

INVESTMENT REPORT
2021/2022



Recovery as a springboard for change

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European
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Bank

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Investment Report 2021/2022: Recovery as a springboard for change.

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About the Report

The EIB annual report on Investment and Investment Finance is a product of the EIB Economics Department. It provides a comprehensive overview of the developments and drivers of investment and its finance in the European Union. The report combines an analysis and understanding of key market trends and developments with a more in-depth thematic focus, which this year is devoted to Europe's progress towards a digital and green future in the post-COVID-19 era. The report draws extensively on the results of the annual EIB Investment Survey (EIBIS) and the EIB Municipality Survey. It complements internal EIB analysis with contributions from leading experts in the field.

About the Economics Department of the EIB

The mission of the EIB Economics Department is to provide economic analyses and studies to support the Bank in its operations and in the definition of its positioning, strategy and policy. The director of Economics Department, Debora Revoltella, heads a team of 40 economists.

Main contributors to this year's report

Report Director: Debora Revoltella

Report Coordinators and Reviewers: Pedro de Lima and Atanas Kolev

Introduction: Atanas Kolev.

Chapter 1: Andrea Brasili, Jochen Schanz (lead authors) and Alina Bobasu.

Chapter 2: Atanas Kolev (lead author), Tessa Bending, Colin Bermingham, Julie Delanote, Peter Harasztosi, Fotios Kalantzis, Peter McGoldrick, Christoph Weiss and Patricia Wruuck.

Chapter 3: Laurent Maurin (lead author), Peter Harasztosi, Rozalia Pal, Alina Bobasu and Sebastian Schich (Box B), Wouter van der Wielen (Box C), Julien Brault, Simone Signore and Wouter Torfs (Box D).

Chapter 4: Patricia Wruuck, Jochen Schanz (lead authors), Alina Bobasu, Julie Delanote and Désirée Rückert.

Chapter 5: Julie Delanote, Désirée Rückert, Christoph Weiss (lead authors), Julie Callaert (ECOOM, KU Leuven, collaboration for PATSTAT data preparation, Box B), Matteo Ferrazzi (Box C), Ana Correia, Océane Peiffer-Smadja and Julien Ravet (all European Commission, DG Research and Innovation, Box D).

Chapter 6: Fotios Kalantzis, Atanas Kolev (lead authors), Koray Alper (Box A), Emmanouil Davradakis, Julie Delanote, Sofia Dominguez, Matteo Gatti (Box B), Peter Harasztosi, Wouter Torfs and Annamaria Tueske.

Scientific advisory committee: Giorgio Barba Navaretti (Università degli Studi di Milano), Eric Bartelsman (Tinbergen Institute), Catherine L. Mann (Citi), Steven Ongena (University of Zurich), Pier Carlo Padoan, Peter Praet, Jan Svejnar (Columbia University) and Reinhilde Veugelers (KU Leuven).

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Executive summary

Less than two years after the pandemic hit Europe, EU real gross domestic product (GDP) is back to pre-crisis levels. Thanks to a rapid, large-scale and comprehensive policy response, the crisis seems to have left fewer scars than originally feared. At the microeconomic level, policy intervention prevented major disruption, but the resilience of firms and jobs to a full phasing out of support has yet to be tested, and further scarring may yet become apparent.

At the macroeconomic level, uncertainty remains about the effect of new waves of the pandemic and the eventual phasing out of emergency economic measures across Europe, as well as the design of the new policy normal. Looking forward, the risk of a recovery that is asymmetric for individuals, firms and countries remains. Meanwhile, the challenges of the climate transition and digitalisation have become more urgent than ever, and the recovery offers an opportunity to address them.

This report looks back at the impact of the pandemic on individuals, firms and countries within the European Union. It also looks forward, at how to use the recovery as a springboard for transformation. Keeping an eye on investment, it looks at the effectiveness of policy support and assesses evidence of post-pandemic scars. It examines how European firms are using the pandemic and the recovery as an opportunity to prepare themselves for a changing world. It also discusses the role of public support in ensuring a just recovery, preventing rising inequalities.

While the swift policy action implemented so far prevented an economic depression, the recovery requires further coordinated efforts across Member States. To prevent an asymmetric recovery and raise long-term growth prospects, the following priorities are key:

- Maintain the momentum on high-quality public investment, assuring the implementation and maximum impact of the **Recovery and Resilience Facility**, while avoiding abrupt fiscal adjustments that may hinder the recovery.
- Catalyse private investment through risk-sharing instruments to mitigate ongoing macroeconomic uncertainty, including a shift from generalised support for firms to targeted incentives for transformation, particularly for digitalisation and the climate transition.
- Create the conditions for an acceleration of the digital transformation of the EU economy, with supportive infrastructure, information security and data-governance, an acceleration of digitalisation in the public sector and an intensified focus on training and skills.
- Reinforce climate policy guidance and implement regulatory proposals to close the remaining gaps in the European Union's decarbonisation strategy, including plans for the energy transition and the further integration of the EU energy markets, and provide the right incentives to capitalise on EU leadership in climate-related innovation.

This time was different: A massive shock mitigated by a bold policy response

The pandemic's immediate economic impact was unprecedented

The pandemic caused the steepest drop in output in Europe's post-war history. By mid-2020, EU real GDP had fallen 14% relative to a year earlier, while the primary income of households had declined by 7.3% over the same period. Corporate turnover hit a trough in May 2020. Since then, as public health

measures have become more selective, the European economy has begun to recover. However, new waves of the virus have hit countries in different ways, making the recovery more uneven and uncertain.

Throughout Europe, real gross fixed capital formation — a measure of investment — declined substantially, but less than predicted. Moreover, it took only two years for investment to recover from the pandemic shock, compared to more than a decade after the global financial crisis. By the end of the second quarter of 2020, real investment in the European Union fell by a dizzying 14.6% relative to the fourth quarter of 2019.¹ It quickly rebounded, however, and returned to its 2019 level by the second quarter of 2021. Government investment rose steadily. Household investment (mostly in dwellings) declined, but rallied quickly, supported by government action that protected jobs and disposable income, as well as by housing price developments.

Some asymmetries in the shock and the recovery are becoming apparent. While the initial shock of the COVID-19 crisis was largely indiscriminate — all countries in the European Union were hit — the impact has now become more uneven with investment recovering at different speeds. By the second quarter of 2021, real gross fixed capital formation was above pre-pandemic levels (compared to the fourth quarter of 2019) in 20 EU members, and below the pre-crisis level in seven countries.

Sales fell dramatically at many European firms, triggering cuts to investment

Data from the European Investment Bank's Investment Survey (EIBIS) reveal the often uneven effects of the crisis on firms.¹ Some 49% of EU firms suffered a drop in sales due to the pandemic, compared to 21% that showed an increase. Low (pre-crisis) productivity proved to be a strong predictor of lost sales, and more digital firms showed slightly more resilience. Sales at small firms declined considerably (at least 25%), and more often than at medium-sized and large firms. Sharp differences emerge among sectors. Losses at firms were concentrated in areas such as transport, in addition to hotels and restaurants. Breaking the data down by country shows that the share of firms recording a sales decline ranged from less than 40% in Denmark and Sweden to 60% in Malta.

Many affected firms also delayed investment. The share of firms reporting investment activities in the previous year declined from 86% in the EIBIS 2020 survey to 79% in 2021. Faced with falling sales, 23% of firms revised down their investment plans, with only 3% expecting to invest more. The greater the loss of sales in 2020, the lower the likelihood that the firm planned to invest.

The policy response was effective, ensuring business continuity

The European Union's timely response enabled its governments to absorb most of the income lost by households because of the pandemic, and to prevent companies from going out of business. With interest rates already ultra-low, three key measures taken at the EU level enabled Member States to implement an effective response. The first was the suspension of the **Stability and Growth Pact's** deficit and debt rules, enabling coordinated national fiscal responses. The second involved grants and subsidised lending facilities offered to firms and individuals at the national level and complemented by the **SURE** job protection facility, the **European Guarantee Fund** and the **European Stability Mechanism's** crisis response. The third consisted of the European Central Bank's large-scale purchases of euro area government bonds. As a result of these purchases, sovereign funding costs remained low or even declined, despite increasing debt levels.

¹ Excluding Ireland, an outlier with a 76% fall in statistically recorded gross fixed capital formation.

Public support compensated for the loss of primary income for households and helped to sustain demand. While households' primary income declined by 7.3% in the second quarter of 2020 vs. one year earlier, their secondary income (from social security benefits and other transfers) rose on aggregate by 6.5% of gross income over the same period, largely offsetting the shortfall. Job retention schemes avoided the costs of job search and rehiring later on, while also protecting job-specific knowledge. With income stabilised and opportunities for spending reduced, households built up large savings in highly liquid assets, which supported a buoyant recovery of consumer demand as soon as lockdown measures were eased. In mid-2021, the gross saving rate was still 18% of gross disposable income in the European Union, above its pre-pandemic norm of 11-13%.

As opposed to the financial and the sovereign debt crises, financing conditions did not deteriorate for smaller firms and riskier borrowers. Fragmentation also did not increase across the European Union. Borrowing costs for small loans, a good proxy for lending to small and medium-sized enterprises (SMEs), fell to record lows in the first half of 2020, and interest rate spreads between large and small loans have remained compressed ever since. In contrast to the sovereign debt crisis, the spread has not increased between the cost of finance for firms in more vulnerable economies (where public indebtedness is higher) and firms in other economies, demonstrating that the policy response succeeded in averting the refragmentation of EU financial markets. Risk spreads also remained stable across asset classes, with the exception of the very first months of the crisis. The share of finance-constrained firms has remained low as a result (6.1% of SMEs and 3.2% of large firms, compared to 5.8% and 3.9% in 2019). However, differences among Member States persist. While the EU average for the share of finance-constrained firms was 4.7%, in Central and Eastern Europe it rose to 8.6%.

Support for firms was life-saving, and not indiscriminate. In the EU economy as a whole, some 56% of firms received some kind of policy support in the form of guaranteed credit, support for social security contributions or deferred payments. The support was tilted towards firms facing greater declines in revenue, and therefore successfully reached the firms that were in greater need. According to the more detailed add-on module to the EIBIS, up to 35% of European SMEs in manufacturing and services say they would have faced an existential threat had they not received the support they did.

Support targeted the short-term liquidity needs created by the crisis, rather than “zombie” firms that were already financially weak. Firms with low cash buffers were significantly more likely to receive policy support. However, indicators of long-standing financial weakness, such as excessive debt, low interest coverage or low returns on assets, had no significant effect on whether a firm received assistance. In fact, many schemes were designed specifically to support firms that were in sound financial health going into the pandemic, rather than firms that were already in difficulty.

Policy support weakened the link between the impact of the crisis and future investment. For firms that received policy support, the link between lost revenue and reduced investment plans was significantly weaker. Firms that received support were more likely to preserve their investment programmes and therefore accelerate their transformation.

This massive and successful government intervention came at the cost of rising public debt, which poses potential risks for the future, particularly in EU members that were already more indebted. The decline in output combined with increased current expenditure triggered a marked increase in government debt. Since 2014, EU debt had been declining thanks to fiscal consolidation, but these gains were erased in 2020-2021, and debt throughout the bloc has now surpassed 2014 levels. Although borrowing costs are not currently under pressure, high sovereign debt levels are a concern in view of the eventual reinstatement of the EU fiscal framework and the normalisation of monetary policy.

Europe's economy has avoided much scarring, but risks remain for some firms, regions and workers

Most firms have remained resilient, but pockets of vulnerability have developed

The impact of the pandemic has been uneven on firms, with strong differences across sectors. EIBIS data reveal significant differences in the share of firms recording a loss of sales, even when controlling for the varying severity of how countries have been affected. Estimating the impact of the pandemic on firms' profitability, it emerges that the crisis has affected sectors differently, with the number of firms losing money in the hotels, restaurants, arts and recreation industries almost tripling (to around 25%) compared to normal times. Transport was also strongly affected. Many other sectors only saw minor effects. In the telecommunications, food and pharmaceutical sectors, the percentage of firms reporting losses has actually fallen relative to normal times.

Size was also a determining factor, with smaller firms more likely to have suffered. Even after controlling for country and sector effects, size appears to be another factor determining whether firms lost sales during the pandemic, with small and micro firms more likely to suffer losses than large and medium-sized firms.

The share of firms at risk of default or insolvency has also increased, and this vulnerability is more concentrated in certain sectors. The share of firms estimated to be at risk of default spiked early in the pandemic and has since eased, thanks to the substantial liquidity support packages made available by national authorities and EU institutions. The share of firms estimated to be at risk of insolvency, by contrast, has climbed steadily. By mid-2021, both indicators were at levels comparable with the peaks of the global financial and sovereign debt crises. Breaking down these estimates by sector shows that this vulnerability is concentrated in the worst hit sectors.

Corporate bankruptcies have been surprisingly low, but might still rise, despite the recovery. The data suggest that the number of vulnerable firms has increased, while bankruptcy filings have declined, partly owing to debt moratoriums. A backlog of effectively insolvent firms may therefore have built up. A corresponding risk is that increases in non-performing loans might lead to a tightening of credit conditions. While there seems to be a consensus that policy intervention averted a massive crisis in asset quality, the extent to which vulnerabilities will cluster, and possibly become systemic in certain specific contexts, remains unclear.

Support helped preserve human capital, but it could not prevent a widening of social inequalities and a loss of investment in education and training

In the European Union, policy was successful at preserving jobs and preventing a significant rise in unemployment, and therefore averted the friction involved in rehiring workers during the recovery. In Europe, furlough and short-time work schemes kept workers employed, while firm bankruptcy filing obligations were relaxed, also allowing workers to remain in their jobs. By contrast, the United States relied on direct transfers and loans to support households and firms, independent of whether existing employment continued. Therefore, while the United States and European Union witnessed declines of about 15% in aggregate hours worked, the increase in unemployment was much larger in the United States. So far, Europe is enjoying a smoother course of adjustment in the labour market, largely avoiding the mismatch experienced by the United States during the recovery. However, going forward, the digital and green transition will likely demand structural changes to the economy and the reallocation of jobs among sectors. While successful, the intervention in the EU labour market might ultimately slow down this reallocation process.

Labour market conditions deteriorated for the young and those with less education. Adverse employment effects, although limited overall, were concentrated among the under-30s and those with lower levels of education. This reflects differences in the two groups' exposure to economic sectors, differences in contractual arrangements and the adverse effect the pandemic had on many young people finding jobs, particularly for the young.

In addition, school closures are likely to have accentuated social disparities, with a greater impact on children who were already at a disadvantage. Regression analysis using educational survey data suggests that factors such as parents' educational background, family wealth and immigration status are likely to have influenced the effectiveness of distance learning. Those factors influence the quality of working conditions and the learning environment at home, as well as the degree of digitalisation in the schools attended.

The share of firms investing in training fell, despite policy measures to allow employees to remain in their jobs. Although the decline was not substantial, it exacerbated existing structural weaknesses. A lack of skills is the barrier to investment most often reported by firms.

The recovery should be seized as an opportunity for retraining and improving skills, but it has not been so far. With nearly 80% of European firms reporting a scarcity of workers with the required skills as an impediment to investment, and with the digital and green transformation of the economy creating new skill and retraining needs, the acceleration of workplace training and adult education is essential. Lockdowns, teleworking and the furloughing of workers, however, made training more difficult, and elevated uncertainty deterred investment in skills. Retraining suffered from the general reduction of investment activity, particularly in small firms.

The asymmetric effects of the crisis pose risks to convergence and cohesion

The pandemic has the potential to widen economic disparities across the European Union because many of the most exposed economies also have less fiscal space to respond. Member States with a relatively high proportion of the workforce employed in personal services are particularly vulnerable to the effect of lockdowns, and they include most of the EU members whose government debt ratios stood at 100% of GDP or higher before the pandemic.

Policy intervention kept funding costs down for almost all EU members, with heavily indebted countries benefiting the most. Between the beginning and end of 2020, funding costs declined for nearly all Member States, with the more indebted countries seeing the greatest reduction in interest rate spreads. In particular, the announcements of the European Central Bank's pandemic emergency purchase programme (PEPP) and the Recovery and Resilience Facility had an immediate impact.

Nonetheless, the short-term economic effects varied strongly across the European Union, and lasting effects could set in because the worst hit countries are recovering more slowly. The importance of different industries and the varying severity of the public health measures resulted in major disparities in the decline in output, with GDP falling by 18% or more in France, Italy, Portugal and Spain by mid-2020. Moreover, the scale of the initial decline in GDP is strongly correlated with the continuing gap in GDP. GDP for these same countries was still lower in mid-2021 than in 2019.

Firms in lower-income regions are more likely to expect the pandemic to cause a lasting reduction in employment. While about 13% of firms in Europe as a whole expect a reduction, the figure rises to 19% in less developed regions. Concerns about accelerated digitalisation and automation after the COVID-19 crisis may be at play here. More firms in these regions expect to lose jobs to automation, and fewer invest in training. Spending on active labour market policies also tends to be lower in some of the countries where many low-income regions are located.

Many European firms are using the recovery as a springboard for structural change

Looking forward, the pandemic has accelerated structural shifts, and Europe's firms increasingly see a need to act on digitalisation and climate

The pandemic has accelerated structural shifts in the economy. The majority of European firms have survived the pandemic relatively unscathed so far, but they now have to adjust to new conditions, not least in the demand for their products and issues with their supply chains. Just over a quarter of EU firms believe the pandemic will have a lasting effect on their supply chains, and 23% see a future effect on the product mix they need to offer, underlining the need for innovation. Another indicator that the cyclical rebound in activity is exacerbating supply-side constraints comes from firms' views on obstacles to investment. The recovery has brought a marked uptick in firms seeing the availability of skills, energy costs and transport infrastructure as constraints, while the uncertainty has eased.

Meanwhile, digitalisation has become even more important. Some 55% of firms see a greater need for digitalisation as a long-term result of the pandemic, and the number of firms seeing digital infrastructure as a constraint to investment decisions has edged upwards to 45%.

Firms are also incorporating the need to take action on climate into their strategies. Around 58% of EU firms say they are affected by the physical risks of climate change. More do so in regions that have experienced extreme weather. EU firms are also starting to internalise the risks associated with the transition to a net-zero carbon economy. This is particularly the case in "brown" sectors (where risks are mostly seen on the downside) and in "green" sectors (where firms are more likely to perceive opportunities). Firms are likely to respond even more strongly to climate transition risks as obligations grow for them to report on emissions, and for the financial sector to report on portfolio risk exposure. Size makes a difference, with smaller firms less aware of the challenges ahead.

The pandemic has prompted many firms to accelerate their transformation

Many firms have stepped up their efforts to transform, particularly for digitalisation. Some 46% of EU firms say they have become more digital, and of the firms that do not use advanced digital technologies yet, 34% used the crisis as an opportunity to start their digitalisation journey. What is clear, however, is that firms have begun the easy part of the digitalisation process during the pandemic. The uptake of advanced digital technologies did not progress overall in 2020-2021, remaining constant at around 61% of EU firms.

European firms are also restructuring their supply chains in response to global pressures. Aggregate data already show some evidence of supply chain changes, such as enhanced diversification and the reduced geographical concentration of suppliers. EIBIS data suggest that more than 30% of exporting and manufacturing firms have been developing new products, services or processes as a response to the pandemic, and nearly 15% have taken steps to shorten supply chains.

Firms' efforts to address the climate transition picked up again in 2021, with EU leadership on climate showing signs of paying off. Although the share of firms investing to deal with climate change stalled, the share of firms planning climate-related investment has now risen from 41% to 47%, after softening in 2020. In the United States, however, only 28% of firms have already invested and only 40% are planning climate investments. The regulatory push for accountability on carbon emissions and exposure to climate risk appears to be having an impact, with 46% of EU firms adopting monitoring targets for carbon emissions

and energy consumption, a factor that is associated with investment. Firms are more likely to invest when they see the climate transition as an opportunity. By contrast, exposure to negative transition risks does not appear to be fully internalised or priced in yet.

So far so good, but risks of asymmetry are emerging

The divide between faster digitalising firms and those going more slowly seems to be growing, with an effect on jobs

EU firms have been digitalising as a response to the COVID-19 crisis, but less so than US firms. Some 46% of EU firms have responded to the pandemic by becoming more digital, vs. 58% in the United States. The share of US firms that have already adopted advanced digital technologies is also higher: 66% vs. 61% in the European Union.

In the European Union, firms that had already implemented advanced digital technologies were more likely to digitalise further as a result of the pandemic — making it even harder for slow adopters to catch up. While close to half of firms that had already implemented advanced digital technologies said they increased their digitalisation as a response to the pandemic, only a third of less digitally advanced firms said the same. In Europe, 26% of firms fall into the “neither” category. They are neither digitally advanced nor on the way to becoming more digital as a response to the pandemic. This compares unfavourably to 18% of similar firms in the United States.

Firms that are not advancing on digitalisation tend to be less transformative in many respects. The digitalisation profile of firms is strongly linked to their size, with 41% of European small and micro firms falling into the “neither” category. They are less likely to see the pandemic as a reason to develop their product portfolios, and they are less likely to plan any investment in the next three years. They also tend to be less innovative (with proportionately less investment in R&D), less productive, pay lower wages and are less likely to have created jobs since the start of 2020. These firms seem to fail to understand the need for digital transformation and innovation.

The growing digital divide poses risks for the labour market. In Europe, 33% of jobs are associated with firms that are doing nothing in the digital sphere, compared with some 20% in the United States. These “sleepwalking firms” are also likely to pay lower wages and are less likely to create new jobs. During the pandemic, they were also less likely to train their workers.

Many firms are moving slowly into the climate transition

With regard to the climate transition, firms can similarly be broken down into those that have already invested, those planning to take (further) action, and those “waiting-to-see.” The 25% of firms that do not invest, plan or set targets are more likely to be small businesses than large companies. Differences between countries are also notable. However, Europe has much fewer “wait-and-see” firms than the United States, where the figure is 45%.

Perceptions of the risks and opportunities associated with climate change and the green transition drive firms’ climate actions. Regression analysis suggests that firms’ perception and awareness of the impact of climate change and the transition on their business are the strongest determinants of investment. Firms that see such an opportunity are almost twice as likely to implement climate-related investment as those that see no impact (60% vs. 31%). The perception that the transition poses a risk is a weaker driver of investment. Overcoming information barriers seems to be important for climate investment, with firms much more likely to invest when they have dedicated climate staff, set climate-related targets or conduct energy audits.

A large share of firms in transition sectors, namely sectors that are neither “green” nor “brown,” do not expect the net-zero transition to affect their activities. Unsurprisingly, firms in “green” or “brown” sectors, which are likely to be most directly impacted by the climate transition, are more likely to see the transition as positive or negative. Firms in other sectors may be less affected overall, or might just be incapable of assessing the impact. Without efforts to assess the need for climate-related investments, many firms may find themselves drifting into a difficult situation as the climate transition accelerates. Firms in transition sectors are also less likely to have set up managerial capabilities associated with the green transition.

A lack of climate action by firms is likely to be correlated with a weak capacity to transform. “Wait-and-see” firms are less likely to be innovative or exporters, or to employ more advanced management practices. They are slightly less likely to be profitable and slightly more likely to face financial constraints. Although those correlations play a role overall, our analysis also shows that awareness and perception of climate risks, as well as information, help determine whether firms pursue climate investments.

Non-transforming firms may hinder convergence across Europe

The concentration of firms that have not taken action on digitalisation, the climate or both is uneven throughout Europe. Comparing data for cohesion regions (“less developed” and “transition” regions) and more developed regions shows that the digital and climate transitions could potentially hinder European convergence, with firms in lower-income regions being less prepared to adapt and seize the available opportunities.

Firms in lower-income countries and regions are less likely to become more digital, and less likely to innovate in response to the pandemic. Becoming more digital was one of the main ways firms reacted to the pandemic, but this response was weaker in less developed and transition regions. Similar evidence exists for innovation.

Firms in lower-income regions are lagging behind in green innovation and are less optimistic about taking advantage of the opportunities offered by the climate transition. The registration of green patents has so far been dominated by firms in Western and Northern Europe. At the same time, firms in cohesion regions with less capacity to tackle climate change (measured as the employment of dedicated climate staff, use of climate targets and energy audits) and greater scepticism about transition opportunities are more likely to view the climate transition as a risk.

Firms that invested in climate and digitalisation are more likely to see the low availability of skills as an obstacle to investment, and were more likely to increase investment in training during the pandemic. Although the low availability of skills is often reported as an obstacle by all types of firms, it seems to be innovative, digital and climate-focused firms that encounter this obstacle most. Again, firms’ perceptions seem to drive transformative investment. The share of green and digital firms (firms that invested in climate and digitalisation) that also invested in training increased during the pandemic by 9 percentage points while the share of non-green, non-digital firms investing in training fell by 12 percentage points. Seeing opportunities in the climate transition and expecting the pandemic to lead to the increased use of digital technologies is also correlated with more frequent investment in training.

Transformative action by firms has already affected regional employment during the pandemic. Firms that invested in climate and digitalisation tended to increase employment, on balance, during the pandemic, while those that did not invest in climate and digitalisation were more likely to see a loss of jobs. This effect holds true for all regional groups.

Going forward, Europe needs to maintain and expand the momentum for transformation

Europe's policy response has lifted expectations and supported the recovery

With the recovery faster than initially expected, and market conditions easing, European firms expect to increase investment this year. By the second quarter of 2021, real investment across most EU members had returned to the pre-pandemic levels of 2019. On balance, firms are also optimistic about investment conditions in the coming year, with EIBIS sentiment indicators for the economic climate and availability of internal finance switching back to positive as the recovery takes hold.

However, current business optimism and the recovery in investment rests partly on growth expectations underpinned by the EU policy response as well as on the willingness of EU members to act together to face the pandemic. With the pandemic far from over, macroeconomic and policy uncertainty remains high, and 73% of firms still say this is an obstacle to investment. Moreover, the withdrawal of some crisis support measures and the implementation of the post-crisis policy framework may test firms' resilience. Risks of scarring in some sectors and regions of the European economy, as well as the difficulty many firms face in adapting to structural changes, emphasise the need for a strategy to phase out the support while ensuring the recovery continues.

Managing the policy shift from emergency support measures to an environment that fosters structural transformation is essential

Continued fiscal coordination across the European Union will be critical to the recovery and the success of structural transformation. After the general escape clause of the Stability and Growth Pact² was invoked, Member States were able to adopt measures to limit the immediate impact of the pandemic. However, simply deactivating the general escape clause and reinstating the pact as it stands would require fiscal adjustments that are barely feasible. These adjustments could also jeopardise the recovery and weigh on public investment in climate adaptation and mitigation, and in digitalisation. This is particularly true for the Member States more affected by the pandemic and whose debt ratios increased more significantly.

The successful implementation of the Recovery and Resilience Facility will help to protect high-quality public investment in the coming years, providing critical support for the structural transformation of the EU economy while limiting the impact on public debt. The facility stands out among the European Union's support programmes for its size and for its ambition to target structurally needed investments. It requests that Member States allocate at least 37% of their investments to green and 20% to digital domains.

The facility could have a significant impact on economic convergence across the European Union. Estimates using the Rhomolo-EIB macroeconomic model suggest that the facility is likely to result in GDP being about 2% higher in 2030, and 1.3% higher in 2040, relative to the baseline scenario. The estimated impact on GDP is highest in Southern Europe, where structural improvements are estimated to raise GDP levels by as much as 5% by 2030, with the effect falling to 2.5% by 2040. The impact is still sizeable and significant in Central and Eastern Europe. In Western and Northern Europe, the effect is likely to be slightly below 1%, and cross-border spillover effects from the rest of Europe account for half of the predicted impact.

