high readiness
- High readiness

Strongest deviations from general growth potential

- Low green readiness and low growth potential
- High green readiness and high growth potential

Notes: The left panel shows the joint score of the four key factors for green readiness (number of road vehicles, CO_2 intensity, greenhouse gas intensity and burdensome cost of housing) with regions grouped into four categories according to their green readiness (see Bertelsmann Stiftung, 2022 for details on the scoring procedure). The right panel shows regions with low (high) potential for economic growth further lowered (increased) by the green transition in pink (green).

Sources: wiiw and Bertelsmann Stiftung illustration based on Eurostat data and authors' calculations.

Regions shown in pink (green) with current low (high) economic growth potential will grow even slower (faster) due to the digital transition than other EU regions. Challenged regions are mostly located in southern Europe or in the eastern parts of Central and Eastern Europe.

Overall, the digital transition is likely to consolidate regional disparities across Europe as better prepared regions are once again those with the highest level of economic development. Regions with an already high growth potential exhibit higher levels of digital readiness and are bound to benefit. These are mainly highly urbanised and highly industrialised areas and high-tech intensive regions such as the Central Bohemian Region in Czechia, Stuttgart in Germany, Emilia-Romagna in Italy or Lower Silesia in Poland, to cite a few examples.

Deviations in economic growth potential caused by the green transition

The readiness of regions for the green transition is assessed using four key factors that capture different dimensions of

the green transition: the number of road vehicles per inhabitant (Boston Consulting Group, 2021), CO_2 intensity (CO_2 emission per unit of GDP), greenhouse gas intensity (greenhouse gas emission per unit of GDP; Alexandri et al., 2018), burdensome cost of housing or the challenge of reducing CO_2 emissions in domestic heating (Prognos et al., 2021).

All four key factors are combined in a single joint green readiness score. Regions with a high (low) level of green readiness are expected to have a higher (lower) potential for economic growth than we assessed above. The results are shown in Figure 4.

Clear disparities emerge between Europe's core around the Alpine area – where most of the regions with the highest level of readiness for the green transition are located – and the rest of the EU. Southern Spanish, Italian and Greek regions as well as those along Europe's eastern border – from Bulgaria to Latvia – are again expected to face the greatest challenges. Many regions in northern France and eastern Germany also face poorer prospects for economic growth caused by the green transition. Highly com-

petitive and innovative European regions that can develop and produce the environmentally friendly technologies needed exhibit higher levels of readiness.

Regions versed in knowledge-intensive services demonstrate the highest level of readiness for the green transition. Their advantage is twofold. First, their production is generally less CO_2 intensive, and they have a relatively high share of public transport that facilitates cuts in emissions. Second, metropolitan regions are centres of innovation, with strong prospects for growth if they help develop green technologies in high demand. Other regions, in particular those specialised in carbon-intensive industries like steel production, will face greater challenges, largely because of the need to invest in new, green production technologies or environmentally sustainable energy supplies.

Regions shown in pink (green) with already low (high) economic growth potential will grow even slower (faster) due to the green transition than other EU regions. As with the digital transition, the regions with low levels of green readiness and low growth potential are predominantly found in southern Europe but also include agricultural regions in Romania and Poland, and carbon-intensive industrial and mining regions in France, Czechia, Slovakia and Sweden. By contrast, regions with high potential for economic growth and high levels of readiness for the green transition are mostly highly urbanised areas, e.g. capital cities and other metropolitan areas. These include the Bratislava region in Slovakia, Île-de-France in France and Lombardy in Italy.

Outlook on economic cohesion in Europe

Our analysis suggests that both transitions are likely to amplify the future general trend of an increasing polarisation in regional income levels, caused by fundamental differences in the potential for economic growth. On the one hand, the already economically strong metropolitan regions as well as regions specialised in high-tech intensive manufacturing industries will benefit most from the digital transition. On the other hand, these regions exhibit equally high levels of readiness for the green transition as they have less carbon or greenhouse gas-intensive production. And they are more likely to develop green technologies than others, seeing a further boost to growth.