2 For more information about the general escape clause, please see [https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI\(2020\)649351](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2020)649351)

Public investment has an essential role to play in the digital and green transitions, not least as a catalyst to accelerate private sector investment and transformation. The rollout of digital infrastructure is still well below what is needed in many regions, as the pandemic revealed. Firms were more likely to take action to become more digital during the pandemic if better quality internet access was available to facilitate the use of digital tools and new working practices. The current strains on Europe's energy system, including energy price rises, is an indicator of the urgent need to invest in both renewable energy generation and Europe-wide transmission networks during a critical decade in the climate transition.

Implementation is crucial. The design and approval of programmes has been an impressive step. Implementation capacity in individual countries is essential at this stage, with the disbursement of resources now made conditional on the effective implementation of reforms and proposed investment programmes.

The focus needs to shift to targeted, risk-sharing interventions to mitigate uncertainty, while creating a conducive environment for action

Keeping a focus on non-financial barriers to transformative investment is critical, with skills and core infrastructure proving to be key obstacles. The scarce availability of workers with the right skills is cited as a barrier to long-term investment by 79% of European firms. Infrastructure also matters. Access to digital and transport infrastructure, as well as energy costs, are all rising as constraints on investment in Europe in the current recovery.

For climate-related investment, uncertainty about the regulatory environment and taxation is a key obstacle. Firms say that setting a clear decarbonisation pathway, advice on the financial support available and technical support would help most in advancing climate-related investment.

The main barriers to investment in digital technologies are the cost of investment activities and the availability of staff with the right skills to identify and implement that investment. Firms name technical support, advice on funding and regulatory consistency across Europe as the most helpful support for digitalisation.

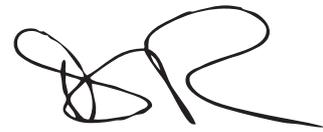
For SMEs, targeted financial support has proved effective in increasing their readiness to undertake transformative investment, including in response to the pandemic. European SMEs that received incentives for digitalisation in the last three years were almost twice as likely to invest more in digitalisation as a response to the pandemic, suggesting that such incentives help to overcome the inertia of many firms. Targeted financial support for climate investments has also been effective, but only 6-7% of firms in Southern, Central and Eastern Europe received it, compared with 16% in Western and Northern Europe. Only 5% of firms in Central and Eastern Europe received incentives for digitalisation, compared with 16-17% elsewhere.

Financial incentives should be accompanied with support for developing technical capacity at firms, municipalities and in individual countries. The implementation of the [European Fund for Strategic Investments](#) (EFSI), the European Union's recovery plan following the sovereign debt crisis, demonstrated how financial support needed to be provided in tandem with strong capacity to identify, prepare and implement high-quality projects. Generating an ample pipeline of high-quality projects is critical for ensuring that public support crowds private investment in, not out. Technical barriers and a lack of information also make it more difficult for firms to take action.

Improving skills and retraining need to be key policy targets to tackle the looming problem of reallocation in the labour market, avoiding a scenario where workers become trapped, on a large scale, in declining industries and failing firms. The risk is that many workers will remain in firms that are failing to innovate and adapt to the new normal — and that also fail to invest in training. At the same

time, the availability of skilled workers could further constrain the investment activities of transformative firms with high growth potential. Improving skills and retraining are essential policy goals to ensure a just transition in which no one is left behind.

With the recovery firmly underway, and an increasing number of firms taking action on climate change and digitalisation, policymakers can be hopeful. Uncertainty remains high, however, and is holding back many firms from taking action. The asymmetric effects of the pandemic on the European economy, moreover, have increased risks for firms, governments and workers. The pandemic offers an opportunity to accelerate change in Europe. Making the most of this opportunity is crucial.



Debora Revoltella
Director, Economics Department
European Investment Bank

Introduction

The rapid spread of the coronavirus pandemic in 2020 forced governments to take drastic measures. Lockdowns and social distancing severely impeded the production and acquisition of certain goods and services, triggering a record decline in economic activity. Cash flows at firms dried up, stoking fears of depleting liquidity and capital buffers — and ultimately of mass job losses. The resulting uncertainty affected investment plans substantially, as even cash-rich firms reduced and postponed their projects.

A swift and decisive public response averted an economic catastrophe. Monetary and fiscal authorities stepped up, as did European institutions, to provide a coordinated package of measures that kept credit flowing to businesses, while rescheduling tax and debt repayments and protecting jobs. The response also ensured that governments could finance the major expenditure required by the emergency measures.

The crisis acted as a catalyst for the digitalisation of social and economic activity and did not divert policymakers' attention from climate change. When a crisis hits, governments tend to focus on limiting damage and addressing the immediate causes, and longer-term structural issues temporarily take a backseat. But this time around, policymakers in Europe did not take climate change off their agendas. The [European Green Deal](#) and the adoption of the [European Climate Law](#) in 2021 are prime examples of how the climate has remained a firm priority. Digitalisation also got an unexpected boost. Social distancing pushed firms and individuals toward digital solutions for working and socialising. Whether this new development will provide enough impetus to accelerate the digital transition is not yet clear, and further policy efforts might be necessary. The [Recovery and Resilience Facility](#), which will provide massive EU funds for rebuilding, is a major step in the right direction.

This report takes stock of the economic recovery and analyses its implications for the digital and green transitions. It is organised into three parts. Part I provides an overview of the macroeconomic environment, governments' policy response to the crisis and recent developments in investment in the European Union. Part II examines the longer-term effects of the pandemic on European citizens, businesses and regions, showing how they could be affected in different ways. The effectiveness of governments' support for European firms is also assessed. Part III explores the challenges and opportunities that the ongoing recovery brings for the digital and green transition of European economies.

The analysis in the report relies substantially on surveys and databases developed by the European Investment Bank. The sixth wave of the EIB Investment Survey (EIBIS), conducted in the summer of 2021, provides valuable information about the impact of the coronavirus pandemic and the effect of government support on European firms. The survey's extended climate and digitalisation modules provide information — unique in its kind — on how the digital and green transitions are affecting firms' decisions. A further one-off module provides more details on the impact of COVID-19, climate change and digitalisation on European small and medium businesses. In addition, this year's report continues to make use of the information provided by the 2020 EIB Municipality Survey about infrastructure investment by EU cities and municipalities. The databases on investment in climate change mitigation and patents, developed in house, broaden our understanding of innovation, digitalisation and climate change mitigation. The European Patent Office's PATSTAT database and our specific in-house work on aggregating patent information by technical area enhances our analysis of innovation.

The opening chapter of the 2021/2022 report outlines the macroeconomic environment and governments' response to the economic crisis. It provides an overview of the effects of the pandemic on key economic indicators, such as gross domestic product (GDP) and household income, stressing the differences among countries in the European Union. The chapter examines the fiscal and monetary policy response, differentiating between national and EU policies. It stresses that well-designed fiscal policies are powerful and indispensable during economic crises. Such policies soften the impact of economic shocks on firms and households, spreading their burden more widely across the economy and staggering their effects over time. The analysis underlines the role of the European Union's joint policy response that reinforced the steps taken at the national level.

Special attention is paid to recovery measures and EU-wide fiscal coordination. As the recovery sets in, fiscal policy is shifting its focus from fighting the crisis towards supporting sustainable growth. Unlike the recovery from the global financial crisis, governments are not yet under pressure to consolidate finances, and no one is planning to introduce fiscal tightening in the immediate future. This first chapter also takes a closer look at the national recovery and resilience plans and gives an initial evaluation of their macroeconomic impact on European economies and regions. The results of our analysis argue in favour of European coordination and suggest that government investment should be protected when countries inevitably tighten their budgets. Finally, the chapter looks at how national recovery and resilience programmes are focusing on investments to deal with climate change and to support digitalisation, and it emphasises how these investments can benefit from policy coordination.

The second chapter presents an overview of recent developments in aggregate investment in the European Union. It provides the background for the economic analysis of investment decisions in the rest of the report. The chapter looks at developments in aggregate investment in different asset types, such as buildings or equipment, and institutional sectors of the economy — government, firms and households. Special attention is paid to aggregate investment in three particular areas — infrastructure, innovation and climate change mitigation.

The analysis in Chapter 2 provides comparisons with relevant peer countries. Such comparisons highlight the relative strengths and weaknesses of European investment, showing for example that the European Union's relatively good position in green innovation is counterbalanced by the widening gap with US investment in equipment and intellectual property products. Comparing investment in climate change mitigation shows that China and the United States are increasingly challenging the European Union's leadership in that area.

The second chapter also gives an overview of the latest EIBIS results regarding corporate investment. Corporate investment fell the most during the crisis and its recovery is lagging behind household and government investment. Investment trends are clarified by the information provided by the EIBIS on corporate investment, the near-term outlook and perceived structural impediments to investment. The 2021 survey results confirm that the ongoing recovery is buoying corporate investment. The results also underline that uncertainty and lost sales pose challenges to firms' investment plans in the near term. In the medium term, firms recognise the growing importance of digitalisation for their businesses.

Chapter 3 dives deeper into corporate investment, corporate finance and economic policy support for firms. It reviews EU corporate investment and financing since the beginning of the pandemic and analyses in detail the sources of corporate resilience, the economic implications of the crisis and the likely consequences for firms' decisions. The analysis provides some nuance to the observation that investment was not affected as deeply as initially feared, showing that trends differ among sectors.

As the crisis has continued, it has hit some economic activities harder — and some firms have been seriously weakened. At the beginning of the pandemic, firms relied on the cash buffers they had built up and available credit to finance working capital and cover operating costs. These resources, however, declined as the crisis progressed and profits dwindled. As policies to contain the spread of the pandemic became more selective in late 2020, certain sectors and types of firms showed greater levels of vulnerability. The impact also varied by country because the structure of EU economies changes from one Member State to the next. The negative effects on corporate balance sheets, and therefore investment, have been partially offset by cash holdings and capital positions, along with solid and lasting public support.

The analysis provided in Chapter 3 sheds more light on the relevance and effectiveness of public support for firms. Using the unique data provided by the EIBIS, the chapter shows that public support — in the form of subsidies, delayed payments or credit guarantees — were instrumental in the recovery of firms. Policy support was allocated to the firms most in need, with more support going to the firms that recorded larger sales declines. The support was broad-based and reached the majority of crisis-stricken firms, with little evidence that funds were misallocated. Furthermore, public support enhanced firms' ability to recover from the crisis. Policy intervention has weakened the link between sales and

investment, reducing the risk of weak investment in the medium term. Firms that received public support were more likely to maintain their investment plans and more likely to respond to the pandemic by increasing digitalisation.

Policy support has been impressive, shielding firms from the worst-case scenario, but certain latent pockets of corporate vulnerability may still exist. The effect of the crisis on firms has been uneven, with strong differences among sectors. Size mattered, as smaller firms were more likely to suffer. The share of firms at risk of default has also increased, but this form of vulnerability is once again concentrated in certain sectors. Corporate bankruptcies might still rise, despite the recovery. While the consensus seems to be that policy intervention averted a massive crisis, the extent to which the economy has been damaged, possibly in some systemic way, is still not clear.

The possible uneven and longer-term effects of the COVID-19 crisis extend to economic, social and geographical cohesion. The pandemic's effects were felt differently across the European Union. Chapter 4 demonstrates that the different social and regional vulnerabilities that existed before the crisis are exacerbating the uneven recovery and amplifying existing inequalities. The structural change brought about by the digital and green transitions also risks entrenching regional differences and a lack of social cohesion in the European Union.

The chapter identifies measures that can be implemented to deal with social and geographic divergence. The opportunities offered by the transition to a greener and more digital economy need to be shared throughout the European Union. Modernising infrastructure and preparing it for the green transition must be accompanied by further investment in social infrastructure, and particularly in the acquisition and enhancement of human capital. Improving the political and regulatory environment to stimulate entrepreneurship and encourage transformative investments is also key. In addition, support is needed for businesses to move up the value chain. The availability of finance and the administrative capacity of local authorities must also be improved if cohesion funds are to be used effectively.

Chapter 5 opens Part III of the report with a discussion of how the pandemic accelerated firms' digitalisation efforts. It shows that digital firms were better prepared for the coronavirus outbreak and have coped better with the disruption caused by the pandemic. They did better at maintaining and increasing sales, investing and accelerating digitalisation in response to the pandemic than non-digital peers. Digital firms are more productive, export more, invest more, are more innovative, grow faster and pay higher wages on average.

Rapid digitalisation is increasing the digital gap in the European Union. Digital firms are increasing their digital investment, while many non-digital, mostly small, firms are not addressing digitalisation. The failure of such firms to adopt digital technologies may have negative implications not only for their competitiveness, but also for productivity in the European Union. A lack of digital infrastructure is one of the main impediments to adopting digital technology, especially in less developed regions. Significant investment in digital infrastructure across the European Union can support a broad-based economic recovery and reduce barriers to digitalisation.

Detailed patent data map out recent patterns in digital innovation. While the European Union is lagging behind the United States and China in digital patents, the European Union leads in areas in which digital and green innovation meet, as well as in automotive technologies. This leadership is enabling traditional sectors, such as the automotive industry, to enter a new era. The analysis in Chapter 5 also discusses the contribution of digital technologies to the European green transition and to healthcare. To improve its performance in digital innovation, the European Union needs effective public policies that incentivise investment in the digital transformation and in solutions to address the COVID-19 crisis and the green transition.

The report concludes with an overview of the strategies developed to deal with climate change. European climate policies have evolved significantly in recent years. In parallel, substantial public funds are being directed to climate investment through the Recovery and Resiliency Facility. The changes

that such policies will bring for our society and economic activity are profound, and they will require significant adjustments to how we live and how businesses operate. Chapter 6 takes stock of existing and upcoming climate change policies, and discusses corporate and local government strategies to accommodate the effects of climate change and the green transition. The discussion is based on survey data from the climate module of the EIBIS and the EIB Municipality Survey.

EU firms' carbon strategies are an important part of the adjustment of business activity to the green transition and the challenges of climate change. An essential factor in these strategies is how firms perceive climate risks. Firms that are aware of climate and transition risks are more likely to invest in climate change measures or to plan such investment in the near future. Green management practices, such as energy audits or setting and monitoring decarbonisation targets, also play a decisive role in firms' strategies. The availability of finance, uncertainty about regulation and high investment costs also significantly influence EU firms' carbon strategies.

The transformation of the financial sector to facilitate finance for climate change projects is another important step in the green transition. The amounts invested in green bonds are growing continually every year. Yet they make up a small fraction of the funds needed for investment in climate change measures. If the overall returns on investment in climate-friendly activities are higher than on investments elsewhere — in other words, if there is a green premium — then investors will direct even more funds to these activities. While this report finds some evidence that a green premium exists, further efforts are still needed to ensure that climate-friendly investment financing is priced in line with the benefits brought to society. Those efforts include everything from creating standards for such investments, such as the **EU taxonomy** for sustainable activities, to putting a price on the greenhouse gas emissions of all economic activities.

A successful transition to a net-zero carbon economy will rely heavily on innovation. The world's carbon budget is depleting rapidly, and without radically innovative solutions the ambitious targets for reducing greenhouse gas emissions will be difficult to achieve. The European Union is leading the way in green innovation in several important sectors of the economy, as discussed in Chapter 6. Maintaining and capitalising on this leadership could bring enormous benefits for the planet and for the EU economy.

The report offers many compelling results and findings that are worth exploring. This brief introduction gives only a flavour of the range of topics discussed. It serves as a roadmap that guides readers towards the topics and analyses of specific interest to them.

Throughout the report, EU countries are often grouped into three regions with common features. Central and Eastern Europe contains the countries that have joined the European Union since 2004 and that rely substantially on EU cohesion and structural funds. Cyprus, Greece, Italy, Malta, Portugal and Spain form the Southern Europe group. The remaining EU countries are in Western and Northern Europe. Although the groups are defined by their geographic location, the countries within each group share many common structural economic characteristics, which is why the use of regions provides a meaningful basis for our economic analysis.

PART I

Taking stock of macroeconomic, policy and investment trends

Real EU GDP reached **99.9%** of the pre-crisis level by the third quarter of 2021

But **9** EU countries are still below pre-crisis levels

EU real investment returned to pre-crisis levels in **the second quarter of 2021** (excluding a one-off in Ireland), a decade after the global financial crisis

As it stands, the Growth and Stability Pact would require a primary surplus of

3% of GDP vs. **1%**

which was the 2015-2019 average for the most indebted countries

Government investment was 6.7%

above the pre-crisis level in the second quarter of 2021

Little divergence in sovereign funding costs:

max 112 basis point difference among euro area members in October 2021

By 2030, the Recovery and Resilience Facility could **raise GDP by**

5%
in Southern Europe

2.3%
in Central and Eastern Europe

0.7%
in Western and Northern Europe

Unprecedented EU fiscal effort
for the pandemic: **27%** of GDP

2/5 as public
spending

3/5 as available credit
guarantees

The pandemic spurred

57% of European
firms to
accelerate
their
transformation

A lack of skills

constrains investment
for

79% of EU firms

Uncertainty
is an obstacle
for **73%**

In the European Union,

3.5% of GDP

less was invested in
machinery and equipment
and intangibles
than in the United States

EU investment in climate
change mitigation was
stable at

1.5%
of GDP

Policy effect: in mid-2020

51% of firms
expected to cut
investment

but only

32% did so by
year end

Chapter 1

The macroeconomic context: Pandemic shock and policy response

The European Union's timely response to the pandemic enabled member governments to absorb most of the household income lost because of COVID-19 restrictions and closures, and to prevent companies from going out of business. The pandemic triggered the steepest decline in gross domestic product (GDP) in the history of the European Union. When the crisis hit the EU economy, more exposed countries had less financial headroom to address it. Three key measures at EU level created the fiscal space governments needed to fight the crisis: the suspension of the deficit and debt rules of the Stability and Growth Pact, grants and subsidised lending facilities, and the European Central Bank's (ECB's) large-scale purchases of euro area government bonds. As a result, government funding costs remained low or even declined despite the increase in debt. This enabled governments to borrow heavily to offset much of the loss in household income.

As much of the global economy started to recover, supply trailed demand and price pressures started to emerge. In the European Union, and even more so in the United States, household income was bolstered by policy support while consumer spending slumped. Households built up significant levels of savings. As the pandemic receded, consumer spending recovered while the composition of demand changed. Frictions emerged in supply chains, holding back production at some businesses. Steep increases in food and raw material prices amplified the pressure on consumer prices. How long these pressures will last — and whether repeated price shocks, even if they prove short-lived, will raise inflation over time — is being widely debated and may differ across countries. While the ECB retains its highly accommodative stance, the central banks of some EU members have begun to tighten monetary policy, ending years of ultra-low interest rates.

The pandemic provides an opportunity for the European Union and its members to coordinate policies to push green and digital advancements. The benefits of a coordinated response to the crisis created the opportunity to align not only the direction of fiscal stimuli but also the composition of fiscal spending. The result was that recovery programmes focused on investments to mitigate climate change and to support digitalisation. These coordinated efforts were strengthened by the **Recovery and Resilience Facility**, which is making €723.8 billion in EU-backed loans and grants available for reforms and investments by Member States. At the institutional level, the joint initiatives have led to a stronger role for the European Commission in coordinating and monitoring EU members' public investments, and in issuing and managing common EU debt. The recovery efforts planned in the next few years will test the durability of this coordination. The role of the public sector in the economy, the sustainability of public debt and the possible adaptation of the rules designed to ensure that EU countries pursue sound public finances will all present substantial challenges.

Introduction

As economies emerge from the pandemic, the focus of fiscal policy is shifting back from fighting the crisis to ensuring that growth is sustainable. This chapter provides an overview of macroeconomic developments, examines the fiscal policy response to the pandemic and discusses past achievements and the challenges ahead.

The European Union's timely response to the pandemic enabled member governments to absorb most of the household income lost due to COVID-19 restrictions and closures, and to prevent many corporate bankruptcies. As a result, government debt increased sharply while households built up significant savings. The release of those household savings is likely to boost economic growth as the recovery unfolds. That growth, however, risks deflating when governments begin to react to the debt accumulated during the crisis by cutting spending or increasing taxes. Less expansionary monetary policy will also curtail growth.

Maximising the catalytic impact of public investment and protecting public investment when governments begin to consider spending cuts will be key for the recovery. An essential tool to do this is the Recovery and Resilience Facility. The facility is a good example of how fiscal policies can be successfully coordinated at the EU level, by aligning fiscal stimuli and by selecting common investment priorities. Making the most of the facility requires strong implementation capacity, good strategic planning and the removal of the barriers that prevent private investment. If these conditions are met, the facility's impact on GDP could be substantial in the short and in the long term. How best to coordinate fiscal policies will remain a key topic for discussion.

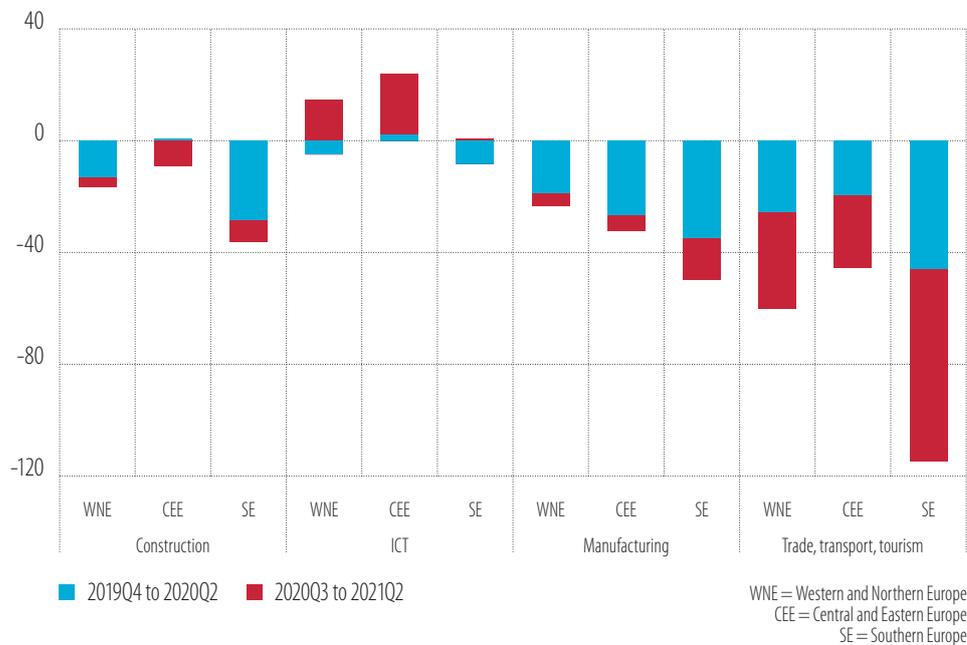
The following sections review the economic shock caused by the COVID-19 pandemic before analysing the fiscal and monetary policies adopted to combat the crisis. They discuss the main features of the economic recovery, examine EU programmes that aim to ensure sustainable growth, and assess the fiscal challenges ahead.

The pandemic shock

The pandemic triggered the steepest recession in the history of the European Union. The measures adopted to contain the spread of COVID-19 forced firms to close or to reduce working hours, thus limiting opportunities to earn and to spend. In the second quarter of 2020, EU real GDP was 14% lower relative to the same quarter in 2019, while households' primary income had declined by 7.3%.

Despite its global nature, the pandemic affected portions of the EU economy differently. Personal services were hit the most and recovered more slowly as doubts lingered about contagion risks. Manufacturing, in contrast, soon returned to pre-crisis output in many countries, benefiting from demand from world regions where the pandemic had receded. Large firms, which had easier access to finance to bridge revenue gaps, tended to be less affected than small firms. The composition of the economy matters when assessing the impact of the crisis. Southern Europe, where the share of personal services and small and medium enterprises is larger, was hit more severely, regardless of the sector (Figure 1).

Figure 1
Changes in output before and after the first pandemic wave (% change compared with the fourth quarter of 2019), by sector and region



Source: Eurostat, authors' calculations.

Note: Bars show the cumulative change in output, measured as a percentage of fourth quarter 2019 output, between the fourth quarter of 2019 and the second quarter of 2020 (blue bars) and between the third quarter of 2020 and the second quarter 2021 (red bars). In each case, the bar shows the total change in output from the fourth quarter of 2019. For example, the total decline in output in Southern Europe in trade, transport, and tourism from the fourth quarter of 2019 to the second quarter of 2021 was equal to 1.2 times the output in the fourth quarter of 2019.

Fiscal and monetary policy responses to the crisis

National fiscal policy responses

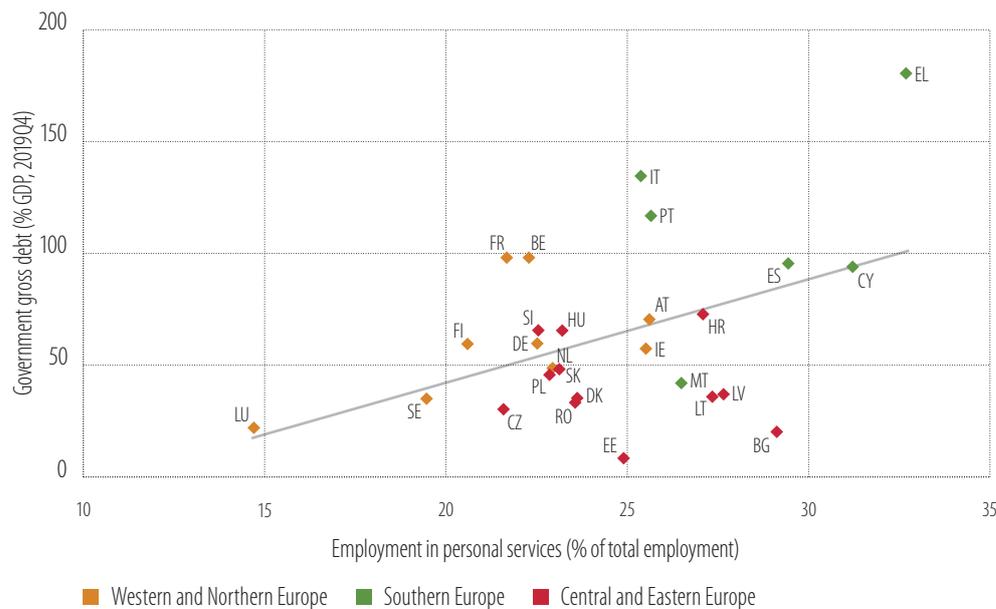
Countries that were more exposed to the pandemic also had less financial space to address the crisis (Figure 2). On the eve of the ECB's announcement of the Pandemic Emergency Purchase Programme (PEPP), the spread of Italian ten-year government bonds over their German peers had widened to 2.7 percentage points, almost twice their size three weeks earlier. Greater refinancing costs threatened to prevent highly indebted Member States from expanding fiscal policy, raising the spectre of a repeat of the 2011-2013 euro area sovereign debt crisis.

The European Union adopted three measures that brought national fiscal policy back into play. First, the European Union invoked the "general escape clause" in the Stability and Growth Pact.¹ Until the end of 2022, Member States do not have to keep budget deficits below 3% and public debt below 60% of GDP.

¹ Regulation (EC) 1466/97, Articles 5(1) and 9(1), state that, "in periods of severe economic downturn for the euro area or the Union as a whole, Member States may be allowed temporarily to depart from the adjustment path towards the medium-term budgetary objective, provided that this does not endanger fiscal sustainability in the medium term."

Second, the European Union announced fiscal support for Member States with the Support to mitigate Unemployment Risks in an Emergency (SURE) and **NextGenerationEU** packages. And third, the ECB established an additional asset purchase programme, the Pandemic Emergency Purchase Programme.

Figure 2
More exposed economies entered the pandemic with greater public debt



Source: Eurostat, authors' calculations.

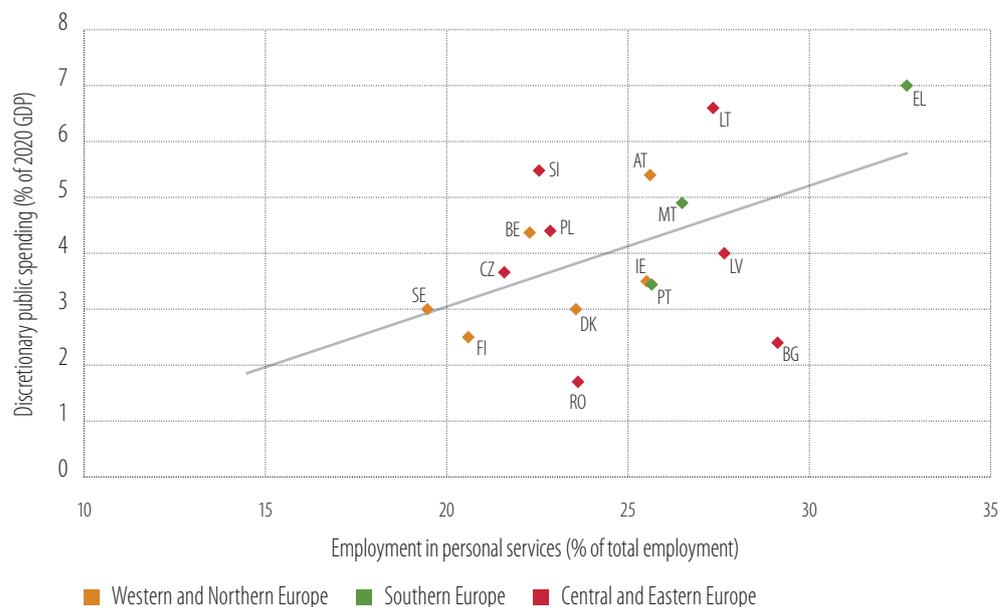
Note: Personal services are codes G to I under NACE (the EU classification system for economic activities). Colours indicate EU regions (Western and Northern in orange, Eastern in red and Southern Europe in green)

As a result of these measures, Member States that were more exposed to the pandemic were able to intervene with mandatory and top-up discretionary support measures, incurring larger primary deficits in the process (Figure 3). Despite their generally higher debt and deficits, EU members financing costs remained stable. In some cases, these costs were even substantially lower in December 2020, when many countries went through the second wave of the pandemic, than in January 2020 (Figure 4). The reverse situation happened in the 2007-2009 global financial crisis when financing costs increased in more exposed countries, ultimately leading to the euro area sovereign debt crisis.

National fiscal policy responses curbed losses in household income while protecting supply. Policy was informed by the experience of the 2007-2009 global financial crisis, when the initial shock to GDP caused long-lasting declines in employment and a jump in banks' non-performing loans. In 2020, policy boosted aggregate demand in roughly equal parts through automatic stabilisers (built-in policy features, such as unemployment benefits, that kick in during periods of economic downturn to ease its impact) and discretionary measures (deliberate government measures that change tax rates, social transfers and other government expenditure). Households' secondary income (provided by transfers such as social security benefits) rose by 6.5% in total, offsetting most of the decline in primary income.²

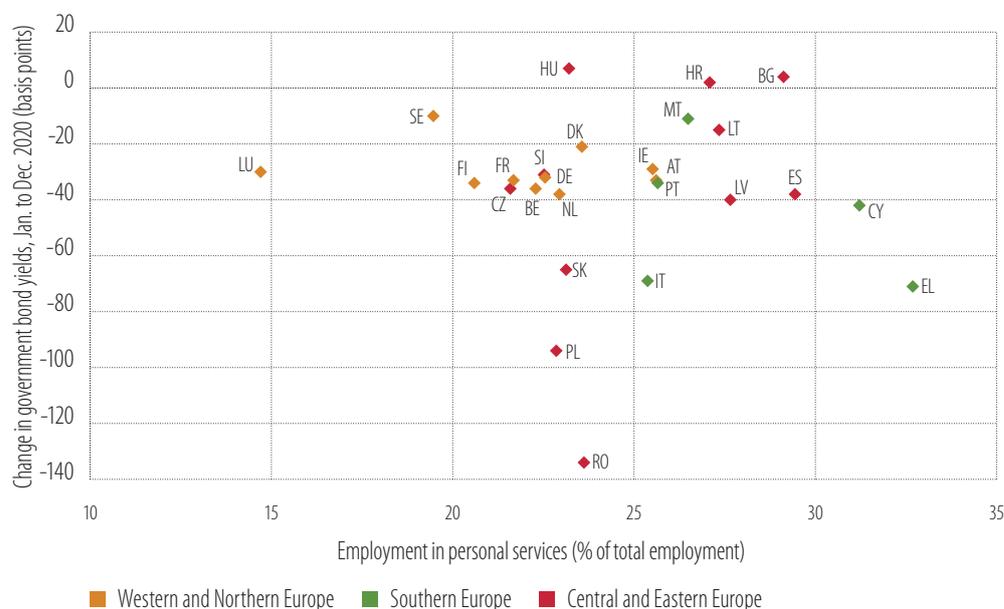
² Second quarter of 2020 relative to a year before. See Almeida et al (2021), for example, for the impact of the pandemic on households' income.

Figure 3
More exposed countries had higher discretionary spending...



Source: Eurostat, national Convergence and Stability Plans, authors' calculations.

Figure 4
... but their financing costs remained broadly stable or even declined



Source: Eurostat, ECB, authors' calculations.

Note: The graph plots the difference between the mean ten-year government bond yields in December and January 2020.

Discretionary fiscal measures aimed to ease the health crisis by subsidising employment, supporting households and providing liquidity to firms. Until June 2021, reductions in revenues and discretionary spending on health-related items made up about 1.5% of EU 2019 GDP, with non-health-related items accounting for 8.3%.³ Key non-health-related items included furlough schemes, wage subsidies, and reductions of social security payments for employees; income replacement for the self-employed; and subsidies and recapitalisation for badly affected sectors, such as transport. Governments also supported liquidity by extending deadlines for tax payments and accelerating spending by a total of 1.5% of EU 2019 GDP.

Job retention schemes avoided the costs associated with reintegrating unemployed people in the labour market and protected job-specific knowledge. But they came at a large fiscal cost. Those schemes paid a high portion of salaries for firms that kept their employees despite a decline in business activity.⁴ Although household income could have been stabilised using unemployment benefits, governments rolled out furlough schemes to protect jobs during what appeared to be a severe but short-lived economic downturn. Job retention schemes also provided additional liquidity to those firms that would otherwise have been unable to keep unoccupied staff. During April 2020, an average of 20% of jobs benefited from such schemes across the European Union. They were the key reason why unemployment in the European Union only rose gradually from 6.7% in 2019 to 7.1% in 2020, even though hours worked dropped by 15% in the second quarter of 2020 compared to the fourth quarter of 2019. Nevertheless, these schemes were costly. Germany, for example, paid EUR 61 billion (1.8% of GDP) in furlough benefits in 2020⁵, with France paying EUR 27 billion⁶ (1.1% of GDP) and Italy paying close to EUR 20 billion⁷ (1.2% of GDP) the same year.

Public credit guarantee programmes aimed to facilitate firms' access to bank loans. Demand for bank loans from firms soared as they scrambled to bridge the liquidity gaps caused by the pandemic. Firms also sought loans to build precautionary buffers or to adapt their businesses to the new environment. To help banks accommodate the surge in demand for loans under favourable conditions, most EU members introduced public guarantee schemes for bank loans (see also Chapter 3, Box B). Between the start of the pandemic and mid-2021, EU governments, in particular in the larger Member States,⁸ made available loan guarantees that were the equivalent of around 15% of 2019 GDP in aggregate. Guarantees were generally offered to banks for new lending only, and often for loans targeting small and medium enterprises.⁹ Typically, the guarantees did not cover the entire principal, but only around 80% of the amount. Leaving banks with some of the risk gave them an incentive to screen loan applications, but may also have excluded younger, riskier firms from the scheme. In the end, banks only took up a fraction of the total amount of guarantees available (about 3% of GDP in aggregate across the European Union by mid-2021).¹⁰ Even though uptake from firms was low in most EU countries, the availability of guarantees may well have helped cushion the impact of the pandemic by stabilising business confidence (see also Chapter 3, Box C).

EU fiscal policy response

The European Union introduced several fiscal policy programmes to combat the pandemic and target longer-term growth. Financial support was made available to fund pandemic-related expenditure for healthcare (via the European Stability Mechanism's Pandemic Crisis Support (PCS) programme) and furlough programmes (the European Commission's SURE scheme), and to support finance for small and

3 Authors' calculations based on International Monetary Fund (2021).

4 See Organisation for Economic Co-operation and Development (2021a) for details. In the European Union, subsidies paid for around one-half to two-thirds of wage costs for hours not worked in furlough schemes in May-June 2020, with the remainder shared to varying degrees between workers and firms.

5 <https://www.arbeitsagentur.de/presse/2021-07-haushalt-der-ba-rekordausgaben-im-jahr-2020>.

6 L'activité partielle a coûté 27 milliards d'euros en 2020, selon le ministère du Travail (lefigaro.fr)

7 Payments for the cassa integrazione COVID, Mar-Nov 2020, II-Mercato-del-lavoro-2020-1.pdf (istat.it), Table 6.1

8 IMF (2021), authors' calculations.

9 European Banking Authority (2021).

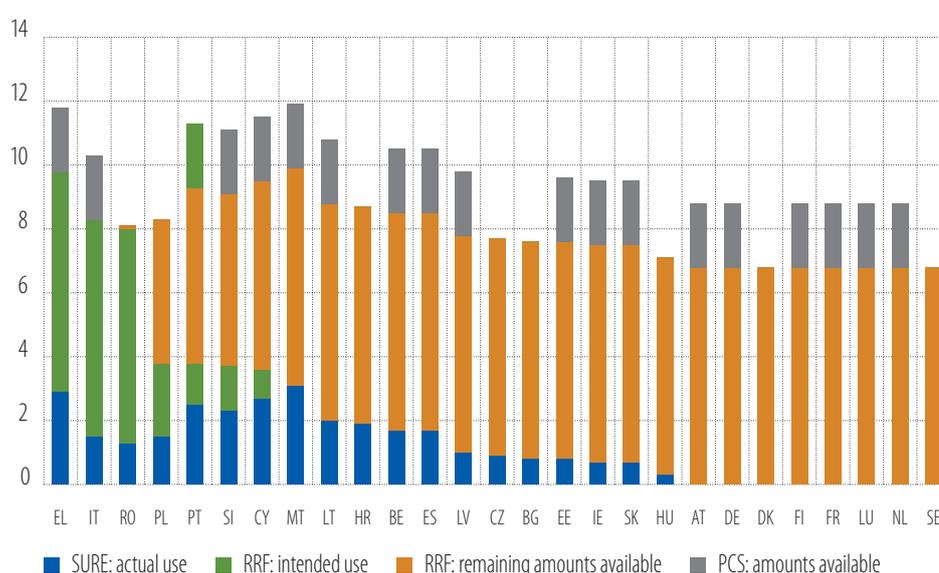
10 European Commission (2021a). Uptake was lower in Germany and higher in France, Italy, and Poland.

medium enterprises (the European Investment Bank's European Guarantee Fund). Promoting digital and green investments for longer-term growth was the focus of the European Commission's Recovery and Resilience Facility (RRF) and of the top-up for structural investment funds provided by Recovery Assistance for Cohesion and the Territories of Europe (REACT EU).

The European Union introduced loan facilities totalling 8-10% of GDP and, for some EU members, grants far in excess of that amount. SURE, the Recovery and Resilience Facility and the Pandemic Crisis Programme made loans available to each Member State that, combined, totalled about 8-10% of the member's GDP (Figure 5). Relative to GDP, Greece, Italy and Romania have made or intend to make the greatest use of these loans. With respect to grants, the Recovery and Resilience Facility adds to the substantial amounts available from the cohesion funds. For some countries in Eastern Europe, these grants add up to over 20% of their 2019 GDP (Figure 6).

Figure 5

Used and available loans for key EU programmes (% of 2019 GDP)



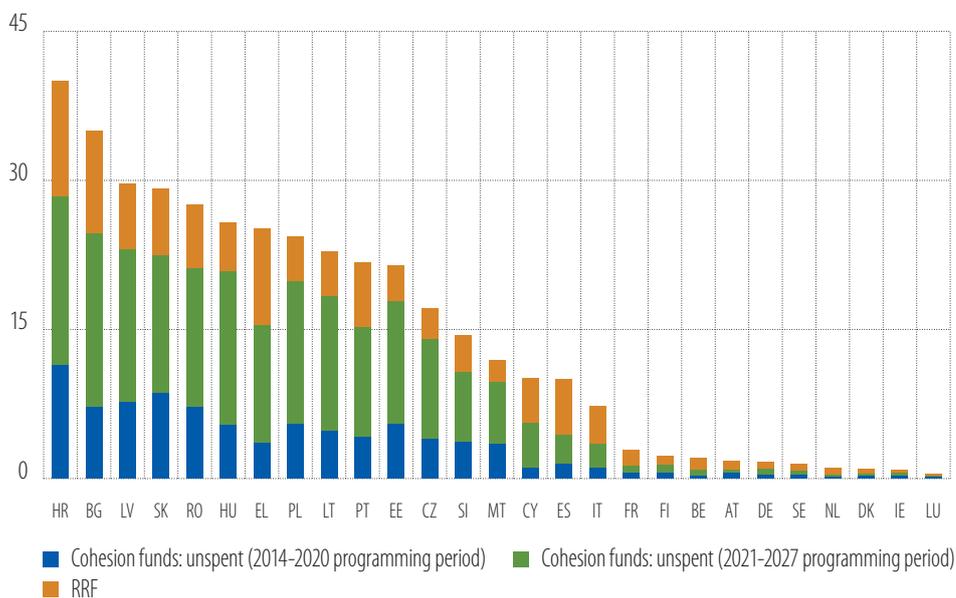
Source: European Commission, authors' calculations.

Note: The figure omits unused parts of SURE (about EUR 60 billion) because these are not pre-allocated to individual countries.

The take-up of loans differed across EU members and appeared to depend on how advantageous the financing terms were and how restrictive the loan conditions. For example, the Pandemic Crisis Support programme offered euro area members a pre-approved credit line of up to 2% of GDP in April 2020. As a credit line, one of its purposes was to alleviate any concerns about the rollover of Member States' debt. However, with the bond markets still calm and concerns lingering about the possible stigma attached to using this credit line, which was offered at a slightly higher cost than the European Stability Mechanism's own funding costs, no Member State had made use of it at the time of writing. In contrast, many members have taken out loans under the Commission's SURE programme, totalling over 40% of the overall budget of EUR 100 billion. Here, the Commission passed on its own funding costs to Member States in back-to-back lending operations. Member States that took out these loans saved close to EUR 6 billion in funding costs. Had they accessed financial markets directly, their funding costs would have exceeded those of the Commission.¹¹

¹¹ European Commission (2021b).

Figure 6
Available grants for key EU programmes (% of 2019 GDP)



Source: European Commission, authors' calculations.

Note: Unspent cohesion funds as of 10 October 2021. Funds from the 2014-2020 programming period need to be spent by end-2023.

Designed to create long-term sustainable growth, the Recovery and Resilience Facility sets comparatively tight conditions on the use of funds. The investments funded under the facility are subject to a large set of conditions, including the requirement that they contribute to digital and green objectives (see below). In addition, their payment is conditional on achieving milestones that Member States need to specify when applying for the loan. While all Member States intend to make use of the grants available under the facility, the take-up of loans is lower than for the SURE scheme, even though the European Commission will once again pass on its own funding costs.

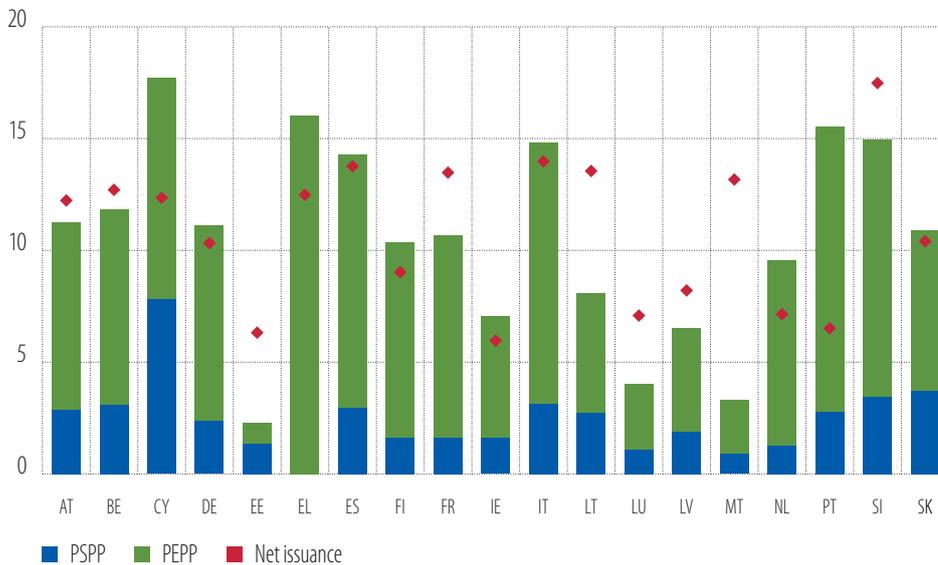
Monetary policy

In response to the pandemic, EU central banks and supervisors eased monetary policy and banking prudential requirements. The cornerstone of the ECB's response was the Pandemic Emergency Purchase Programme, which aimed to lower borrowing costs and increase lending in the euro area. This programme supplemented the asset purchase programmes in place since 2014, in particular the Public Sector Purchase Programme. Under both programmes, the ECB purchases of public sector securities from March 2020 to July 2021 were about equal to the net amount of government bonds issued (Figure 7). The announcement of the ECB programme substantially lowered the financing costs of more indebted EU members, and had an even greater effect than the announcement of the Recovery and Resilience Facility (Figure 8).¹² Throughout the pandemic, the ECB purchases helped ensure that sovereign funding costs barely moved despite growing public deficits. The ECB also eased the funding conditions for banks that increased certain categories of lending, in particular loans to small and medium enterprises, and broadened the eligibility conditions for its Corporate Sector Purchase Programme.¹³ Finally, European and national regulators softened certain rules to encourage banks to lend to firms.

¹² For the announcement effects on sovereign bond yields of various EU policy initiatives, including the Recovery and Resilience Facility and the Pandemic Emergency Purchase Programme, see also Corradin et al (2021).

¹³ For the effectiveness of the Corporate Sector Purchase Programme, see De Santis and Yaghini (2021), for example.

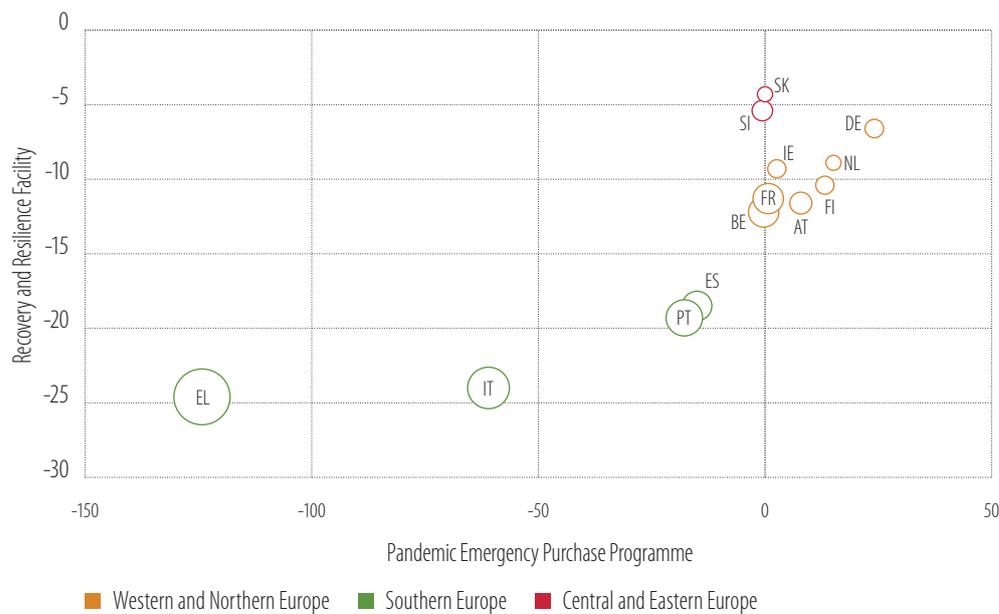
Figure 7
ECB purchases of public sector securities vs. net issuance of government bonds
(% of 2019 GDP)



Source: ECB, authors' calculations.

Note: The bars in the graph show the ECB's cumulative purchases of each country's public sector securities, and that country's net issuance of euro-denominated government bonds, from March 2020 to July 2021. PSPP stands for the public sector purchase programme, while PEPP refers to the Pandemic Emergency Purchase Programme.

Figure 8
Effects of the announcement of the Pandemic Emergency Purchase Programme and the Recovery and Resilience Facility on government bonds (in basis points)



Source: Bloomberg, AMECO (the European Commission's macroeconomic database), authors' calculations.

Note: Response of government bond yields in two-day windows starting with the announcement date (Pandemic Emergency Purchase Programme: 18 March 2020; RRF: 23 April 2020). Radius of circles are proportional to 2019 debt to GDP. Colours indicate EU regions (Western and Northern in orange, Eastern in red and Southern Europe in green).

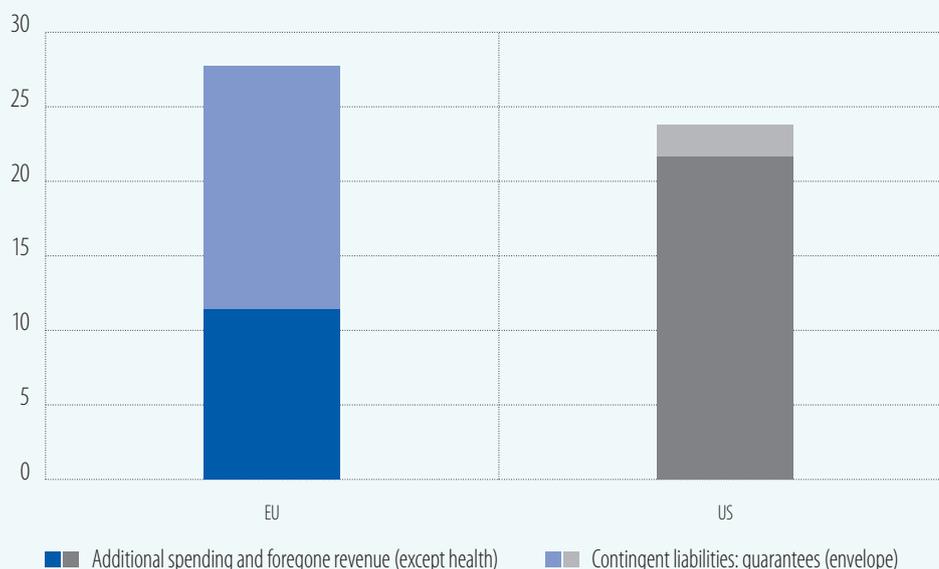
Box A

Fiscal policy design in the United States and the European Union: repercussions on savings, the labour market and the recovery

Fiscal support in the European Union and the United States was on about the same scale, but relied on different tools. While additional government spending and foregone revenue were about twice as high in the United States as in the European Union until mid-2021, EU members relied to a much greater extent on loan guarantees to support firms (Figure A.1; for guarantees, the available amount is shown, not their eventual uptake). Guarantees helped provide funding for firms without having an immediate impact on public finances — an advantage for the more indebted EU members.

Figure A.1

Fiscal measures in response to the pandemic (% of 2019 GDP)



Source: International Monetary Fund (2021), authors' calculations.

Note: Includes measures taken until June 2021.

Fiscal support stimulated demand in both the United States and the European Union, but the European Union focused on protecting existing jobs and firms. With a much less flexible labour market, EU members rolled out job retention schemes while helping firms avoid liquidity problems by offering credit guarantee programmes and increasing the flexibility of bankruptcy regimes.¹⁴ In contrast, the United States relied to a much greater degree on direct transfers to support households and firms while they were adjusting to the pandemic shock.

Transfers to US households overcompensated income losses during the first months of the pandemic, creating even larger excess savings than in the European Union.¹⁵ The closest equivalent of a furlough scheme, the USD 800 billion Paycheck Protection Programme, provided loans that could be forgiven if employment levels were maintained. The programme has forgiven an estimated USD 560 billion in loans. However, in contrast to the furlough schemes in the European Union, firms were under no obligation to keep the same employees.¹⁶

¹⁴ See European Banking Authority (2021) for a succinct overview.

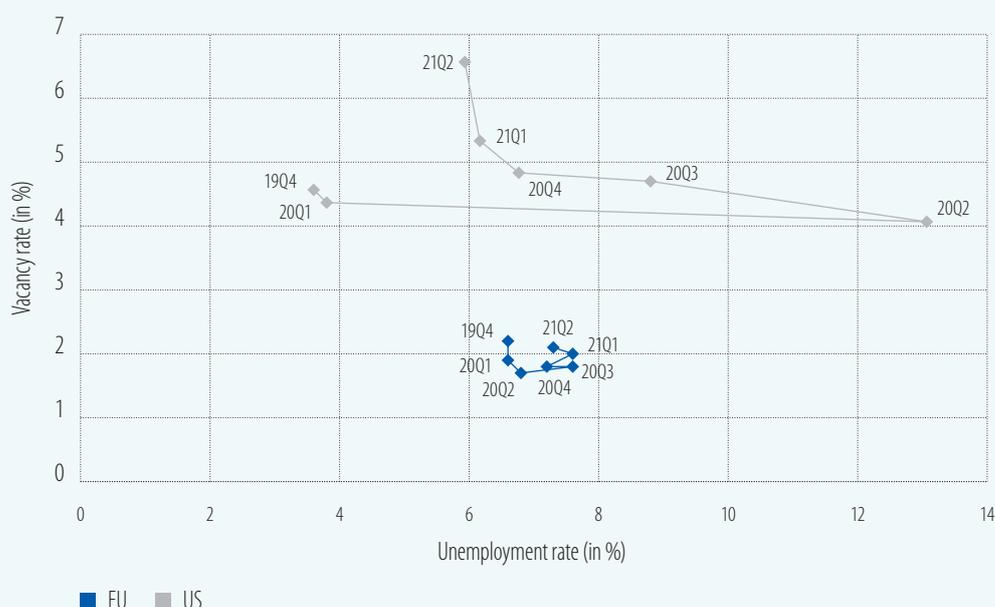
¹⁵ Congressional Budget Office (2021).