Therefore, we expect the twin transition to lead to greater regional disparities. Strikingly, Figure 5 shows that regions with a higher level of GDP per capita are endowed with a higher twin transition growth potential. These are predominantly found in western and northern Europe. Regions in southern Europe with already poor economic performance exhibit the lowest twin transition growth potential. However, some regions in southern Europe exhibit

Figure 5
Twin transition growth potential against current economic prosperity by geographical location
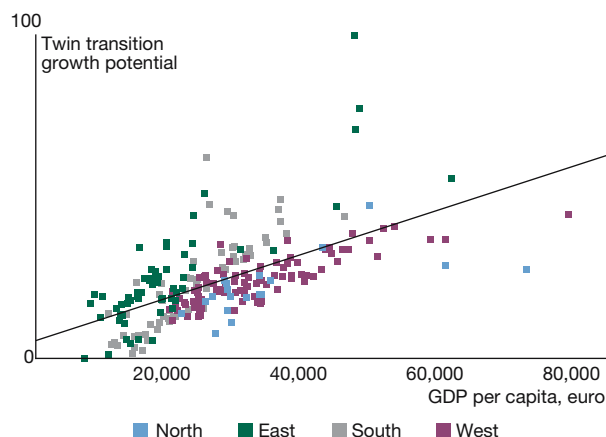
Notes: Twin transition growth potential for EU NUTS 2 regions (joint score of general growth potential, digital readiness and green readiness) against current GDP per capita (2019, measured in purchasing power standards). $R^2 = 0.6221$. The scoring procedure is described in Bertelsmann Stiftung (2022).

Source: wiiw and Bertelsmann Stiftung illustration based on authors' calculations.

a high growth potential and thus prospects for catching up. For eastern European regions, the overall picture is brighter and includes some regions with the highest twin transition growth potential in Europe.

Disparities will intensify in numerous areas in the EU with economically strong regions pulling ahead and those already struggling falling further behind. In Germany, border regions in the west and east are facing lower potential for economic growth than regions located in the north-south "spine" running all the way from Bavaria to Hamburg. In France, the economically strong regions of Paris, Rhône-Alpes and Midi-Pyrénées have the highest levels of readiness.

In Bulgaria, Poland and Romania, regions located at the EU external borders (mostly agricultural regions) display low general growth potential and low levels of readiness for the twin transition even though they enjoyed the fastest growth rates in recent years. Capital city regions as well as regions with concentrated foreign direct investment (FDI) display higher potential for economic development. In Czechia, Hungary and Slovakia, older industrial and mining areas located in the east, as well as the Czech north-western regions, have a comparatively lower level of potential for growth and readiness for the transition than the respective capital city regions and regions that received significant FDI inflows in the past.

Greek regions overwhelmingly show a low potential for economic growth in the twin transition, with some islands and the capital city of Athens being notable exceptions. Given that those regions experienced an economic recession in recent years, their development prospects are probably among the grimmest in Europe.

Summary and recommendations

Our results suggest that difficult times lie ahead for regional economic cohesion in the EU. High-income regions exhibit the highest potential for economic growth while low-income regions exhibit the lowest. The twin transition is likely to amplify this worrisome future tendency of economic divergence.

Our results have direct implications for European cohesion and cohesion policy. EU cohesion policy must overcome the economic forces that favour a growing agglomeration of high-value economic activities in urban and industrial centres if the EU wants to pursue its goal of economic, social and territorial cohesion as enshrined in the Treaty.

Tackling this challenge could mean novel approaches in economic development more tailored to the individual regions. In the case of agricultural regions for instance, they lag behind all others in general growth potential as well as digital and green readiness. Optimal policies need to address skills endowment, infrastructure, innovative capacity and other disadvantages in these regions. But the EU today follows a rather sectoral approach, for example supporting R&D, SMEs, the development of skills, green investments in different policy priorities and programmes. This makes a coordinated and integrated policy approach that addresses many development needs of the least developed regions simultaneously more difficult to enact.

Notably, if cohesion policy is to overcome the "natural" differences in specialisation in the EU Single Market, such integrated regional policies must come with massive investments. They would build up a critical mass of economic activity to counteract agglomeration pressures from incumbent European economic centres.

For other regions that specialise predominantly in low-tech manufacturing or carbon-intensive sectors, policy approaches can be more gradual, but still tailor-made to their characteristics and needs. Specific sectoral programmes, for example supporting companies and households in their green transition, might suffice to keep them on a steady path of economic development.

Overall, our analysis provides a strong pointer towards a more differentiated and targeted approach to cohesion policy, switching from using income-related criteria to determine the level of support towards criteria that consider the regions' characteristics and future growth potential, not least how they might fare in the ongoing twin transition.

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