¹⁶ Data as of 3 October 2021. For forgiveness terms, see PPP loan forgiveness (sba.gov).

As a result, a similar decline in aggregate hours led to greater job losses (and later to greater employment gains) in the United States. Aggregate hours worked declined about 15% in the second quarter of 2020 compared with a year earlier in the United States and the European Union. Unemployment, however, increased much more in the United States (Figure A.2), while EU firms were able to retain unoccupied employees because of furlough schemes. This finding is in line with earlier evidence on the effectiveness of job retention schemes, as discussed in Chapter 3, Box C.

Figure A.2

Labour market frictions in the European Union and the United States



Source: Bureau of Labor Statistics, Eurostat, authors' calculations.

Note: Private sector vacancies for the United States, non-farm business vacancies for the European Union.

Firms in the United States also invested more in digitalisation during the pandemic. Controlling for firm characteristics, a US firm is 10% more likely to have invested in digitalisation during the pandemic than its EU peers. US firms' investment in digital technologies also responded more to changes in their sales, perhaps because cash flow at US firms was less cushioned by policy support than at their EU peers.¹⁷

Looking ahead, the pandemic could have a lasting impact by adding to structural shifts in the labour market and by ushering in early the changes required by the digital transition. More adjustments may therefore lie in store for households and firms in the European Union. During the crisis, the European Union's fiscal support may have taken off some of the pressure for firms to adjust, by increasing digitalisation, or for individuals to find new jobs or improve their own skills. As long as the main impact of the pandemic was to cause a large but temporary decline in demand, the approach in the European Union avoided the large costs associated with economic adjustment. But if the pandemic provokes longer-lasting structural shifts, EU firms and households may have to catch up to their US peers.

¹⁷ Source: EIBIS, Question 70: "As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)?" Changes in sales are instrumented by firm characteristics and the stringency of containment measures up to the date of the interview.

Impact on the EU economy

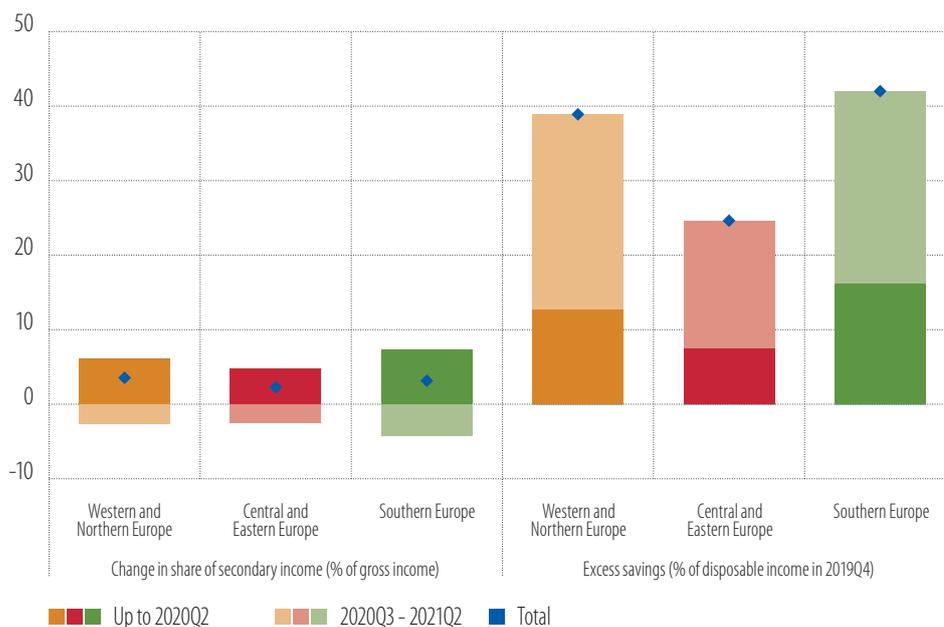
Aggregate developments

Fiscal and monetary policy measures softened the economic shock and laid the foundation for a strong, yet rocky, recovery. GDP declined sharply in the second quarter of 2020 — to 86% of its level before the crisis (the fourth quarter of 2019). By the third quarter of 2020, GDP in the European Union had recovered to 96% of its pre-crisis level, and it had reached 99.4% by the third quarter of 2021. As economic growth rebounded globally, price pressures emerged, signalling that the period of ultra-low interest rates could be coming to an end.

Governments largely absorbed the shock to income. Fiscal transfers led to an increase in EU gross government debt, to around 15% of GDP in 2019. Households' gross disposable income, meanwhile, had only fallen by 2.5% from the first to second quarters of 2020, as secondary income (from sources such as social security benefits) offset most of the loss in primary income (Figure 9, left panel). By the third quarter of 2020, households' gross disposable income had already recovered to its level before the crisis.

Figure 9

Outside sources stabilised household disposable income, swelling savings



Source: Eurostat, authors' calculations.

Notes: Secondary income is not seasonally adjusted, and therefore shows the annual change in income. Excess savings are seasonally adjusted; they show changes relative to the fourth quarter of 2019. Region-wide simple averages were used for Austria, Belgium, Germany, Denmark, Finland, France, Ireland, the Netherlands, Sweden (Western and Northern Europe), Hungary, Poland, and Slovenia (Central and Eastern Europe), and Greece, Spain, Italy, and Portugal (Southern Europe). Figures for excess savings also include the Czech Republic.

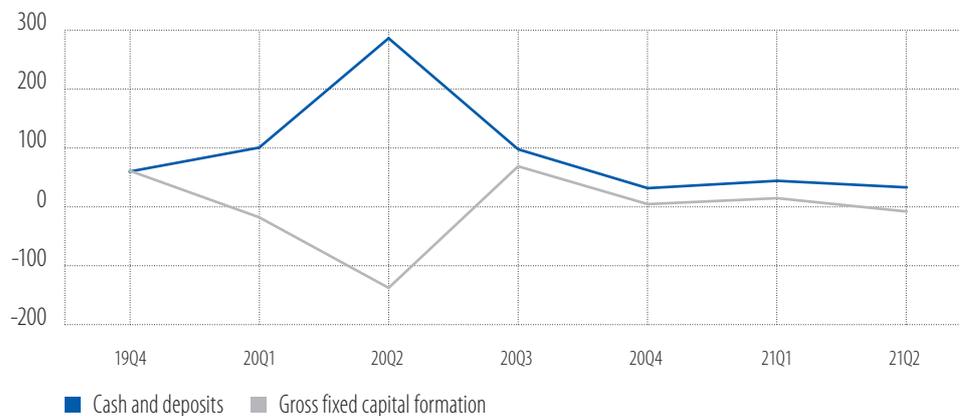
With income stabilised and opportunities for spending reduced, households built up substantial savings in highly liquid assets. While household income weathered the crisis well, consumer spending fell more than 15% in the second quarter of 2020, compared with its level before the crisis. Consumer spending picked up relatively quickly thereafter as the economy reopened, but it remained about 5% lower than before the crisis. As a result, households accumulated substantial savings (Figure 9, right panel). Households invested these savings mostly in highly liquid assets, particularly cash and bank deposits.

By the second quarter of 2021, euro area households had invested over EUR 1 trillion more in cash and deposits than before the crisis, just below the EUR 1.3 trillion channelled into the economy by the ECB during its purchases of public sector bonds. The accumulation of savings slowed as economies emerged from yet another lockdown in mid-2021, but the gross saving rate remained at around 18% of gross disposable income in the European Union — far above its pre-pandemic norm of 11-13%.

Firms cut investment and issued more debt during the first phase of the pandemic to prop up their cash buffers before turning to equity issuance as economic prospects improved. Corporate borrowing costs remained at record lows of 1.5% to 2%, even during the second quarter of 2020. Firms issued new debt and cut investment, leaving them with more cash than before the pandemic (Figure 10). Driven by low interest rates, the stock market boomed once economic prospects improved. Firms took advantage of this environment to issue more equity over the following months than in 2019 (Figure 11).

Figure 10

Euro area corporate gross fixed investment and holdings of cash and deposits
(change vs. previous quarter in EUR billions)

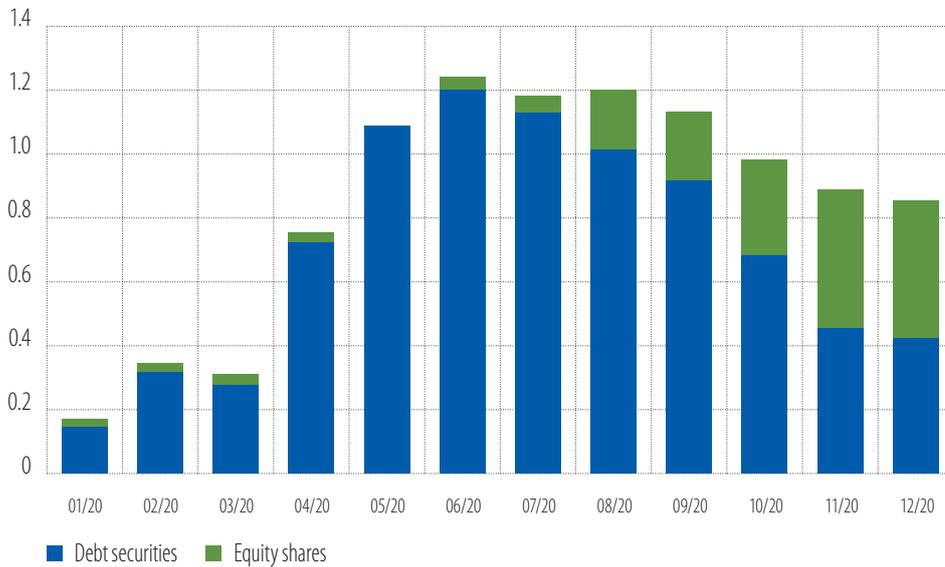


Source: Eurostat, authors' calculations. Gross fixed investment is seasonally adjusted.

As economic growth rebounded globally, price pressures emerged in most developed economies and key emerging markets, which could put an end to ultra-low financing costs. Raw material prices increased globally, feeding through to producer and consumer prices. Demand increased rapidly and its composition changed, overwhelming supply chains (see next section). Higher prices for energy and services pushed annual consumer price inflation in the United States and the European Union to its highest point in a decade — 5.4% in the United States in September and 4.1% in the European Union in October (Figure 12). This pressure on prices is expected to be temporary. How long these pressures will last and whether repeated price shocks, even if they prove short-lived, will push up inflation over time has become the subject of widespread debate.¹⁸ While the ECB retains its highly accommodative monetary policy, the central banks of some EU members (such as in the Czech Republic, Poland and Romania) have begun to tighten policy, ending years of ultra-low interest rates. Sovereign bond yields, still relatively low because of the ongoing increase in central banks' purchases, have started to pick up in the United States in 2021, and marginally so in the euro area.

¹⁸ Czech National Bank (2021), ECB (2021).

Figure 11
Changes in the issuance of corporate debt securities and equity (% of 2019 GDP)



Source: ECB, authors' calculations.

Note: The height of each bar corresponds to the year-on-year change in the net issuance of corporate debt and equity securities, with these net changes cumulated from January 2020 onwards.

Figure 12
Components of consumer price inflation in the euro area (annual change in %)

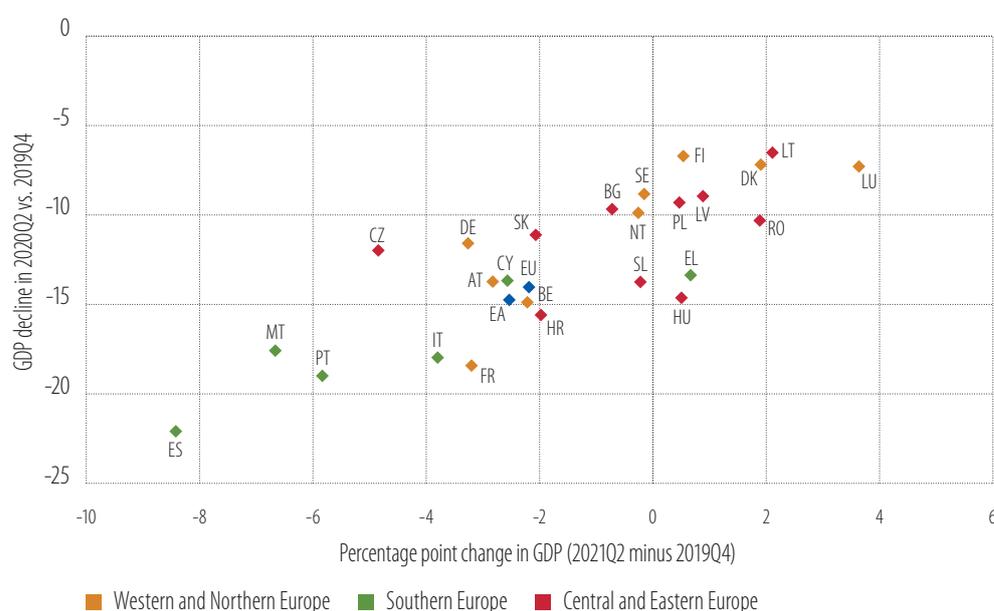


Source: Eurostat.

Differences among countries

Policy support prevented the pandemic from creating major economic gaps within the European Union, but the recovery is still asymmetrical. Aggregate figures for the European Union as a whole mask differences among members. In 2020, most members of the European Union experienced their largest decline in output since World War II. The European Union's GDP contracted by 6% with individual Member States suffering to varying extents, from -10.8% for Spain to -0.8% for Lithuania and -1.8% for Luxembourg. 2021 is the year of recovery. In the third quarter of 2021, EU GDP had reached 99.9% of its level in the fourth quarter of 2019. Some heterogeneity persists across Member States, possibly due to the different sectors and types of firms dominating the economy. For example, Spain's GDP is still at 93.4% of its pre-crisis level; Malta is at 97.1%; and France is close to 100%. The Baltics, along with 14 other EU countries, are already above 100%. By comparison, only 11 countries were above 100% in the second quarter of 2021.

Figure 13
Comparing EU members' decline and recovery



Source: Eurostat, authors' calculations.

The countries hit the hardest are taking more time to fully recover. The COVID-19 crisis was a global but asymmetrical shock and prompt policy intervention helped to cushion and curtail its effects. However, the correlation between the difference in GDP in the second quarter of 2021 and the fourth quarter of 2019, and the drop in GDP from the fourth quarter of 2019 to the second quarter of 2020, is extremely high (82%). In other words, the countries that suffered the most still have not fully rebounded, and they are the furthest from their pre-crisis GDP levels¹⁹. An active approach to economic policy is still needed to address the asymmetry generated by the crisis. Recently, economic performance has also been diverging for other reasons, such as different vaccination rates in the European Union.

Thanks to policy support, the differences are less pronounced in employment than in output. In August 2021, the number of unemployed people in the European Union declined by about 2 million from its peak 12 months earlier. The unemployment rate stood at 6.8% vs. 7.7% in August 2020 and 6.6% before the crisis. For persons employed, the decline from the pre-crisis level is just 1%, but in terms of hours worked, the slack is larger. This phenomenon is largely due to the furlough schemes that prevented layoffs and

¹⁹ As shown in Figure 2 above, these countries are also among those with larger public debts.

helped avoid knowledge losses in firms. Asymmetry in the EU labour market is less pronounced than it is in GDP. If the employment level in the fourth quarter of 2019 is 100, the European Union as a whole now stands at 99, while Spain is at 95.9 and, at the other extreme, Luxembourg is at 103.3.

COVID-19 is expected to have a more persistent impact on trade, possibly generating heterogeneity among EU countries. A number of changes are happening simultaneously. The COVID-19 crisis was a global shock, but it did not affect all areas at the same time. Supply sources were reshuffled as a result, and firms were often forced to change their products and services. The emergence of supply bottlenecks suggests that firms might be reconsidering the structure of their supply chains. A specific European shock also played a role in 2021. Since January, the transition period after Brexit for UK trade with the European Union came to an end. In the first eight months of 2021, imports from the United Kingdom declined 16.7% compared with the same period in 2020, and 30.9% compared with 2019. The European Union imported EUR 17.8 billion less from the United Kingdom than in 2020, and EUR 39.7 billion less than in 2019.

Exports and imports rebounded compared to 2020, with the trade balance worsening in late summer. This overall trend masks significant differences within the European Union. In the first eight months of 2021, the EU trade balance showed a surplus of EUR 93.4 billion vs. EUR 110.6 billion in the corresponding period of 2020. Exports to outside the European Union rose by 13.8% compared with the same period of 2020 and declined 0.2% vs. 2019. Imports from outside the European Union increased by 16.7%, and by 1.1% vs. 2019. Within Europe, diverging trends are emerging for exports of goods and services as reported in national accounts statistics and in monthly nominal goods exported²⁰. The standard deviation of export growth rates among EU countries has increased massively and has remained high during the recovery

Box B

Using trade data to measure the recovery's impact in EU countries

Heterogeneity among EU countries can be assessed by looking at trade in goods from three angles: changes in the trade balance, the growth in the pace of exports and changes in the country's share of world exports.²¹ The first indicator measures how the trade balance for each country evolved in the first nine months of 2021 compared with the same period of 2020.²² The second charts the growth of exports over the first nine months of 2021 compared with 2019 (the 2020 data cannot be used as the comparison because they were skewed by the lockdown).²³ The third measures the share of total world exports represented by each EU member. The export share is calculated using the International Monetary Fund's (IMF) Direction of Trade Statistics database (which includes all of the bilateral trade flows of goods in the world). The calculation uses monthly data and compares the average share of world exports for each EU country²⁴ in the first six months of 2021 with the average for the same period in 2019.

20 In this case, the reference is to each country's exports, including exports to other EU countries. Both the standard deviation of quarter-on-quarter growth in the national accounts' quarterly data on real exports and year-on-year growth in nominal exports from trade balance statistics at a monthly frequency show an increase in volatility.

21 The focus is on trade in goods and does not include services because of data availability and because trade in services is still severely influenced by the COVID-19 crisis.

22 For each country, a worsening in the trade balance is signalled in Figure B.1 if, irrespective of the surplus or deficit position, the negative change is greater than 1% of GDP.

23 For each country, a worsening in export dynamics is signalled in Figure B.1 when export growth vs. the same period in 2019 is lower than the pace of growth calculated by adding up all EU countries' exports (including within the European Union), which works out at 5%.

24 Again, the calculation of EU countries' share of world trade includes exports within the European Union. Here, the EU share is calculated by adding up the shares of the individual Member States to define a reference value, or average. Compared with the first half of 2019, the European Union's share declined from 31.8% to 31.2% in the first half of 2021, corresponding to a percentage decline of -1.9%. Using this decrease as a benchmark, ten countries are showing a greater decline in their share and 17 are displaying a lesser decline or an increasing share. The actual EU share (excluding trade within the European Union) is stable at around 12.8% from 2016 to 2019.

Figure B.1
International trade performance according to different indicators

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LV	LT	LU	MT	NT	PL	PT	RO	SK	SL	ES	SE
Change in trade balance	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Export growth vs. 2019	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
World export share change	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Source: Eurostat, authors' calculations. A red dot indicates a worsening in the corresponding indicator, while a black dot indicates no change or an improvement.

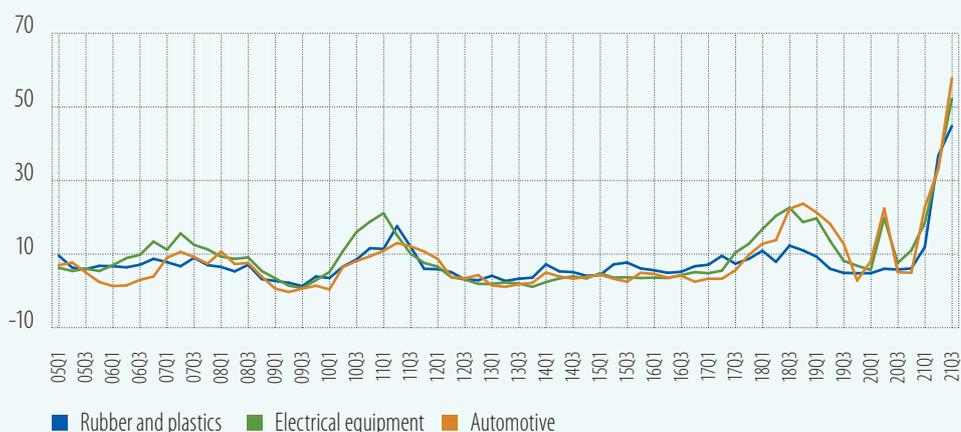
Using these three indicators to analyse trade (Figure B.1) highlights diverging trends among EU countries, with Member States clustering into groups where clear winners and losers emerge. A first group of countries performs well in all three indicators, signalling the countries' capacity to seize the opportunity offered by the recovery. The group includes Belgium, the Netherlands, Sweden, Italy, Poland, the Czech Republic and Slovakia. These countries include members of the euro currency union and non-members, have a strong manufacturing base and their exporters were able to respond to the shock caused by the pandemic. A number of countries, mainly in Central and Eastern Europe, are also improving on the export side, for goods exports and export market share. This group includes Bulgaria, Croatia, Hungary, the three Baltic countries, Slovenia and Greece. However, this second group is also integrated into global value chains and therefore depends heavily on imports, resulting in an overall deterioration in their trade.

At the opposite end of the spectrum, Cyprus, Malta, Luxembourg and Romania showed a deterioration in all three of the indicators. The first three countries are small, open economies, which suffered from the general disruption to trade. Other countries also showed declines in at least two of the indicators. Austria and Denmark were weak on exports and the trade balance. Germany, France, Finland and Portugal followed a negative trend with declines in their total goods exported and their share of world exports. The trends were also influenced by difficulties in specific sectors (for example aeronautics in France).

Most of the trade differences among EU members are likely crisis-related and will not persist over the long term. However, the pandemic and the digital and green transition are also triggering or accelerating structural shifts in demand for some sectors, along with adjustments in global value chains. The trade performance of EU members over the past couple of years probably does not reflect changes in competitiveness. It is more likely that the COVID-19 crisis caused trade bottlenecks that hit countries differently. If these bottlenecks and disruptions are temporary, their negative effects will disappear in a few months. That said, structural changes in supply and demand are also afoot, ushered in by the digital and green transition and economic shifts triggered by the pandemic. For example, the pandemic spurred an increase in demand for medical devices and pharmaceuticals, along with IT products. While cross-border trade in medical devices and pharmaceuticals might well recede when the health situation returns to normal, trade in IT products will likely rise permanently. The structure of supply is also under pressure, given the current difficulties in obtaining raw materials and intermediate goods (Figure B.2). The delivery times and prices of many products have been affected, and firms are increasingly focused on securing the supplies they need.

Total EU exports of goods to the rest of the world point to shifts in demand. Comparing the composition of EU exports shows a fairly large decline in the trade of machinery and machine tools (for countries outside the European Union) and vehicles. In contrast, prepared food, chemicals and precious metals have increased their share of total exports. While the automotive sector has been hit by specific issues, such as a shortage in semiconductor chips, the shifts in demand witnessed by other sectors might be structural. The European Union does not appear to be increasing its share of global exports of electronics or IT products.

Figure B.2
Shortage of materials and/or equipment as an obstacle to production (% of firms)



Source: European Commission, Business Survey: Industrial Confidence.

Note: Shown is the share of firms reporting that shortages limit their production.

Question: What main factors are currently limiting your production? Shortages of material and/or equipment?

The potentially changing structure of the global value chains was a subject of debate even before the crisis. The twin pressures of greater digitalisation and the need to become less dependent on imports of strategic supplies had already pushed some firms to bring manufacturing back home and to diversify their supply chains. Concerns about dependency on certain countries resurfaced at the beginning of the pandemic, when medical supplies were hard to secure. Similar supply issues then arose with semiconductors, chips, and electronic products in general, which suffered from supply bottlenecks.

Trade data provide an initial confirmation that global value chains are diversifying, while evidence of shortening of supply chains and of moving manufacturing back home is less clear. To make its supply chain more resilient, a firm can choose to diversify the portfolio of its suppliers or look for suppliers closer to home. Trade data provide some evidence of a move to find suppliers closer to home. The Herfindal index, which is calculated based on the geographical sources of EU imports, shows that the concentration of the sources is declining, both generally and in certain sectors (specifically, the automotive, electronics, machinery and rubber and plastics sectors, which have been the most affected by recent supply shortages).

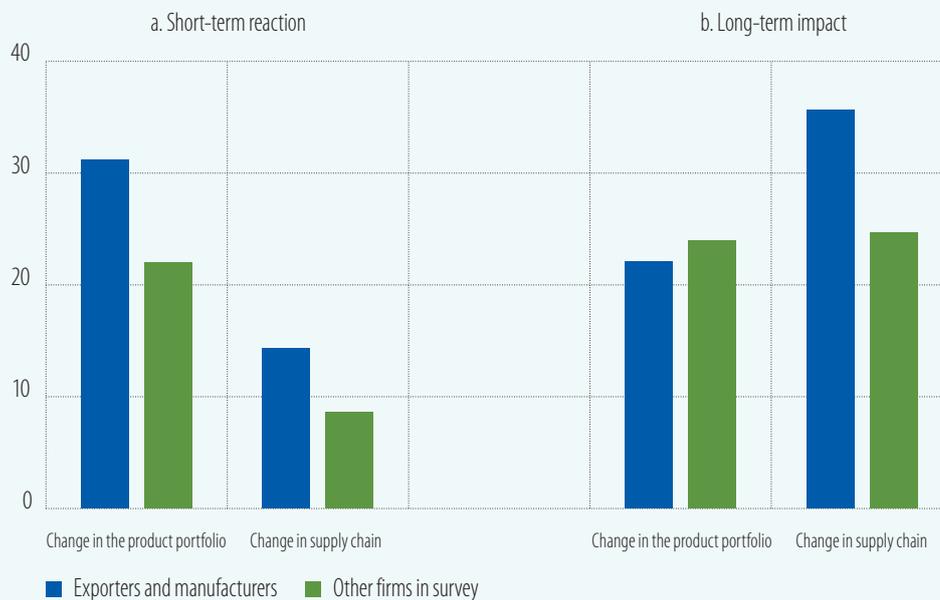
The evidence for refocusing production at home is more limited. If the phases of production were brought back inside a firm after having been outsourced, the aggregate impact would be a reduction in imported intermediate goods. The aggregate data show no signs of such a reduction in the European Union. In fact, the share of total imports represented by imports of intermediate goods from non-EU trading partners has climbed back to early 2018 levels. No clear evidence exists either for the shortening of value chains. The average distance travelled by EU exports and imports is calculated based on the distance in kilometres²⁵ between the capital cities of the countries involved in each bilateral flow, weighted by their share of total exports or imports. Exports from Central and Eastern European countries tend to travel fewer kilometres than those from Western and Northern Europe or Southern Europe. The same applies to imports. However, comparing the first six months of 2021 with the same period for 2019 shows that while the distance traveled by imports increased substantially for Central and Eastern European countries, it stayed constant for both Southern Europe and Western and Northern Europe.

²⁵ Notes on CEPIL's distances measures: The GeoDist database (2011).

Evidence from the EIB Investment Survey confirms that firms perceive the COVID-19 crisis to be a catalyst for change in the structure of supply and demand, particularly for exporters of manufactured goods. As Figure B.3 shows, exporters in the manufacturing sector were more active in adjusting their supply chains and their product portfolios in response to the crisis. Moreover, around one-third of firms interviewed said they see long-term changes in their supply chains for manufactured goods destined for export. A mild but significant positive correlation is also emerging between a country's increased share of world exports and the share of firms that expect demand to structurally change. In other words, export performance is better in countries in which firms feel a greater need to update their offering. In the same vein, a mild negative correlation is emerging between a country's share of firms that expect changes in the organisation of their supply chain with the change in the concentration of import sources shown by the Herfindal index.

Figure B.3

Firms (in %) and the impact of COVID-19 on supply chains and product portfolios



Source: EIB Investment Survey (EIBIS) 2021.

Question: Chart A (left): And as a response to the Covid-19 pandemic, have you taken any actions or made investments to...?

Develop new products, services or processes

Shorten your supply chain

Chart B (right): Do you expect the Covid-19 outbreak to have a long term impact on any of the following?

Your service or product portfolio

Your supply chain (e.g. different organisations involved in producing and distributing your products and/or services)

Fiscal policy in the recovery phase

The need to place EU economies on a more resilient and sustainable path put the coordination of fiscal policies to the test — and the outcome has been successful. A large part of Member States' recovery programmes focuses on investments in health, digitalisation and climate change mitigation. A substantial part of the programmes is not funded by EU members or their normal contributions to the EU budget but through bonds backed by the EU budget, and therefore all EU members. This demonstrates the willingness of EU members to show additional fiscal solidarity during crises as long as controls are in place to help ensure that the funds are put to productive use. Recovery efforts have also laden governments with more debt, and for some, returning to a sustainable path will not be easy.

This section discusses how ensuring sustainable growth and coordinating policies might shape EU fiscal policy in the coming years. Both elements are present in the Recovery and Resilience Facility, the European Union's flagship recovery programme.

The impact of the Recovery and Resilience Facility on economic growth

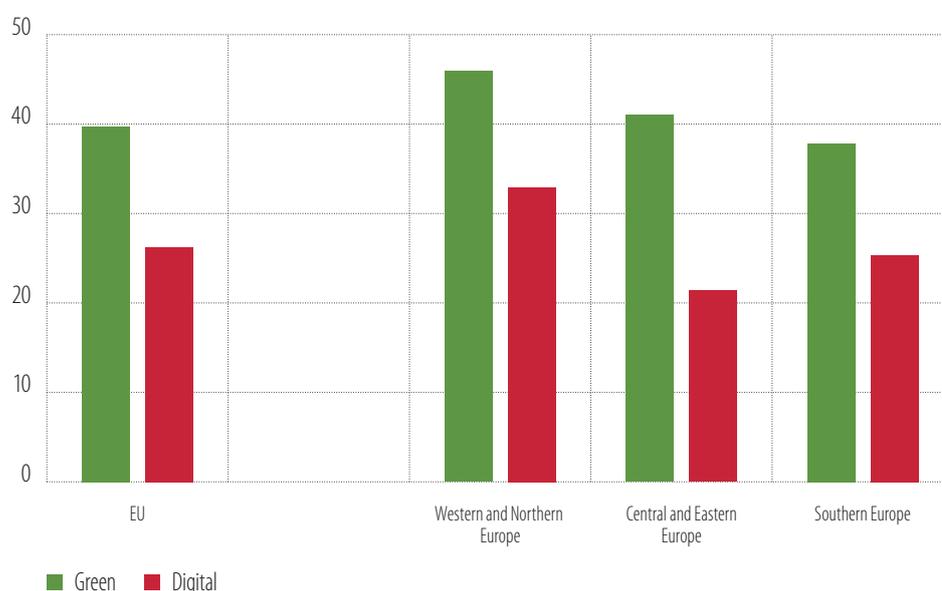
The Recovery and Resilience Facility stands out among the European Union's pandemic support programmes, not only for its size but also for the level of detail with which the European Commission is involved in coordinating, approving and monitoring countries' investments. The facility is the centrepiece of **NextGenerationEU**, the European Union's temporary recovery support plan. Member States intend to use about EUR 500 billion in loans and grants offered by the Recovery and Resilience Facility, equal to about 40% of the European Union's 2021-2027 multiannual budget.²⁶ To receive funds from the Recovery and Resilience Facility, EU members must prepare detailed investment plans. For example, the Italian government outlined over 130 individual projects in its Recovery and Resilience Plan. These projects included not only investments but also structural reforms, particularly in the areas of public administration, justice and competition. The European Commission had previously recommended many of these reforms, and its approval will be required. Achieving the milestones set within the plans will be a condition for continuing to receive RRF payments.

The economic emergency prompted the European Union to fund, for the first time, a large part of its budget via the issuance of common debt. Most of the EU budget had previously been financed using contributions from Member States (70%) and revenues from excises and value added taxes. This system of funding continued to be used for the European Union's new long-term budget (also known as the 2021-2027 Multiannual Financial Framework), which contains, for example, the grants made available through cohesion funds. Grants made available through the Recovery and Resilience Facility, by contrast, are funded through the issuance of bonds by the European Commission. Because this debt is guaranteed by EU members, the Commission's funding costs will be closely aligned with the highest-rated EU members. The Commission intends to use new sources of revenue to repay the bonds issued to fund the grants.

The Recovery and Resilience Facility focuses on investments that reduce the risk of climate change and support digitalisation. Member States must allocate at least 37% of their investments to green and 20% to digital investments. Many countries are exceeding those targets significantly (Figure 14). Notable public investment areas, many of which include green and digital components, include transport (such as railway tracks and electric vehicles for public transport), human capital formation (for instance, digitalisation of schools), and water and waste management.

²⁶ The final amount of the Recovery and Resilience Facility will depend on the extent to which Member States take out loans from the facility. The 2021-2027 multiannual budget amounts to EUR 1.2 trillion.

Figure 14
Green and digital investments (in %) funded by the Recovery and Resilience Facility



Source: European Commission, authors' calculations.

Note: Regional and EU averages are weighted by plan volumes.

Funds from the Recovery and Resilience Facility will stimulate investment in the public and private sectors. About a third of the facility's funds are expected to flow to the private sector through investment incentives. Funds will go to R&D, energy efficiency projects and investments in physical capital. The investment incentives also typically include requirements to involve private investors. The amount of investment generated by the facility might therefore exceed its financial contribution.²⁷

Southern Europe is set to receive the largest share of funds from the Recovery and Resilience Facility, relative to its GDP. Grants under the facility were allocated based on the size of population, pre-pandemic GDP per capita, pre-pandemic unemployment and the decline in GDP from 2020 to 2021.²⁸ Most of these grants are set to flow to Eastern and Central Europe and Southern Europe, and they represent a significant investment — 5.2% of 2019 GDP for Eastern and Central Europe and 4.9% of 2019 GDP for Southern Europe. In addition, Southern European countries have made greater use of the loans offered under the facility (4% of 2019 GDP vs. 1.9% of 2019 GDP for Eastern Europe).

The Recovery and Resilience Facility is expected to have the highest impact in Southern Europe. The facility will boost GDP during the implementation of the investments (2021-2026) by creating additional demand. Estimates for the size of these effects are outlined in Box C. In the following section, we focus on the impact on GDP once the investments are operational. By that time, GDP will rise because the capital stock will be larger and more productive. Over time, the effect generated by the large capital infusion will decline because capital depreciates. For example, newly built roads deteriorate over time without additional, yet unbudgeted, investments. Simulations suggest that the facility will push up Southern Europe's GDP the most, mainly because of the large investments planned. In Southern Europe, GDP is expected to rise about 5% by 2030 and about 2.7% by 2040 (Figure 15).²⁹ In Eastern Europe, the impact will be about half the size relative to GDP for both periods, and in Western and Northern Europe about 0.7% of GDP.

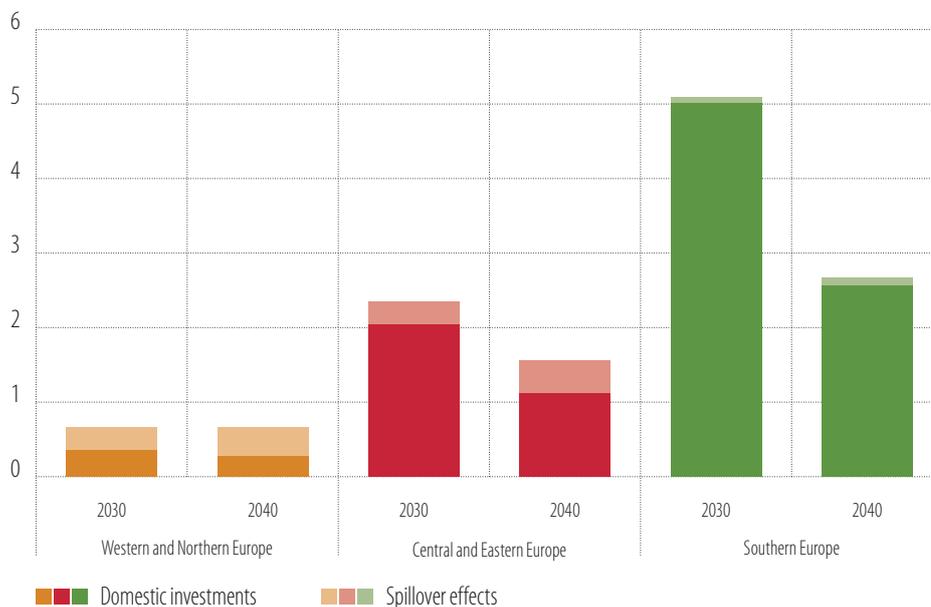
²⁷ The impact results reported in this section assume a co-financing requirement of 30%.

²⁸ See EU (2020), Annex 1, for details.

²⁹ Results obtained using the Rhomolo-EIB model; see Bending and Weiers (2021) for a description. Quest, another established macroeconomic model, yields qualitatively similar results (see the European Commission's analyses of national Recovery and Resolution Plans, for instance European Commission (2021c) for Italy).

The effects of extra investment will spill over to neighbouring regions. Such spillovers should account for about half of the facility's impact in Western and Northern Europe. Western and Northern Europe is a key exporter of investment goods. It is, therefore, expected to benefit substantially from the demand generated by the facility in other regions. About half of the facility's impact in Western and Northern Europe is expected to come from spillover effects (indicated by the light-coloured part of the bars in Figure 15). The importance of spillover effects is also high for Central and Eastern Europe but negligible for Southern Europe, primarily because the facility is expected to fund significantly more investments in the south than in its neighbouring regions.

Figure 15
Recovery and Resilience Facility's impact on GDP (in %)



Source: Authors' calculations using the Rhomolo-EIB model (see Bending and Weiers (2021) for a description) based on national Recovery and Resolution Plans as per end-September 2021.

Note: The bar shows the estimated impact the facility will have on regional GDP. The light-coloured parts of the bars show the estimated impact on GDP that originates from investments in other EU regions. Spillover effects are estimated by assuming that a region only contributes to the overall financing of the facility but does not invest itself. The model-generated impact on its own GDP is then only due to spillover effects from other regions' investments.

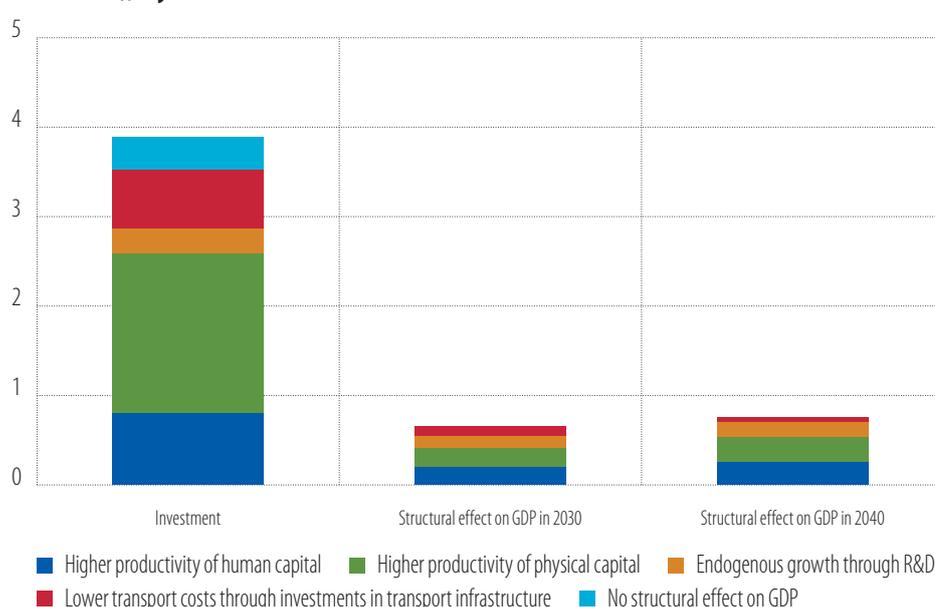
Investments in human capital and research and development are likely to have the highest return in the long run. While the effects of some types of investment gradually decline (transport costs tend to rise again as the quality of newly built motorways gradually deteriorates), the effects of other investments grow over time. Investment in human capital (educating and training people) lays the groundwork for the further acquisition of knowledge. Discoveries made through R&D investments often stimulate further advances. EU members intend to allocate about a quarter of their investment to human capital and to R&D. Over time, these investments are expected to account for about two-thirds of the facility's structural impact on GDP (Figure 16).³⁰

EU members need strong technical capacities to plan and execute investments if the Recovery and Resilience Facility is to meet its goals of improving the sustainability of the European economy. Countries should also ensure that investments catalyse change. The implementation of the European

³⁰ Strictly speaking, it is within the overall combination of investments set out in recovery and resilience plans that human capital and R&D have the highest long-run returns. This result could change if less money is invested in other areas. For more information on the split of the overall effect on GDP into a temporary investment effect (essentially the impact of increasing the amount of capital, net of financing) and longer-lasting structural effects (such as the impact of lower transportation costs through investments in transport, and greater knowledge through investment in R&D), see EIB (2018).

Fund for Structural Investment, the European Union's recovery plan following the sovereign debt crisis, offers some lessons. First, barriers to investment do not just stem from access to finance. The capacity to identify concrete projects and implement them is equally important. As the capacity to generate a pipeline of projects is likely to be a major constraint, dedicating enough resources to administrative functions is crucial. Second, public sector investment should be catalytic. EU members can amplify the impact of the Recovery and Resilience Facility by involving the private sector and national and supranational development banks in the funding of the projects. Many countries are planning to do just that for a substantial share of the funds provided under the facility.

Figure 16
Breakdown of the impact of Recovery and Resilience Facility investments
 (% of 2019 GDP), by effect



Source: Authors' calculations using the Rhomolo-EIB model (see Bending and Weiers (2021) for a description).
Note: The left column breaks down the aggregate size of facility-funded public investments without assuming any private sector participation. The two right columns show the impact of these investments on GDP that arises from greater quality of capital (the "structural" effect of the investments), assuming that the private sector co-finances one-third of investments in physical capital not related to transport. These benefits arise every year once the investments are completed; the graph illustrates their impact in 2030 and 2040. Not shown are the effects that originate from the greater quantity of capital, which depreciates over time.

Countries should also create a regulatory and policy environment that stimulates private investment. Investment plans should be accompanied by structural reforms. Public investments offset gaps that arise because market failures or barriers thwart private investment. Structural reforms can eliminate some investment barriers and raise economic growth substantially.

Box C

The potential impact of the Recovery and Resilience Facility using a panel vector autoregressive (VAR) model

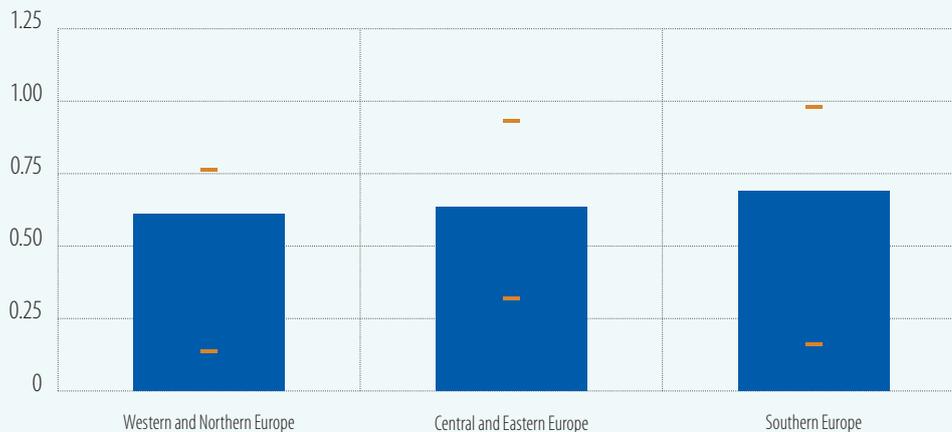
This box provides an analysis of the short-run impact of the Recovery and Resilience Facility on GDP and of the importance of coordinating national fiscal policies. It applies a Bayesian Panel vector autoregressive model to 2000-2019. This approach makes it possible to quantify the benefits of

coordinating the fiscal stance across EU members. It also helps assess the role of monetary policy in the facility's effect on GDP. In contrast to the structural approach in the main text, this autoregressive model does not differentiate between types of investment. It includes a handful of macroeconomic variables for each EU country: the long-term interest rate (as a proxy for the monetary policy stance), private and public gross fixed capital formation, and real GDP³¹.

In technical language, each EU country represents a unit in the panel and, as suggested in the literature (Canova et al., 2013), using a Bayesian setting is the only viable option³² for allowing for static and dynamic interactions³³ between units (countries) in the estimation process. Allowing for these interactions is a prerequisite for taking into consideration potential spillover effects. Using this autoregressive model provides evidence on multipliers and co-movements of variables. The impact of the Recovery and Resilience Facility is assessed using a conditional forecast.

The analysis shows that country-specific public investment multipliers³⁴ at the EU level range from 0.2 to around 1. Regional aggregation of the multipliers shows that regions with lower GDP per capita (Central and Eastern Europe and Southern Europe) benefit slightly more from public investment than the richer countries in Western and Northern Europe (Figure C.1). This finding is in line with the literature, which signals that the different effects of public spending depend not only on the stage of the business cycle, but also on different countries (Amendola et al., 2019).

Figure C.1
Fiscal multipliers across regions (in percentage points)



Source: Authors' calculations

Note: The fiscal multipliers are computed and standardised to represent the percentage change in GDP for each percentage change in public investment. Fiscal multipliers are aggregated based on country-specific estimates using nominal GDP weightings. The yellow lines represent minimum and maximum fiscal multipliers within regions. The panel VAR model includes 18 EU countries with the following variables: long-term interest rates, gross fixed capital formation, public capital formation and real GDP. The nominal series for total and public investment have been deflated using the GDP deflator. We use a Bayesian approach to account for the rather limited time sample, 2000-2019. The model allows for dynamic interactions between units (such as countries) to facilitate the assessment of spillover effects. We use quarterly annual growth rates and employ a four-lag specification. Estimates are conducted using the BEAR 5 Toolbox by Dieppe et al. (2021).

31 Total and public investment and GDP are quarterly and expressed in constant prices and in year-on-year growth rates. Four lags of the variables are included. The sources are Eurostat for these three variables and the ECB for long-term interest rates.

32 Allowing for these interactions involves estimating a large number of parameters.

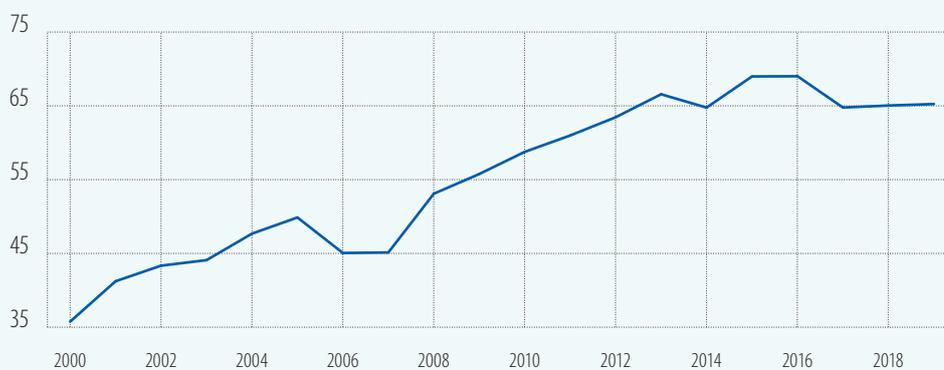
33 Static interdependencies are related to the potential non-zero correlations between contemporaneous error terms of equations for different units, for example common shocks can exist across units. Dynamic interdependencies are related to the fact that lags of investment in one unit can have effects (such as a non-zero coefficient) in the investment equation in another unit.

34 The fiscal multipliers are standardised so that they represent the increase in GDP for a 1% increase in public investment in the first four quarters following the shock. The sample over which they are estimated is 2000-2019.

Co-movements in EU investment policies have been stronger in recent years. As the estimation technique is based on reducing the number of parameters by using a common factor structure, it is worth considering public investment as common factor across EU countries. This factor shows the co-movements across countries over the years (Figure C.2) and tracks the aggregate variable for public investment in the European Union relatively well. The interesting point is that the variance explained by the common factor increases over time, from around 45% before the global financial crisis to 63% in 2019. The economic policies across the various EU countries therefore seem to be gaining in consistency.

Figure C.2

Variance in public investment in the European Union explained by the common factor



Source: Authors' calculations.

Note: The common factor is expressed in annual growth rates over the sample 2001-2019 according to the VAR model.

At the same time, the spillover effects across countries have also increased over time. The panel vector autoregressive model also gives a direct assessment of the effects at work among countries, through the impulse response functions. Figure C.3 (picking Slovenia and Germany as an example) shows that spillover effects have increased over the last decade compared to the period before the global financial crisis. While greater spillover effects can be expected in an environment of increasing trade and financial links, it seems plausible to consider that higher synchronisation is part of the EU convergence process.

According to the estimated model, the Recovery and Resilience Facility will increase regional GDP growth by 0.3 to 0.8 percentage points over the next few years (Figure C.4). GDP growth is projected (with a conditional forecast exercise) with and without investments under the facility using two assumptions for monetary policy: first, that long-term interest rates will remain constant, and second, that they will rise, in line with past patterns, as the facility is implemented. Unsurprisingly, the impact on GDP growth is somewhat larger when long-term interest rates remain constant. For the whole European Union, the impact would be 0.5 percentage points in 2022 vs. 0.38 percentage points if the conditional forecast is run without constraining long-term rates.

Spillover effects between countries add about 0.1 to 0.2 percentage points to the European Union's GDP growth, showing the benefits of coordinating fiscal stimulus among EU countries. Implementing the Recovery and Resilience Facility not only increases GDP locally but also in the other EU countries. The size of these spillover effects can be estimated approximately by comparing the results of the conditional forecast, which includes spillover effects, with what is yielded by a simpler, static exercise, which uses multipliers. The difference between these estimates is around 0.1 to 0.2 percentage points at the EU level, which could be interpreted as the benefit of coordinating fiscal stimulus across Member States. An alternative way to compute the role of spillover effects is to compare the results

of different paths for variables in the conditional forecast exercise, using a scenario that includes spending under the Recovery and Resilience Facility for Western and Northern Europe, and a scenario that excludes this spending (the facility is set to zero over the projection horizon). The difference in Southern Europe's GDP growth between the two scenarios represents the spillover effects and, in this case, the difference works out to be around 0.3 percentage points in 2022.

Figure C.3
Spillover effects on Slovenian GDP over time after a 1% shock in Germany public investment (in percentage points)



Source: Authors' calculations.

Note: The chart shows the response of Slovenian GDP to a shock of one standard deviation in German public investment for two sub-samples. Y axis: magnitude of response, X axis: quarters after the shock.

Figure C.4
Annual impact on regional GDP from the Recovery and Resilience Facility (in percentage points)



Source: Authors' calculations

Note: The impact is assessed using a conditional forecast exercise for 2021-2024, restricting the monetary policy to remain constant (dark colours) and free (light-coloured bars). The impact also includes spillover effects from one country to the others. The results across countries are aggregated at the regional levels using nominal GDP weightings.

This exercise shows that there is already an ongoing process of growing co-movements among public investments in EU Member States and of increasing spillover effects that will in turn amplify the positive effects of the spending planned under the Recovery and Resilience Facility. A coordinated package such as the Recovery and Resilience Facility could further enhance this process and, in turn, will benefit from the presence of such effects. Moreover, maintaining favourable financing conditions would strengthen the final impact.

Fiscal coordination in the recovery phase

The fiscal policy response to the pandemic was structured in two phases: the emergency response and the recovery phase. The general escape clause allowed EU members to act flexibly and to tailor their individual responses to the emergency. However, soon after the pandemic erupted, the European Commission deployed a range of fiscal tools that were coordinated and common to the entire European Union, the largest one being NextGenerationEU. The strategy now is to strengthen the recovery phase with spending and investment that improve the structural soundness of the European economy. The goal is to change the EU economy structurally, steering it towards the twin green and digital transition, while addressing some of its weaknesses and strengthening its potential. However, the success of this strategy will depend on the EU fiscal framework and the impact of the pandemic on the indebtedness of EU countries.

The decline in output in 2020 and the rescue and recovery efforts of 2020 and 2021 caused a notable increase in public debt. Debt levels in the European Union had peaked in 2014, due to the global financial crisis and the subsequent sovereign debt crisis. In subsequent years, debt levels declined, significantly in some countries, less so in others. The pandemic erased all the gains made after 2014 and debt rose massively in 2020 and 2021 (Figure 17). The number of countries with debt to GDP ratios exceeding the 60% threshold in 2014 was 15, while in 2019 it was 11, and in 2022 it will be 15 (according to the Commission's forecasts). In the European Union, the government debt to GDP ratio increased from 78.8% in 2019 to an estimated 92.1% in 2021. For the euro area, the corresponding numbers are 85.5% in 2019 and 100% in 2021.

Applying the debt rule included in the Stability and Growth Pact mechanically could provoke an extremely harsh fiscal correction for the most indebted countries. Figure 18 portrays the debt levels for the seven most indebted countries and compares the average primary surplus of 2015-2019 with the surplus needed to satisfy the debt rule (reducing the debt/GDP ratio to 60% in 20 years). These figures are computed using relatively benign hypotheses for the projected interest rate–growth differential: the average cost of debt in 2015-2019 is used for interest payments, and the average pace of nominal growth in 2000-2019 is used for growth. For these countries, the primary surplus required should be on average 3% of GDP (unweighted) compared with the 1% recorded in 2015-2019. These seven countries were also the hardest hit by the pandemic, collectively experiencing an 8.7% decline in GDP in 2020.

The European efforts to coordinate fiscal policy will also play an important role in the transition towards normality, after the likely deactivation of the general escape clause in a reformed EU fiscal framework. The general escape clause, which releases EU members from the financial obligations of the Stability and Growth Pact, will likely be deactivated in early 2022. The European Commission was clear³⁵ about making the deactivation conditional on the European Union's GDP returning to its level before the crisis. If real GDP in the fourth quarter of 2019 is set at 100, the European Union's GDP stands at 99.8, based on the available data (third quarter of 2021). It is likely that the European Union will meet this condition in the last quarter of 2021 or at the beginning of 2022, a little earlier than previously thought.

35 One year since the outbreak of COVID-19: fiscal policy response COMMUNICATION FROM THE COMMISSION TO THE COUNCIL Brussels, 3.3.2021 COM(2021) 105 final.

However, the Commission kept a clear reference to specific country conditions, stating that if a country does not reach the pre-crisis level, all the flexibility allowed by the Stability and Growth Pact will be used in setting future policy guidance. Having said that, the Commission has also reopened a debate on reviewing the EU fiscal framework.³⁶

Figure 17

Gross public debt levels (% GDP), by country and macro area

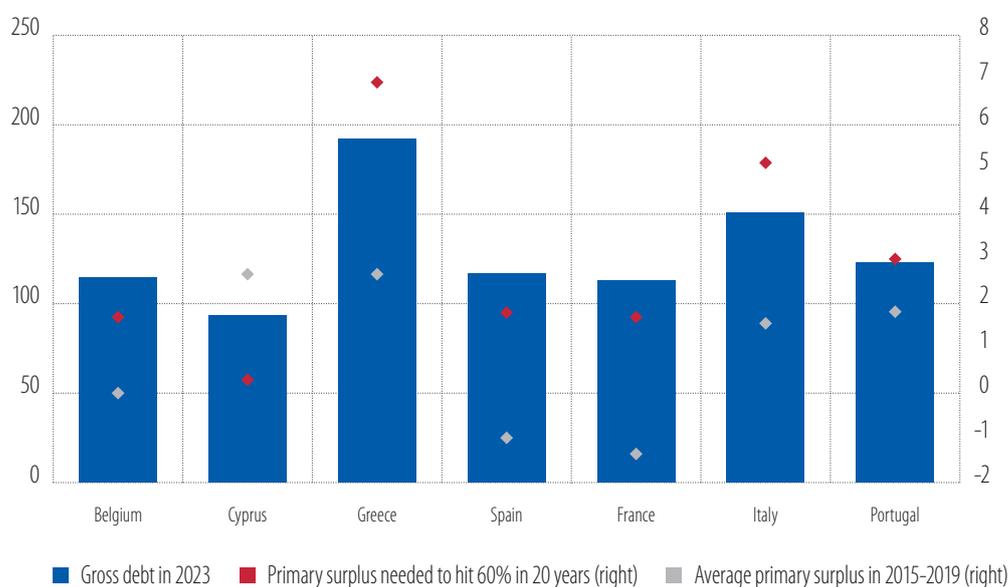


Source: AMECO (the European Commission's macroeconomic database), authors' calculations.

36 In the speech on the state of the Union, European Commission President Ursula Von der Leyen said: "But, as we look ahead, we also need to reflect on how the crisis has affected the shape of our economy – from increased debt, to uneven impact on different sectors, or new ways of working. To do that, the Commission will relaunch the discussion on the Economic Governance Review in the coming weeks. The aim is to build a consensus on the way forward well in time for 2023."

Figure 18

Recent primary surpluses and surpluses needed to comply with the debt rule (% GDP)



Source: AMECO (the European Commission's macroeconomic database), authors' calculations.

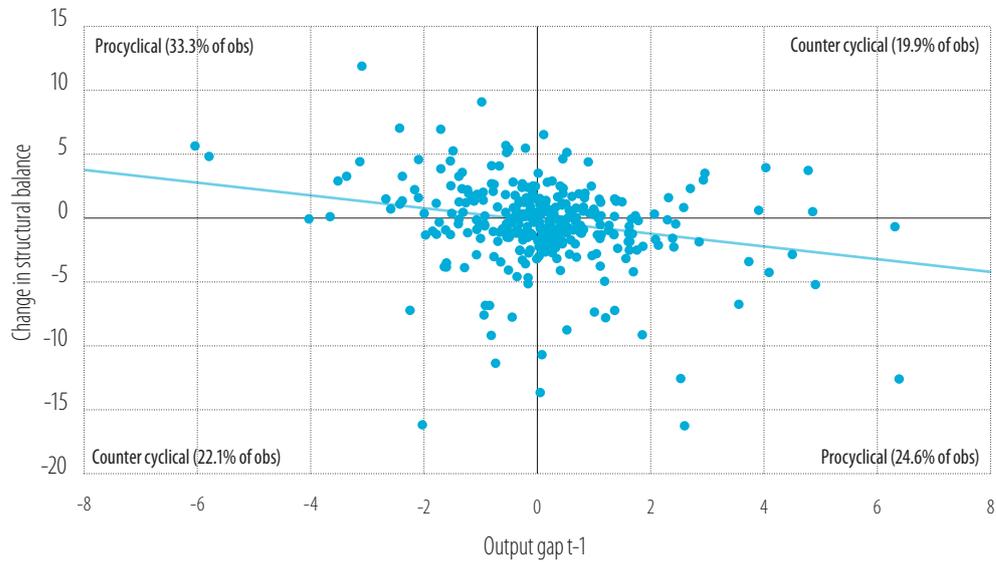
A public consultation on a reformed EU fiscal framework was launched at the beginning of February 2020, but it was soon put on hold due to the pandemic. As the EU economy recovers from the pandemic, the discussion has emerged again. While it seems unlikely that there will be enough time to make legislative changes before the end of 2022, it is useful to summarise the main arguments. Two of the most examined issues are the degree to which fiscal constraints aggravate economic cycles and how to best protect government investment.

The role of fiscal policy in stabilising fluctuations of economic activity, or at least remaining neutral to them, is widely accepted in academic and policy circles. A quick look at the available data, however, suggests that for euro area countries from 2001 to 2019, governments' fiscal stance tended to amplify economic volatility (Figure 19). In this period, more often than not, fiscal policy was contractionary when the economy was operating below its potential. Limiting the observations to 2012-2019 does not change the picture.

The prolonged decline in public investment in the European Union after the global financial crisis suggests public investment was not shielded from spending cuts. When governments consolidated their finances, public investment is treated as the other expenditures, despite its potential role in strengthening growth. The negative correlation between improvements in government finances and investment expenditure is similar to the negative correlation between government expenditures and business cycles. Public investment could be better protected by excluding it at least partially from the calculation of total primary expenditures, particularly for spending in areas with high social benefits (such as climate investments). Pro-cyclicality can be avoided through stronger coordination at EU level on fiscal and economic policy.

Through the Recovery and Resilience Facility, the European Commission's efforts in shaping and coordinating Member States' fiscal policy in the next few years will be invaluable. If the facility's implementation is successful, the help it will provide might prove decisive. The revenues generated by higher economic growth might help some EU members to reduce their debt levels by 20% in the next 20 years.

Figure 19
Fiscal stance and the economic cycle



Source: EIB calculations on the AMECO and the IMF's World Economic Outlook databases.
Note: The structural deficit and the output gap are expressed as a ratio of potential GDP.

Conclusion and policy implications

While continuing to fight the pandemic, EU members are also starting to plan investments and implement reforms to push the green and digital transition. Some countries are set to receive substantial loans and grants from cohesion funds and the Recovery and Resilience Facility to support their investments. The Recovery and Resilience Facility is not only a source of funding for investment, but also a tool to coordinate policy priorities, for example by setting minimum thresholds for green and digital investments. These investments alone could lift the European Union's output for a long time after their implementation. Many recovery plans also include needed structural reforms.

For EU support to have the desired effects, governments must have the technical capacity necessary for projects to succeed. Given how large the funds are, and how short the eligibility period is for receiving them, governments will be under considerable pressure to plan, implement and evaluate their investments. The implementation of the European Fund for Strategic Investments shows that technical assistance can play an important role in ensuring that investments are a success.

Once the pandemic subsides, some EU members will need to address the sustainability of their sovereign debt. Sovereign debt rose sharply when governments stepped up to cushion the pandemic's impact. The countries most exposed to the pandemic were already facing high levels of debt. Returning to a sustainable path will not be easy.

In the European Union, fiscal policies will need to be coordinated during the recovery, not least to protect public investment. The European Union's decision to invoke the escape clause of the Stability and Growth Pact provided countries with the flexibility they needed to address the COVID-19 crisis. With the European Union's GDP almost back to pre-pandemic levels, the normal EU fiscal framework is set to apply from 2023 onwards. The key question is how to avoid some countries' making harsh cuts to spending and investment if they are forced to meet the pact's debt and deficit rules. The green and digital transformation requires substantial public investments, but public investments have often been victim to fiscal consolidation in the past. A range of options is available to protect public investment, while ensuring that the European Union's fiscal goals continue to be met.

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Chapter 2

The state of investment in the European Union: Government, corporate, infrastructure, climate

Despite the far-reaching economic effects of the COVID-19 crisis and the large decline in output, investment in the European Union fell less than expected. Governments' timely and ample fiscal response and central banks' enhanced monetary stimulus supported investment in a difficult economic environment. The decisive policy mix arrested the decline in household incomes and prevented corporate finances from further worsening. Government investment was not affected and continued to increase throughout the pandemic.

The investment decline was most acutely felt in machinery and equipment, while investment in structures and buildings rebounded quickly after a dip in the second quarter of 2020. Corporate investment contributed the most to the contraction in total investment. It experienced the sharpest decline and was the slowest to rebound.

Overall, however, investment rebounded strongly in 2021 and had broadly returned to pre-pandemic levels by mid-year, thanks to the resilience of household and government investment. Large and innovative firms resisted the economic shock better. Innovative firms were also more likely to have increased their workforce compared to before the pandemic. Some firms, however, are still holding off on investments.

For many firms, uncertainty remains a key obstacle. While public support allowed firms to restart operations when countries came out of lockdown or other restrictions, weaker corporate finances caused by the pandemic might suppress corporate investment once government support is withdrawn.

The COVID-19 crisis adds to the challenges created by years of low productivity growth and the sometimes radical economic transformation required to adapt to a more digital world. Firms should therefore seize the opportunity offered by current public policies and invest in innovation and digitalisation to increase their competitiveness. Some firms have already embarked on this course, including innovative firms that are more likely to invest in the digital transformation. That said, the European Union has a higher share of firms that are not innovating compared to the United States.

Investing for the green transition, which is being actively promoted by the European Green Deal and the recovery plan for Europe, will help firms improve their competitiveness in the post-pandemic world. Investment in climate change mitigation in the European Union increased modestly in 2020. To meet its targets, the European Union has to substantially accelerate investment. That said, the European Union spends more than the United States on climate change mitigation technologies as a share of gross domestic product (GDP), but half as much as China.

Introduction

This chapter presents an overview of recent developments in fixed capital formation, a measure of investment, in the European Union and provides the background for the economic analysis in the rest of this report. As in 2020, the investment discussion is dominated by the pandemic's effects, which have shaped economic performance in 2020 and 2021 and influenced the near- to medium-term outlook. The chapter draws on official and publicly available aggregate data from Eurostat, the Organisation for Economic Co-operation and Development (OECD) and national statistical offices. It also uses the latest wave of the EIB Investment Survey (EIBIS) extensively. In addition, it presents the latest updates of the EU infrastructure dataset and the dataset on investment in climate change mitigation and adaptation, which are developed by the Economics Department of the European Investment Bank.

The chapter is organised into four sections. The first section presents an overview of aggregate investment dynamics, investment in different asset types, including infrastructure, and institutional sectors. The second section focuses on corporate investment through the lens of the EIBIS. It discusses the investment outlook, along with the short- and longer-term effects of the COVID-19 crisis on corporate investment and investment in intangible assets and innovation. The third outlines recent developments in investment in climate change mitigation and adaptation. The fourth and concluding section examines the implications for public policy.

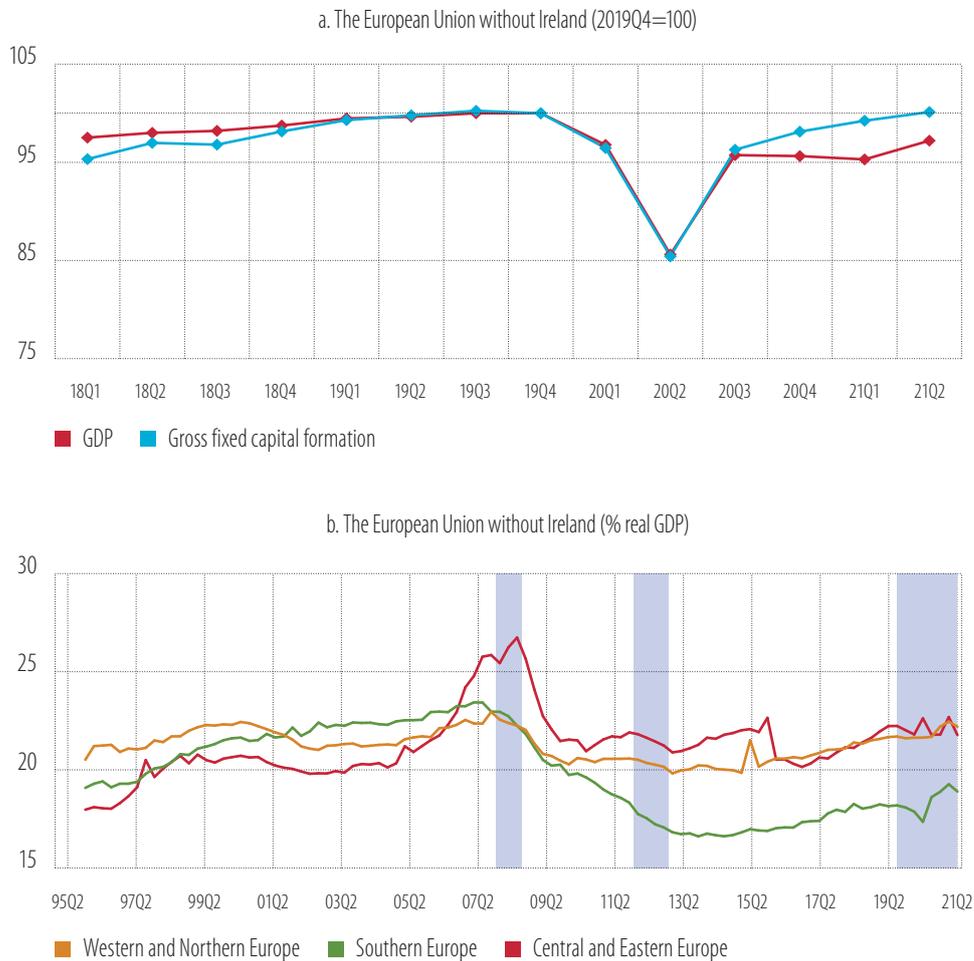
Aggregate investment dynamics

Gross fixed capital formation (GFCF) in the European Union declined substantially in the first half of 2020 following the coronavirus outbreak, but recovered quickly, returning to pre-crisis levels in the first half of 2021. By the end of the second quarter of 2020, real GFCF fell 21% relative to its level in the fourth quarter of 2019. Part of this record decline was due to considerable volatility in Irish GFCF, which plunged 76% in the same period (see Box A). Excluding Ireland from the EU aggregate, real GFCF in the EU26 fell 14.6% — still a steep decline (Figure 1a). The recovery that followed brought EU real investment back to pre-pandemic levels by the end of the second quarter of 2021. By comparison, real GDP was still some 3 % away from pre-pandemic levels at the end of the second quarter of 2021.

Despite the record decline, EU investment held up surprisingly well. Excluding Ireland, the decline in real GFCF at the end of the second quarter of 2020 was the same as the drop in real GDP, or 14.4%. One often-cited fact is that investment is more volatile than GDP over the business cycle. The average standard deviation, a measure of volatility, of real investment growth in the European Union since 1995 is about 4.75, compared to 2.75 for GDP. Investment and GDP typically move together over the business cycle. However, the higher variation in investment causes the investment rate (the ratio of investment to GDP) to decline during recessions and increase during expansions (Figure 1b). Empirically, the investment multiplier model, a standard econometric model of investment, implies that real investment changes by about 2% for every 1% change in real GDP. In 2020, however, investment “only” declined to the same extent as GDP, which was reflected in investment rates holding broadly steady in 2020 (Figure 1b).

The swift and determined policy response to the economic crisis stabilised household incomes and reassured businesses. Chapters 1 and 3 of this report provide a detailed analysis of the economic effects of policy support during the pandemic. Because the initial decline in employment was contained and household disposable incomes remained stable on aggregate, businesses were reassured that as soon as the pandemic waned and restrictions were lifted, demand would increase again. The direct support for firms, on the other hand, with government contributions to social security expenses, subsidies, rescheduled payments and credit guarantees, preserved corporate finances to some extent. Despite the general success, small pockets of vulnerable firms remain.

Figure 1
Real gross fixed capital formation and real GDP

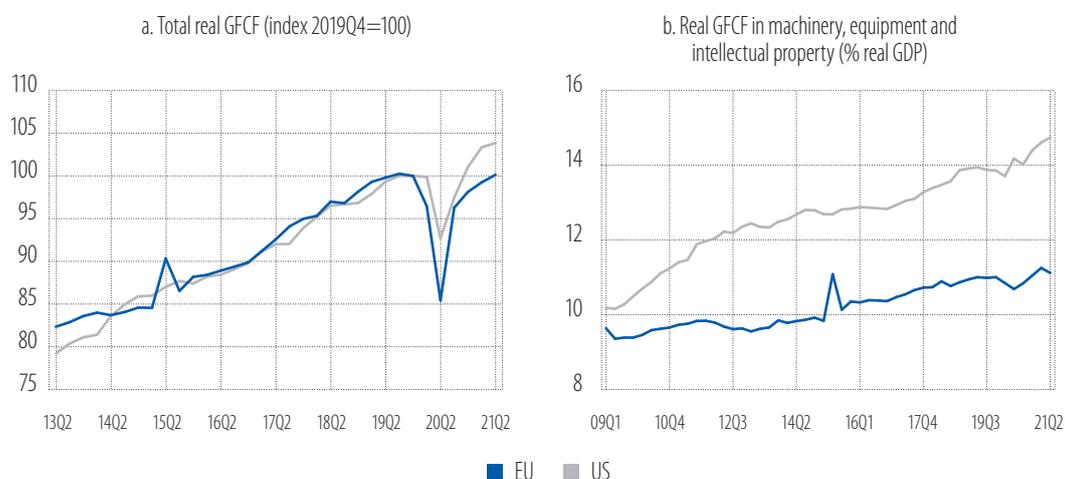


Source: Eurostat and OECD National accounts, EIB staff calculations.
Notes: Western and Northern Europe without Ireland. Shaded regions on the chart denote euro area recessions as recorded by the business cycle dating committee at the Centre for Economic Policy Research.

Investment dynamics in the European Union and the United States were similar. However, by the end of the second quarter of 2021, EU real investment was back to pre-pandemic levels, while US real investment was back to pre-pandemic growth trends. Real GDP declined less in the United States than in the European Union. In the second quarter of 2020, real GDP in the United States declined 9.1% from a year earlier compared with 13.7% in the European Union (14.1% excluding Ireland). The decline in US investment was, as in the European Union, commensurate with the decline in GDP (Figure 2a). That said, investment in the United States had already rebounded to its pre-crisis level and had returned to its previous growth trend by the second quarter of 2021, while in the European Union real investment had only reached the pre-crisis level. Overall, investment in the United States has grown much faster since the end of the global financial crisis. Real investment in the United States has increased by about 4% annually on average since the first quarter of 2010, whereas in the European Union it has grown at 1.7% per year.

Since the end of the global financial crisis, a gap has emerged between the United States and the European Union in the ratio of non-residential investment to GDP, with the European Union trailing the United States by about 2 percentage points. The different components of non-residential investment are moving in different directions. The gap in investment in machinery, equipment and intellectual property products is about 3.5 percentage points of GDP (Figure 2b). The gap in investment in buildings and structures, however, was 1.5 percentage points in the European Union's favour — closing the total gap to 2 percentage points. This composition is particularly worrying as investment in equipment and research and development (R&D) enhances productivity (EIB, 2020). The investment gap between the United States and the European Union is therefore augmenting the competitive edge of US firms.

Figure 2
Total gross fixed capital formation in the European Union without Ireland

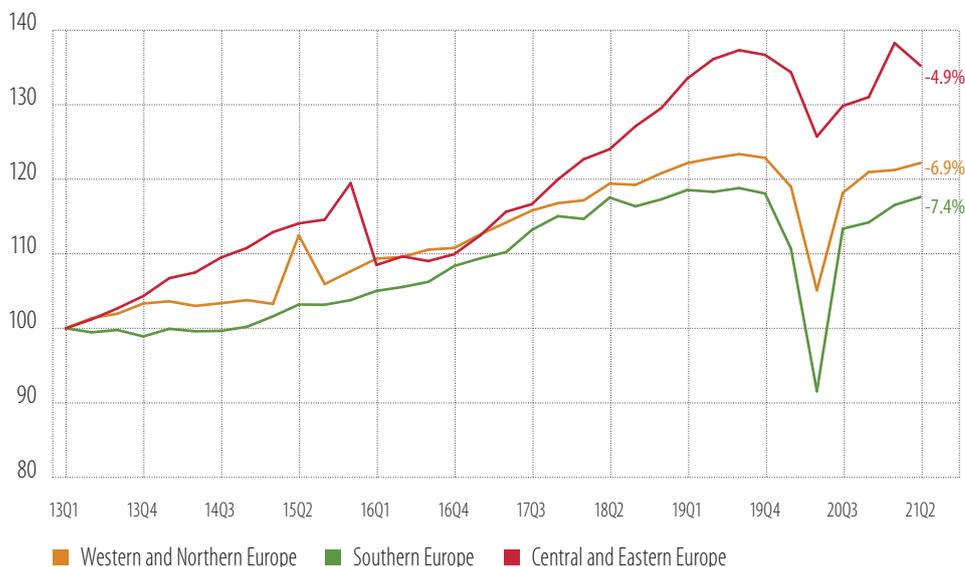


Source: Eurostat and OECD National accounts, EIB staff calculations.

In the European Union, differences in the dynamics of real investment have intensified between countries. Real investment in the European Union returned to pre-pandemic levels in the second quarter of 2021. Real investment therefore took a year to recover from its lowest point in the second quarter of 2020. Real investment is still far off its pre-pandemic trend, and those trends differ across groups of countries (Figure 3). Western and Northern Europe is 6.9% below its growth trend from 2013 to 2019. Southern Europe is 7.4% below its trend, and Central and Eastern Europe is 4.9% (see numbers in Figure 3). The average annual growth of real investment in Western and Northern Europe was 2.9% from 2013 to 2019, while in Southern Europe it was 2.4%, and in Central and Eastern Europe it was 4.5%.

Among asset types, investment in machinery and equipment declined the most in the European Union and remained some 3.5% below pre-pandemic levels in the first half of 2021. The contraction continued throughout 2020, accounting for half of the decline in total investment (Figure 4). Investment in machinery and equipment started increasing again in the first half of 2021, but remained 3.5% below pre-pandemic levels at the end of the second quarter of 2021. Investment in structures and buildings, including dwellings, accounted for about 40% of the decline in total investment. France, Italy and Spain, where the early effects of the pandemic were particularly marked, accounted for 88% of the decline in investment in buildings and structures. The rebound was strong, however. Investment in buildings and structures, including dwellings, rose to 1.7% above its pre-crisis levels at the end of the second quarter of 2021, including in France and Italy, although not Spain. In Central and Eastern Europe, investment in dwellings did not decrease at all during the pandemic, while investment in other buildings and structures fell and remained 3.5% below pre-pandemic levels at the end of the second quarter of 2021.

Figure 3
Real gross fixed capital formation (index 2013Q1=100)



Source: Eurostat National accounts, EIB staff calculations.
Notes: Western and Northern Europe without Ireland.

Figure 4
Real gross fixed capital formation, by asset type
(% change from the previous year)



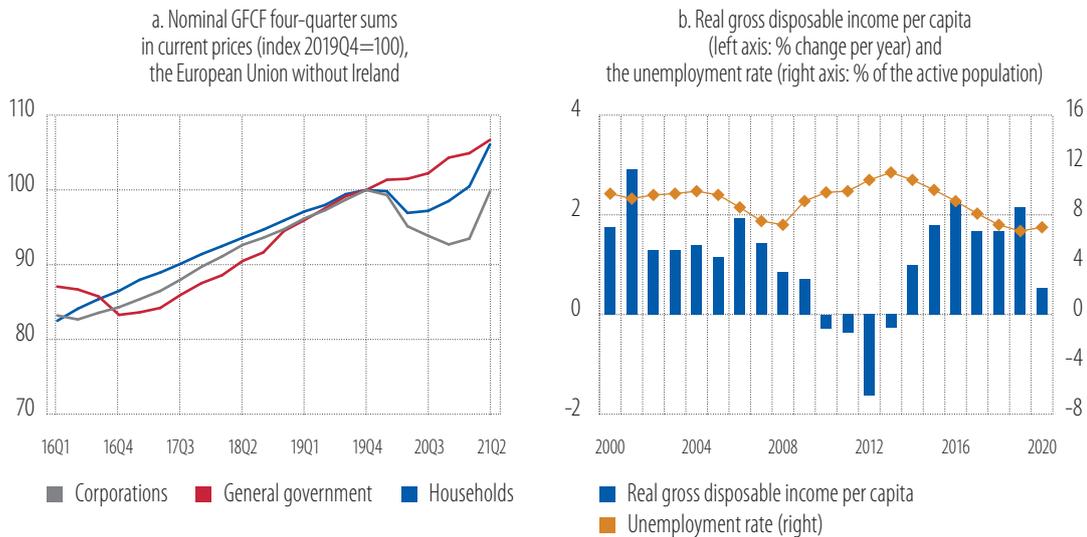
Source: Eurostat National accounts, EIB staff calculations.

Corporate investment declined the most, while government investment increased (Figure 5a). At the end of the second quarter, corporate investment was just 0.22% below the level in the fourth quarter of 2019 and about 7% below its 2013–2019 trend. Household investment, which is almost entirely in dwellings, declined too, but had rebounded to its pre-pandemic trend in the second quarter of 2021. Government investment continued to rise throughout 2020 and early 2021, fuelled by the large-scale fiscal response, but also by the capital expenditure had already been budgeted in 2020, before the pandemic.

The relative strength of household investment is rooted in timely and decisive government support as well as in the specific features of the pandemic-induced recession. Government policies to maintain employment and income kept a tight rein on job losses and protected real disposable income (Figure 5b). These protective measures, along with low mortgage lending rates and the limited tightening of mortgage lending standards, helped maintain demand for housing. Furthermore, fewer disruptions in construction activity relative to the rest of the economy ensured a relatively stable supply of new residences and home refurbishment (Box A).

Figure 5

Gross fixed capital formation, by sector and real disposable income



Source: National and sector accounts of Eurostat, EIB staff calculations.

Box A

The effect of COVID-19 on construction investment

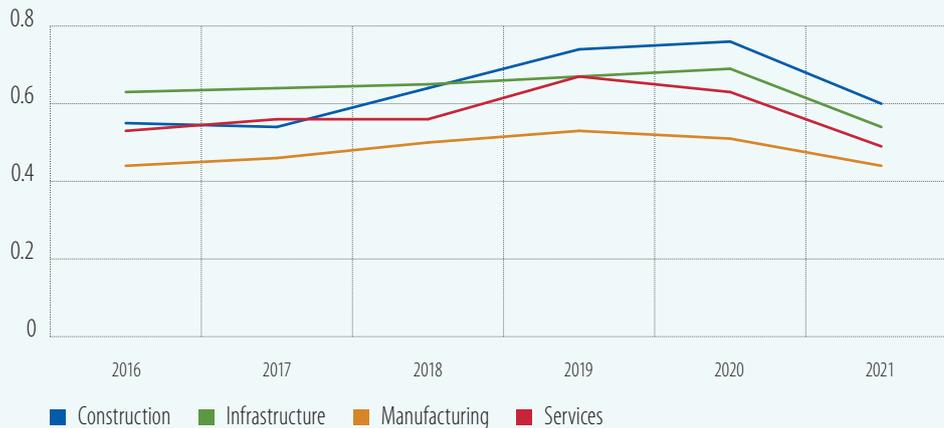
Construction activity and investment suffered relatively less during the pandemic. While investment and economic activity in the construction sector tend to be strongly pro-cyclical, the pandemic was felt less in construction than in sectors. Total gross value added in the construction sector fell less than for the EU economy as a whole overall: -1.3% in 2020 against -4% for the EU27. Activity held stable or increased in most EU countries, helping to offset the extent of the contraction in the economy and investment.

EIBIS data further corroborate the relative resilience of the sector. Fewer construction firms state that they had to abandon or delay investment plans compared to infrastructure, services and manufacturing firms, and a higher share reports working at full capacity or above (Figure A. 1). The

pandemic's effect was less severe for several reasons. Many firms had full order books at the start of the pandemic; they were less sensitive to the disruption in global supply chains, which strongly affected many manufacturing firms, and their activity was less disrupted by lockdowns. These factors allowed construction to sail through the worst of the pandemic.

Figure A.1

Firms (in %) operating at or above capacity, by year



Source: EIBIS, 2016-2021.

Base: All firms.

Note: Full capacity is the maximum capacity attainable under normal conditions, namely the company's general practices regarding the utilisation of machines and equipment, overtime, work shifts, holidays etc.

Question: In the last financial year, was your company operating above or at maximum capacity attainable under normal circumstances?

Policy measures helped to maintain demand for housing and construction activities. Measures to stabilise household incomes and employment, along with low interest rates and the time people spent at home during lockdowns, supported demand for housing. Compared to past crises, government transfers insulated household incomes from the decline in economic activity. Many workers in more high-skilled, better-paid jobs on permanent contracts were relatively shielded from the worsening labour market. Many people watched their savings increase as their consumption declined. At the same time, sometimes mandatory teleworking shifted demand to housing that could better accommodate the remote working. Housing investments held up well as the cost of financing remained very low and lending conditions relatively lenient. Investment in construction by the public sector added to demand.

The construction sector stands to benefit from a favourable outlook due to good recovery planning and structural shifts in the economy. Part of the relative resilience that the construction sector has shown during the pandemic may also reflect other factors. While the majority of firms expect climate change to have an impact on their business (64%, the highest in the sectoral comparison), most see it as a positive factor, notably for demand (Figure A. 2). The European Union's reinforced commitment to climate action and the timely release of recovery funds are likely to increase demand for renovation and more energy-efficient buildings over the next few years. At the same time, demand for affordable and more energy-efficient housing should increase.

While longer-term shifts in consumption and working patterns are still uncertain, construction activity could also benefit from the conversion of commercial real estate to housing and urban renewal measures.

Figure A.2
Impact of EU carbon emissions reduction over the next five years (in %)



Source: EIBIS 2020.

Base: All firms.

Note: Net effect in percentage points.

Question: What impact will the transition to a reduction of carbon emissions have on market demand / the supply chain / reputation over the next five years?

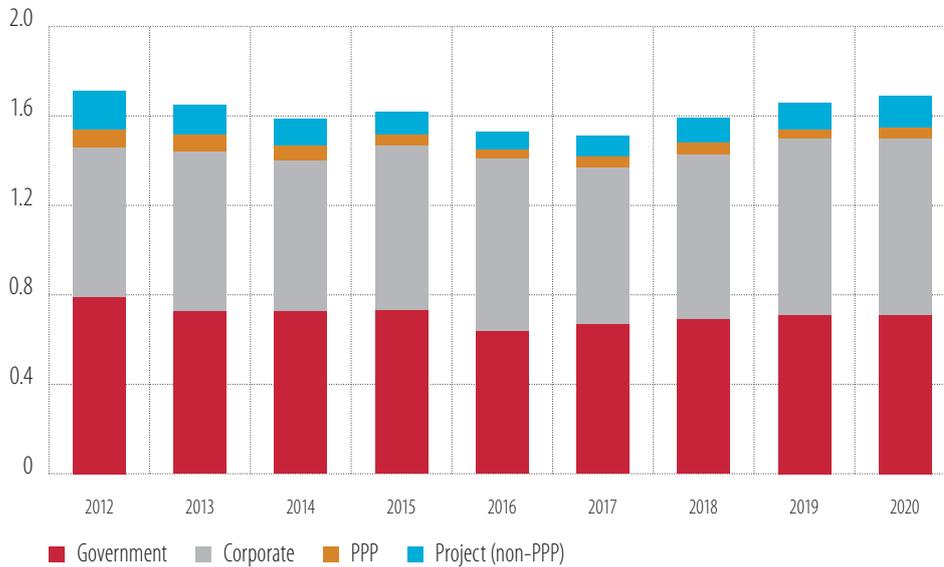
Infrastructure investment

Infrastructure investment is a subset of investment in other buildings and structures. Governments and non-financial firms, including companies focused on one specific project, typically make these kinds of investments. Given the importance of infrastructure for economic and social development, this report pays special attention to infrastructure trends.

In the wake of the pandemic, infrastructure investment declined slightly less than EU GDP (Figure 6). Infrastructure investment had been somewhat subdued since the global financial crisis, notably in southern EU members. From 2018, the share of infrastructure investment in EU GDP started increasing again, after hitting a low of 1.5% of GDP in 2017. Despite contracting in nominal terms in 2020, infrastructure investment's share of EU GDP marginally increased again, reaching 1.7%, mainly because of the larger contraction in GDP. In the breakdown by EU region, infrastructure investment's share of GDP remained constant in Western and Northern Europe. In Southern as well as in Central and Eastern Europe, its share increased, driven by government and corporate investment.

Communication and utilities have driven an increasing share of infrastructure investment, with health and education also making some headway (Figure 7). In the breakdown by asset, transport and utilities, including energy, jointly make up some 60% of infrastructure investment. Utilities' share has risen in recent years and represented just over half of infrastructure investment in 2020. Health's share has also increased since 2017, representing 25% in 2020. By far the largest increase since 2013 has been in communications, however, rising from 9% to 13% in the same period.

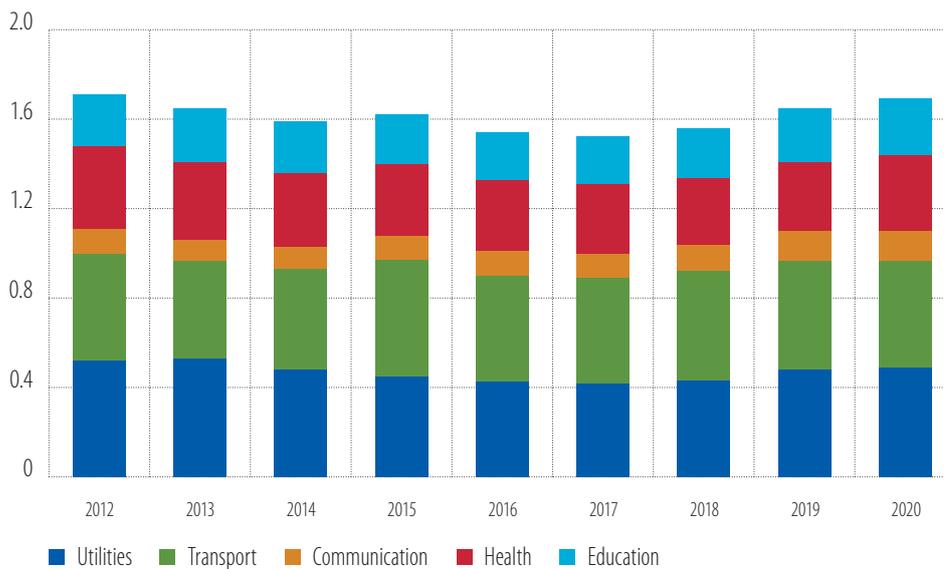
Figure 6
EU infrastructure investment (% GDP), by institutional sector



Source: EIB calculations, European PPP Expertise Centre (EPEC), Eurostat, IJGlobal.

Note: The bars show estimates of annual infrastructure investment in the European Union by institutional sector as a share of EU GDP, expressed as a percentage. Annual infrastructure investment expenditure in the European Union here is estimated using the methodology outlined by Wagenvoort et al. (2010). Non-government infrastructure investment is split into general corporate infrastructure investment, labelled Corporate, and investment by project companies benefiting from project finance. These project companies are further split into public-private partnerships, labelled PPP, and non-PPP investments, labelled Project (non-PPP).

Figure 7
EU infrastructure investment (% GDP), by economic sector



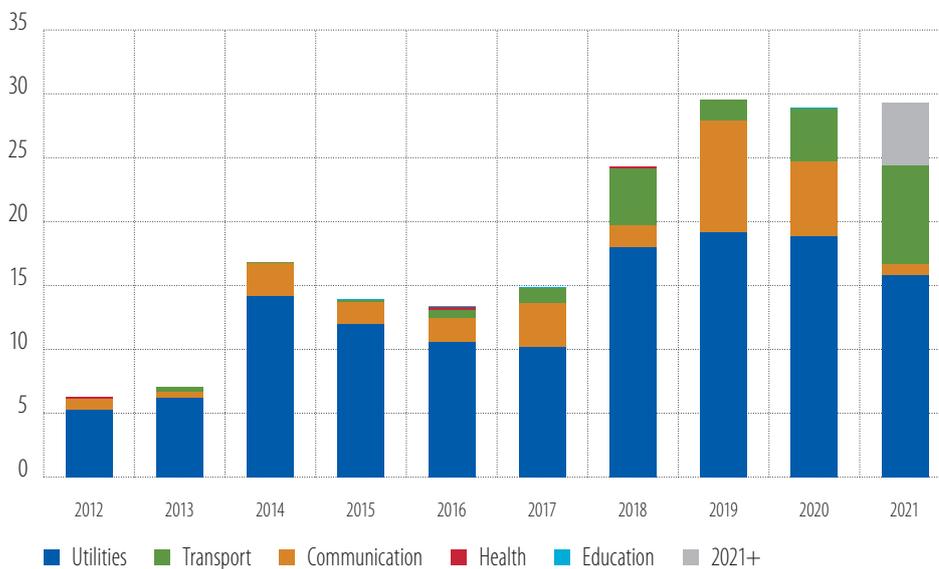
Source: EIB calculations, EPEC, Eurostat, IJGlobal.

Note: Annual infrastructure investment in the EU by infrastructure asset, as a share of GDP, expressed as a percentage. Relevant data are not published for Belgium, Croatia, Lithuania, Poland and Romania. Where sector-specific data are not yet available, the sector share is assumed to have remained constant. The number of data points for 2020 remains insufficient to provide full confidence.

Volumes of infrastructure projects not involving public-private partnerships are stable, although they are declining for public-private partnerships, according to initial data for 2021. These projects make up only a small part of total infrastructure investment, however (Figure 6). Volumes of projects not involving public-private partnerships have remained steady since 2019 (Figure 8). The way these projects are structured may have helped them resist the crisis. After remaining steady in 2020, however, the volume of projects using public-private partnerships collapsed in 2021 (Figure 9). With the exception of utilities, the disruption caused by the pandemic was broad-based and particularly stark for transport, the principal asset type. While the factors driving this contraction are unclear, a certain wait-and-see approach might be at play. To begin with, the preoccupation of governments with their national recovery and resilience plans in 2021 would have tied up administrative capacity. Furthermore, the prospect of significant recovery funds, such as those provided by **NextGenerationEU**, might have affected procurement.

Figure 8

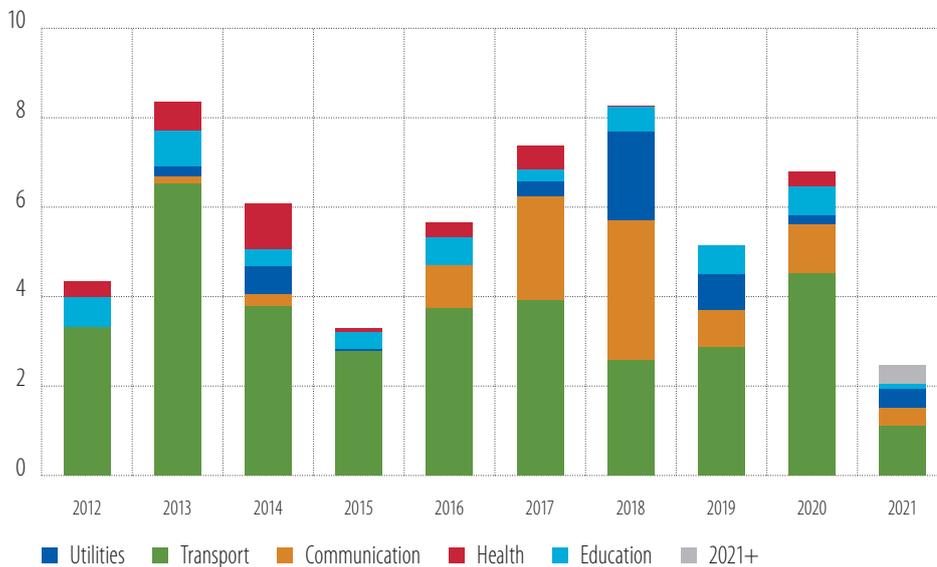
Value of projects without public-private partnerships obtaining financing (EUR billion), by asset class



Source: IJGlobal.

Note: Total annual value in euros of public-private partnership projects brought to financial close in the European Union. 2021 includes deals brought to financial close by 13 October 2020. The grey "2021+" part of the 2021 column provides a simple indication of possible outstanding 2021 volumes.

Figure 9
Value of public-private partnerships obtaining financing (EUR billion), by sector



Source: EPEC.

Note: Total annual value of public-private partnerships reaching financial close in the European Union, in billions of euros. 2021 includes deals brought to financial close by 13 October 2020. The grey "2021+" part of the 2021 column provides a simple indication of possible outstanding 2021 volumes.

Government investment

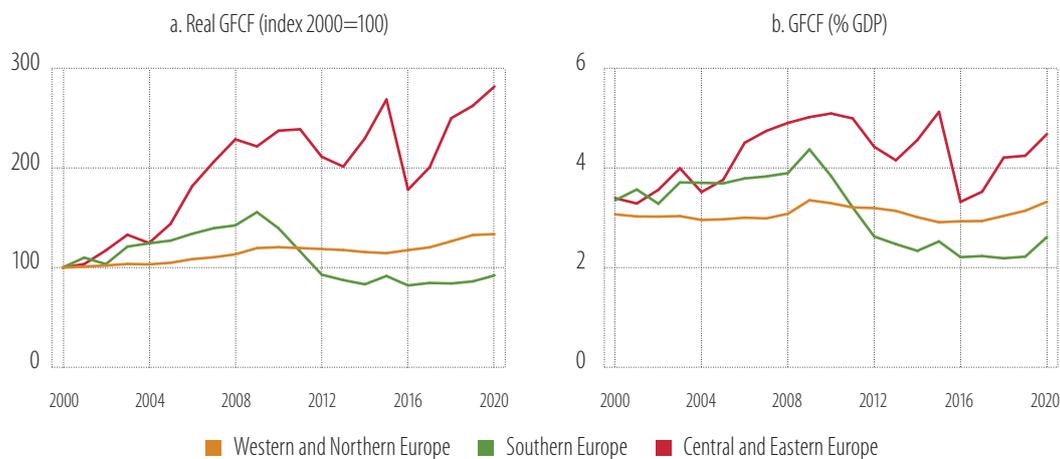
Real investment by the government increased in almost all EU members in 2020, despite the pandemic (Figure 5a, Figure 10a). Compared to 2019 levels, real investment rose about 7% in Southern and Central and Eastern Europe, and slightly less than 1% in Western and Northern Europe. This development reflects the strong countercyclical response of fiscal policy in the European Union. At the same time, much of the capital expenditure was budgeted before the pandemic hit.

The substantial decline in GDP in 2020 further lifted investment rates (the ratio of investment to GDP) across the European Union (Figure 10b). The rate of government investment in Western and Northern Europe increased to just below its 25-year high. In Central and Eastern Europe, the overall investment rate scraped historical highs, too. Government investment as a share of GDP rose to 2.6%, which is still well below the historical average. The increase, however, is a long-awaited and welcome development.

Other government capital expenditure also increased in 2020. In addition to normal investment, governments provide investment grants and other capital transfers, which make up a portion of capital expenditure. Investment grants typically include investment subsidies and incentives that cover part of the costs of acquiring fixed assets. Other capital transfers include transfers to firms or other organisations to cover losses for events beyond the control of the enterprise or debt cancellation, among other things.

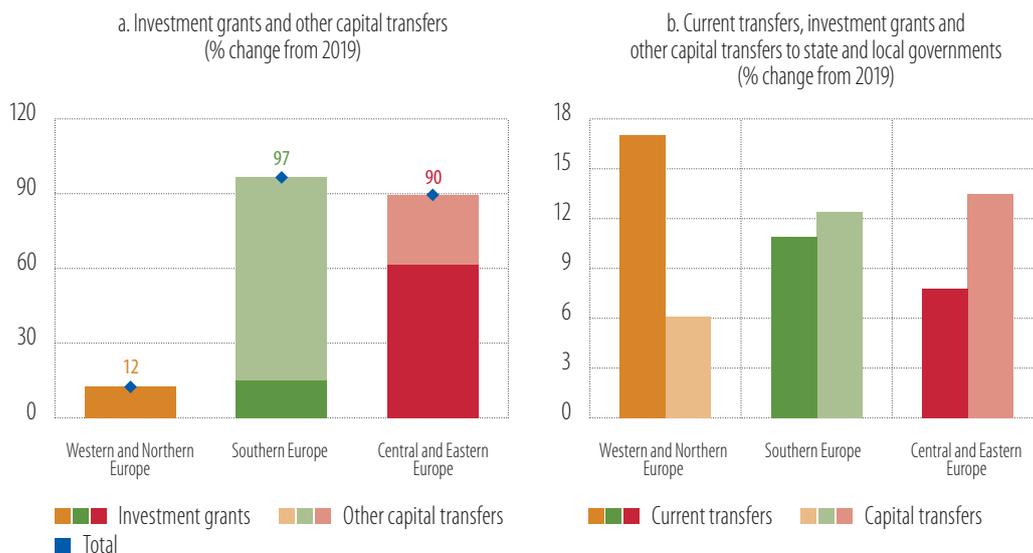
Capital transfers and investment grants rose in 2020, nearly doubling in Southern Europe (97%) and in Central and Eastern Europe (90%). In Western and Northern Europe, these forms of capital expenditure grew by 12% compared to 2019 (Figure 11a). Governments in Southern Europe mostly increased “other” capital transfers not related to investment grants. Those transfers accounted for four-fifths of the increase in the two categories. In Central and Eastern Europe, as well as in Western and Northern Europe, governments relied heavily on investment grants. Governments used transfers and grants as tools to support the economy during the pandemic. While in Southern Europe, governments focused on covering business losses, they focused on investment incentives in the rest of the European Union.

Figure 10
General government gross fixed capital formation and net lending



Source: Eurostat National accounts, EIB staff calculations.

Figure 11
Government investment grants and other capital transfers in 2020

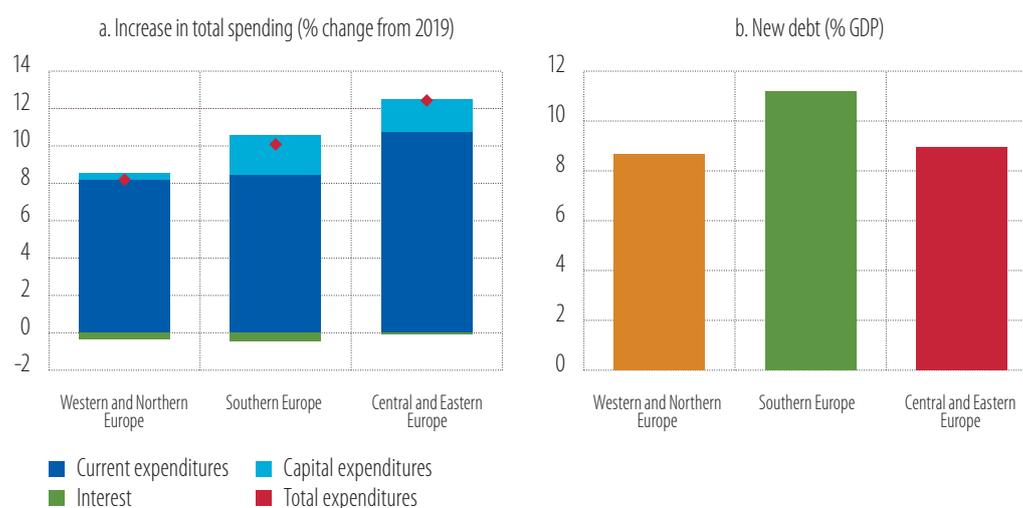


Source: Eurostat National accounts, EIB staff calculations.

State and local governments increased investment in Southern Europe, but they kept investment levels largely steady in the rest of the European Union. Unlike the recession in 2008-2009 that hit Europe after the global financial crisis, state and local governments in Southern, Central and Eastern Europe did not run up deficits to pay for the new investment. In Western and Northern Europe, state and local governments did register some budget deficits, but those deficits were much lower than in 2008. The difference this time was that the higher spending by state and local governments was mostly funded with transfers from the central government. Transfers to state and local governments increased by 8% to 17% in 2020, compared to 2019, while investment grants and other capital transfers rose 6% to 14% (Figure 11b).

The investment increase in 2020 occurred despite the significant, unplanned rise in other government expenditures (Figure 12a). Total government expenditure rose 8% in Western and Northern Europe and more than 12% in Central and Eastern Europe. Much of the increase was for current spending, but capital expenditure also rose and represented up to 15% of the total spending increase in Southern and Central and Eastern Europe. Governments across the European Union were able to increase borrowing and cover the large deficits (Figure 11b) resulting from the exceptional policy measures in 2020, thanks to the suspension of the European Union's Growth and Stability Pact rules and the willingness of the European Central Bank (ECB) to buy government bonds.

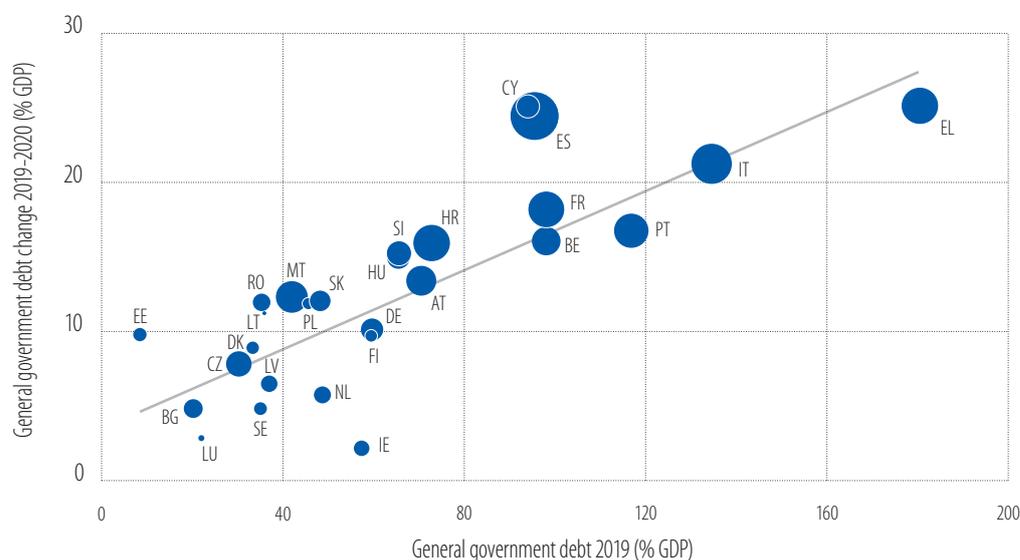
Figure 12
General government expenditure and debt in 2020



Source: Eurostat National accounts, EIB staff calculations.

GDP declined most in countries with higher debt levels, many of which were in Southern Europe (Figure 13). Governments that were already carrying very high levels of debt saw their debt increase significantly. While their borrowing costs are not facing any pressure for the time being, this situation could change quickly. EU fiscal rules of some kind are likely to be reinstated in 2023, and the ECB might decide to wind down its purchases of government bonds if higher inflation persists. EU members should therefore be planning credible policies to rein in debt and to preserve their investment plans. To facilitate the process, the European Union is intensively discussing mechanisms to shield government investment from future belt-tightening. Previous efforts to trim spending relied disproportionately on cuts to government investment. Cutting investment would be very costly at a time when major spending is needed for digitalisation and climate change.

Figure 13
General government debt and growth in 2020



Source: Eurostat National accounts, EIB staff calculations.

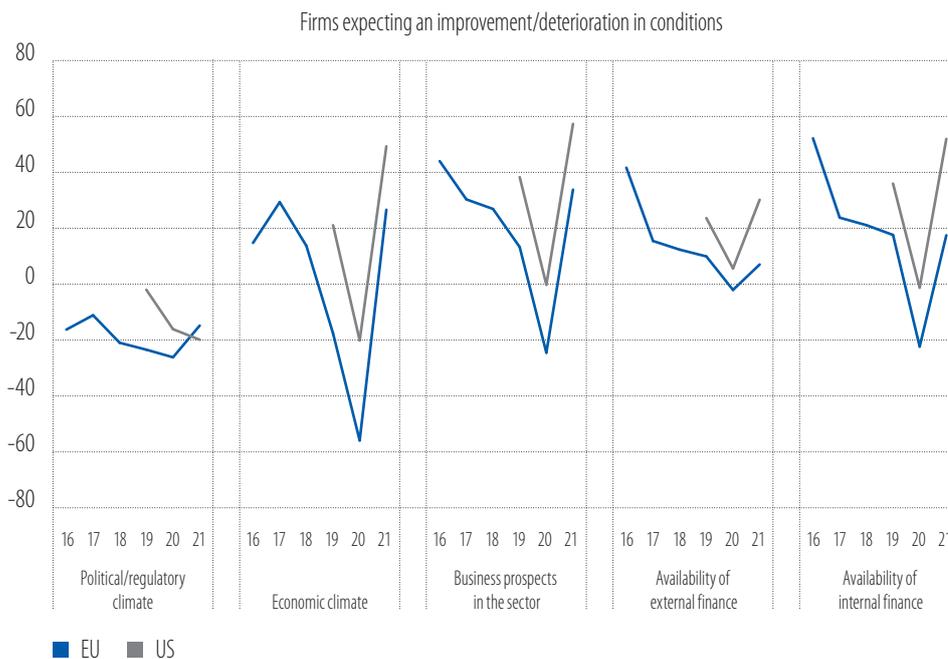
Note: The size of the bubble reflects the size of the decline in real GDP in 2020.

Corporate investment seen through the EIB Investment Survey

Investment cycle and outlook

The short-term outlook in the European Union has improved substantially in 2021 (Figure 14). While the pandemic is not over yet, high vaccination rates in most EU members have paved the way to a gradual return of normal business activity. Compared to recent years, a higher share of firms in the European Union think the political, regulatory and economic climate is improving, along with business prospects. The share of firms expecting to be able to finance their investments with their own resources is the same as in 2019. While the share of firms saying that the availability of external finance has improved is somewhat lower than in 2019, the sentiment has improved since 2020. To compare, the share of firms in the United States that think the economy and business prospects are improving is higher than in the European Union and above 2019 levels, although US firms are less enthusiastic about the political and regulatory climate.

Figure 14
Business sentiment in the European Union and the United States (net balance, in %)



Source: EIBIS, 2016-2021.

Base: All firms (excluding don't know/refusals to respond).

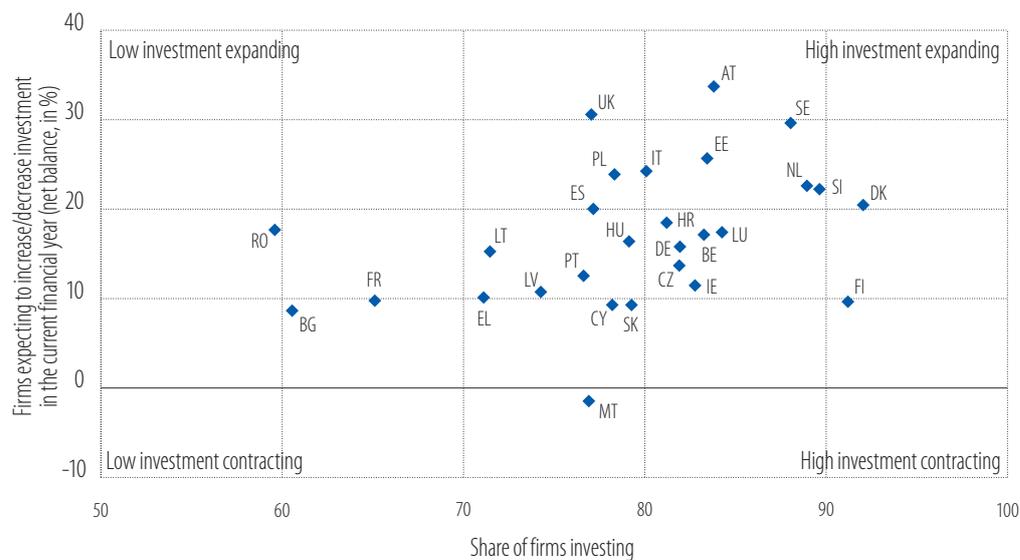
Question: Do you think that each of the following will improve, stay the same, or get worse over the next 12 months?

The share of firms expecting to increase their investment in the current financial year has bounced back from the dismal levels of 2020 (Figure 15). In addition to an improving outlook, the share of firms expecting to increase investment in 2021 has returned to levels seen in the years leading up to the pandemic. The caveat is that investment is expected to rise from a very low base, as many firms cut investment in 2020. Wide differences exist among countries, however, and investment is often influenced by the near-term outlook along and pandemic indicators such as vaccination rates.

The lack of availability of staff with the right skills has returned as the most important impediment to investment in the European Union (Figure 16). In 2020, uncertainty about the future was the main barrier to investment in the European Union, after being in second place for the two previous years. But in 2021, firms are faced with renewed demand as the pandemic wanes, and they are finding it increasingly difficult to hire workers with the right skills. The lack of availability of staff with the right skills is clearly the most commonly cited impediment to investment in Western and Northern Europe — 80% against 68% for uncertainty. In Central and Eastern Europe, the availability of skills (82%) and uncertainty about the future are of equal concern (81%). In Southern Europe, uncertainty about the future is clearly the most reported impediment (88%), well ahead of business and labour market regulations (75%) and the availability of skilled labour (73%).

Energy costs have joined business and labour market regulations as the next biggest impediments to investment. Increased energy costs stemming from rising carbon prices and demand for energy are a concern for European firms. This is especially true in Central and Eastern Europe (69%), where energy costs ranked third in the list of investment impediments. In the rest of the European Union, energy costs ranked after business and labour market regulations, but were nevertheless an important concern for a large share of firms (73%). Box B discusses how a rapid rise in primary energy costs influences investment in climate change mitigation and prepares sectors for the energy transition.

Figure 15
Investment cycle



Source: EIBIS, 2020 and 2021.

Base: All firms (excluding don't know/refusals to respond). Share of firms investing shows the percentage of firms whose investment per employee is greater than EUR 500. The y-axis crosses the x-axis at the EU average in the previous four waves of the survey.

Note: Net balances show the differences between firms expecting to increase investment activities in the current financial year and firms expecting to decrease them.

Figure 16
Barriers to investment



Source: EIBIS 2021.

Base: All firms (excluding don't know/refusals to respond).

Note: A red circle means that the share of mentions of a particular obstacle is in the top quartile; a green circle means that it is in the bottom quartile; an orange circle that it is between the two. The size of the circle and the number inside indicate the share of firms mentioning an area (as either a minor or a major obstacle).

Box B

Will high energy prices drive or deter investment?

The global economic recovery in 2021 brought a sharp rise in the price of energy, particularly gas. Many short-term factors were responsible for the most dramatic price movements, and many EU energy suppliers were able to hedge against higher prices and limit the immediate impact on consumers as winter approached. That said, energy prices are likely to remain high for some time.

A number of concerns have been raised as a result, notably that economic growth could be undermined, or that the determination to push ahead with the green transition could be destabilised. For corporate investment, high fossil fuel prices could push green investment. However, energy costs are also frequently cited by firms as an obstacle to investment. High energy prices could therefore ultimately turn out to be a positive or a negative factor. This box discusses the implications and the likely policy response.

What is driving the current rise in energy prices?

A number of short-term factors influenced the scale and timing of the spike in gas prices in the autumn of 2021. The global rebound in economic activity was one factor, as was the relative energy intensity of output during the autumn, since consumers focused more on manufactured goods while services were slower to recover. The relatively cold winter in Europe in 2020-2021 and low wind-power generation the following summer also led to low levels of gas storage at the start of the autumn.

However, the spike in gas prices also reflects a number of long-term trends and structural factors. European oil and gas production is undergoing a rapid decline as reserves are depleted, reducing the ability of European gas production to act as a buffer to global supply or demand shocks. At the same time, increased demand from Asia has stretched the global liquefied petroleum gas (LNG) market, also limiting its effectiveness as a buffer (BloombergNEF, 2021). At the same time, strategic gas storage capacity (which could cushion shocks beyond the regular yearly cycle) is not uniformly developed or well-coordinated across Europe. The European Emissions Trading System, meanwhile, has functioned as it was designed, with the price of emissions rising with the price of gas to deter substitution by more emissions-intensive alternatives, namely coal.

What is the role of the climate transition?

The global climate transition is increasing the need for energy supply buffers, while the development of new buffers is lagging. The switch to renewables, in China as well as in Europe and elsewhere, comes with greater exposure to weather extremes and a need for investment in energy storage, energy interconnections and increased reserves. Alternative buffers could be provided by hydrogen storage and next-generation nuclear or battery technology further down the line, but the technological development and large-scale infrastructure investment needed to utilise these sources are still lacking. Natural gas storage will remain critical in the medium term, but there is a lack of strategic gas storage in many EU members and limited coordination of this storage at the EU level.

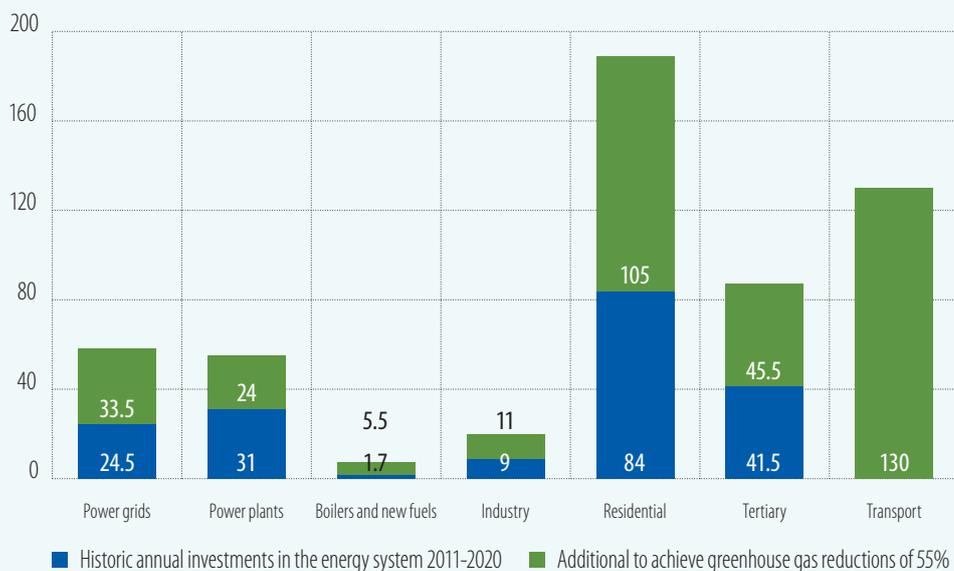
Pushing ahead with the climate transition could solve the current bottlenecks. The climate transition will gradually tackle underlying issues by lowering dependency on energy imports and enhancing the security of the energy supply. For example, investment in energy efficiency will reduce demand for energy, particularly for winter heating, while increased investment in renewables in Europe will boost the amount of energy generated from local clean sources. The development of long-range energy interconnections will help manage irregularity in the power supply resulting from renewables, and other supply or demand shocks. Looking ahead, the climate transition will also entail the development

and implementation of some combination of new technologies to increase stores of energy that can be used as a buffer, such as hydrogen, large-scale battery storage and new-generation nuclear energy.

Europe is paying the price for a lack of progress in some areas, and it will continue to be vulnerable to energy fluctuations, at least during the current decade. Accelerating investment in green energy is essential. With a new, hard deadline of 2050 for reaching net-zero carbon emissions, earlier investment in renewable energy, transmission networks and energy efficiency would have reduced the world's dependence on gas and increased gas's ability to act as an energy buffer. Earlier investment in the development of alternative storage technologies could have helped as well.

As things stand, gas will continue to play a major role in energy systems, and global gas and LNG markets are likely to be under pressure for the rest of this decade, if not longer, with implications for European energy security. The more Europe can accelerate investment in clean energy, including in renewable energy, energy networks and storage, energy efficiency and technological R&D, the faster this vulnerability will be overcome. The European Commission's impact assessments provide estimates on how fast the clean energy transition needs to go to reduce emissions 55% by 2030 and to put Europe on track to achieve net-zero emissions by 2050 (Figure B. 1).

Figure B.1
Average annual investment from 2011 to 2020 and additional annual investment needed from 2021 to 2030 to reduce greenhouse gas emissions by 55% (EUR billion)



Source: European Commission, 2020, "Stepping up Europe's 2030 climate ambition, impact assessment," SWD(2020) 176 final.

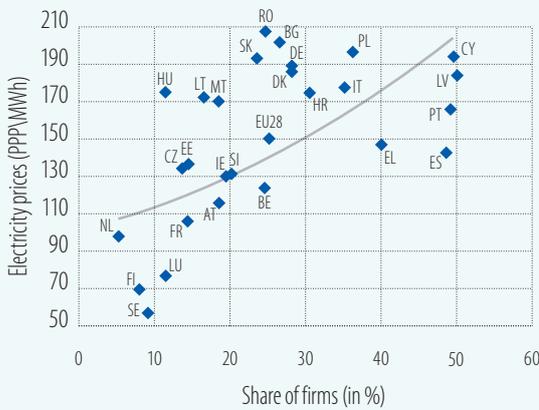
Note: Transport only shows additional, green investments.

What would high energy prices mean for corporate investment?

High energy costs could negatively affect overall investment by firms and slow down the rate of energy efficiency improvements. Firms see energy costs as a constraint that weighs negatively on their profitability and general propensity to invest. EIBIS data show a strong relationship between national electricity prices and firms reporting energy costs to be a long-term obstacle to investment (Figure B. 2). This relationship is broadly confirmed by comparing energy prices and the EIBIS indicator

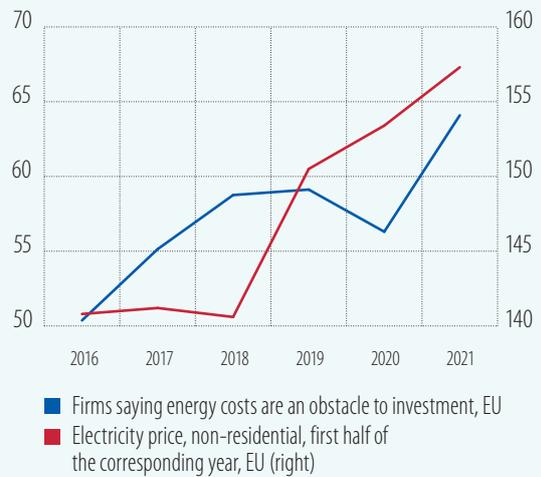
(energy costs as an obstacle to investment) since the introduction of the EIBIS in 2016 (Figure B. 3). Persistently high energy costs could therefore adversely affect corporate investment, including investment that renews the existing capital stock. This could have the perverse effect of hampering advancements in energy efficiency, as well as the adoption of greener energy sources and fuels in industry, the tertiary sectors (retail, offices, etc.), and commercial transport. Older, less energy-efficient machinery, equipment and buildings might be kept in service for longer, despite higher energy costs.

Figure B.2
Firms saying energy costs are a major obstacle to investment, vs. electricity prices (2016-2021 averages)



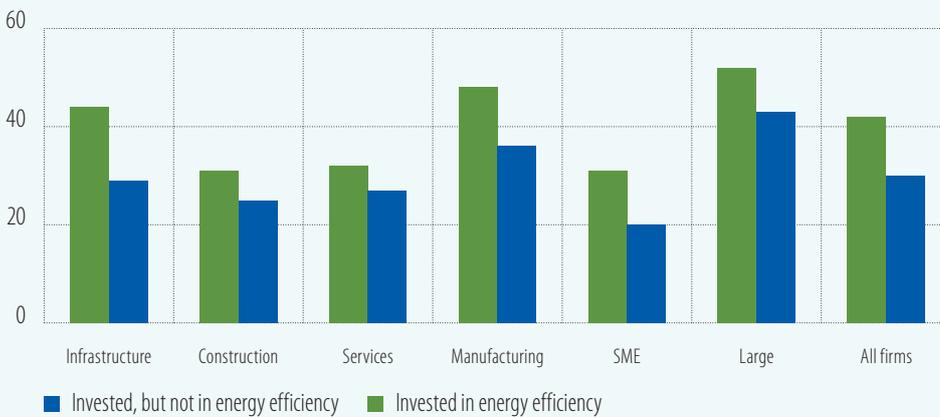
Source: EIBIS, Eurostat.
Base: All firms.
Question: Thinking about your investment, to what extent are energy costs an obstacle?

Figure B.3
EU firms (left axis: in %) saying energy costs are an obstacle to investment and EU average electricity prices (right axis: EUR/MWh, 2016-2021)



Source: EIBIS, Eurostat.
Base: All firms.
Question: Thinking about your investment, to what extent are energy costs an obstacle?

Figure B.4
Firms (in %) perceiving energy costs as a major constraint, by investment in energy efficiency



Source: EIBIS 2021.
Base: All firms.
Question: Thinking about your investment, to what extent are energy costs an obstacle?

However, high energy costs could also push firms to invest in energy efficiency. Energy costs, unlike many other obstacles to investment, are something that firms can partially tackle themselves, through investment that lowers their energy consumption per unit of output. EIBIS data reveal an unsurprising correlation between whether a firm sees energy costs as a constraint to investment in general, and whether it invests in energy efficiency specifically (Figure B. 4). Moreover, higher energy costs will tend to accelerate the depreciation of older, less energy-efficient assets (because improving energy efficiency requires replacement, rather than refurbishment, as in the case of vehicles and much machinery and equipment), and so could potentially also lead to a higher rate of investment overall.

Tackling other barriers to investment can tamp down the negative impact of high energy costs. While energy costs weigh on overall profitability, investment decisions also depend on factors such as financing conditions, policy uncertainty, the availability of skills, the regulatory context, infrastructure constraints and demand. It may be hard to avoid increased energy costs at this stage of the climate transition, but their impact on general investment can be counterbalanced.

Policy implications

The green transition should be seen as the solution to high energy prices, rather than the cause. While it is important to soften the burden on vulnerable consumers, it is also crucial that the policy response eschews market intervention that would promote a switch to coal or reduce incentives for green investment, including by increasing uncertainty about climate policy going forward.

While gas will continue to play a role for some time, accelerating innovation in new technologies would help provide additional energy buffers. Natural gas will continue to play a critical role as a buffer in the medium term. In this context, governments need to devote their attention to improving Europe's capacity for gas storage as well as long-distance interconnections. These efforts will require EU-level coordination. Greater EU-wide energy systems and energy market integration could help cushion energy shocks. At the same time, accelerating R&D investment in next-generation storage and capacity technologies — such as hydrogen, batteries and new nuclear energy — is critical, even if there is still uncertainty about the role each of these technologies will eventually play.

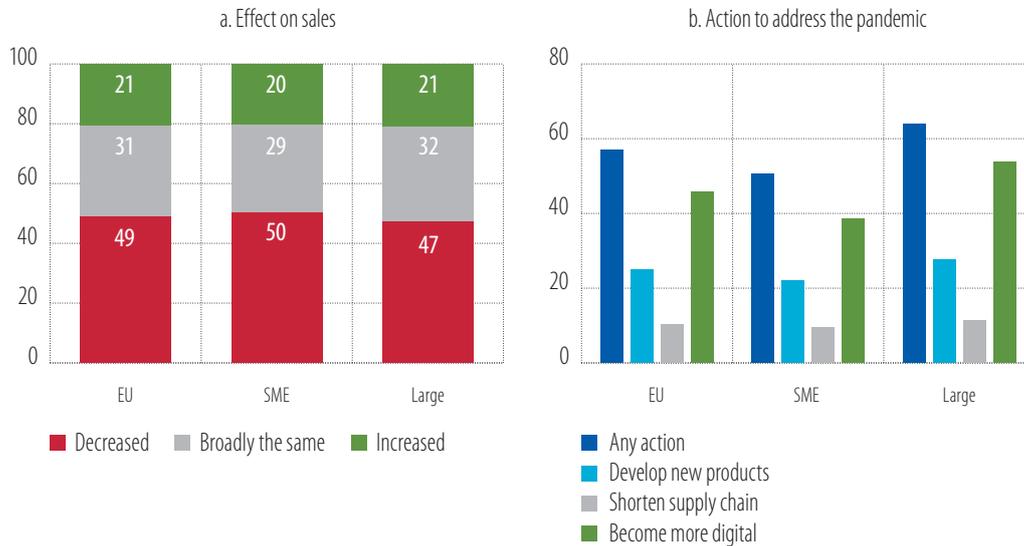
With energy prices likely to remain high in the medium term, an environment conducive to investment is critical for facilitating the needed climate investment. Investment obstacles other than energy costs must therefore be tackled to ensure that energy prices are a help, and not a hindrance, to accelerating the adoption of greener and more efficient technologies.

The pandemic's short-term effects on investment

The social distancing measures and restrictions on movement introduced to curb the spread of the virus have had a major effect on businesses' sales (Figure 17a). Half of non-financial firms in the European Union have experienced declining sales due to COVID-19. Smaller firms are more affected than larger ones. The depth of the decline is different across different firms and sectors. Sales fell less than 25% for about 27% of firms. About 16% of firms says sales declined 25% to 50%, while around 7% of firms experienced sales drops of more than 50%. Some 21% of firms have, on the other hand, increased their sales during the pandemic.

Firms have taken different steps to face the challenges posed by the pandemic. In the European Union, about 46% of firms have addressed the pandemic by becoming more digital (Figure 17b). More large firms increased digitalisation (54%) than small firms (38%). Many firms (25%) also used the pandemic as an opportunity to develop new products or services. Some 10% of firms have adjusted their supply networks to address difficulties.

Figure 17
Effects of the pandemic on the activity of non-financial firms (in %)



Source: EIBIS 2021.

Note: SME refers to small and medium-sized enterprises.

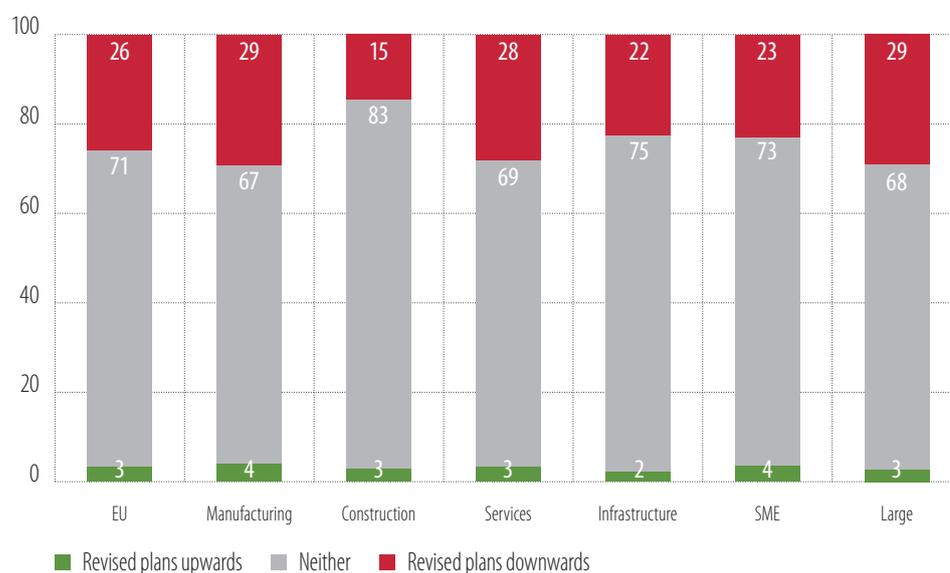
Base: All firms (excluding don't know/refusals to respond).

Questions: What has been the impact so far of the COVID-19 pandemic on your company's sales or turnover compared to the beginning of 2020? (panel a); As a response to the COVID-19 pandemic, have you taken any actions or made investments to...? (panel b)

The pandemic has weighed heavily on corporate investment in the European Union. Since the beginning of the pandemic, 26% of firms have cut back on their investment plans, while only 3% planned to increase spending (Figure 18). Manufacturing firms cut back the most (29%) compared to the other sectors covered in the EIBIS, while construction reported the smallest reduction in investment plans (15%, see also Box A). A bigger share of large firms (29%) reduced planned investment due to the COVID-19 crisis than smaller firms (23%).

The significant share of firms that reduced investment in 2020 was offset by the large number of firms that increased investment in 2021; big firms accentuated the swing (Figure 19). In the European Union, 32% of firms reduced investment in 2020, while 24% increased it. Previous waves of the survey from 2016 to 2019 showed that on average, 18.6% of firms reduced investment relative to the previous year, while 36.7% increased it. This trends clearly changed in 2021, as the share of firms increasing investment exceeded the previous five-year average, and the share of firms reducing investment fell significantly. Large firms are largely responsible for these swings in investment, especially the decline in the share of firms reducing investment. Large firms seem to have adopted a wait-and-see approach amid the uncertainty caused by the pandemic. This conclusion is supported by evidence from EIBIS 2020. About half of the firms that decided to reduce investment in 2020 said that they were merely postponing their investment plans (EIB, 2021).

Figure 18
Change in investment plans due to COVID-19 (% of firms)

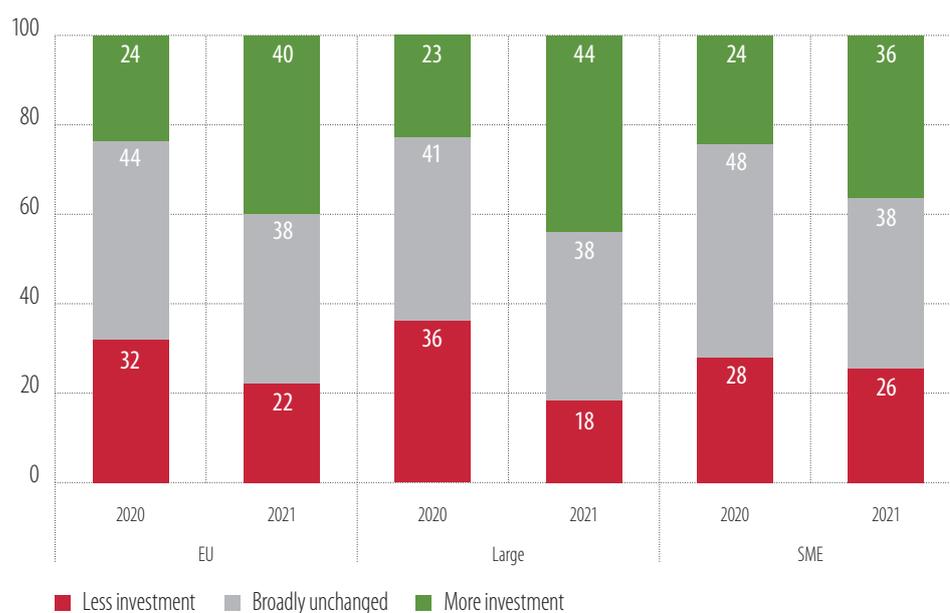


Source: EIBIS 2021.

Base: All firms (excluding don't know/refusals to respond).

Questions: Has your company taken any of the following actions as a result of the COVID-19 pandemic? You mentioned revising your investment plans due to the COVID-19 pandemic. Did you revise them upward or downward?

Figure 19
Investment in 2020 compared with 2019 (in %)



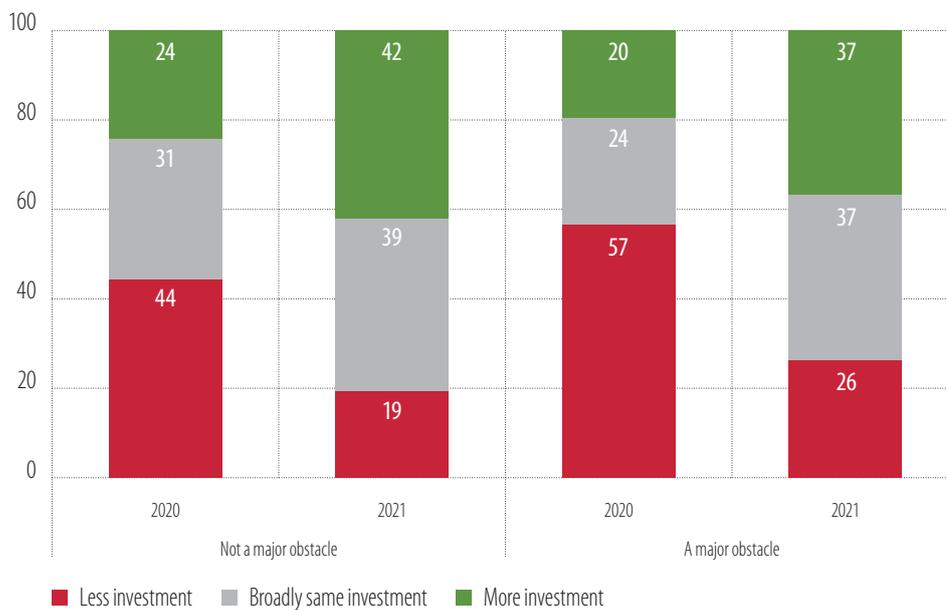
Source: EIBIS 2021.

Base: All firms (excluding don't know/refusals to respond).

Questions: Overall, was this more, less or about the same amount of investment as in the previous year? For the current financial year, do you expect your total investment spend to be more than last year, about the same or less?

Uncertainty about the pandemic and about the effectiveness of government intervention depressed investment in 2020 (Figure 20). In 2020, 57% of firms that said uncertainty was a major obstacle to investment planned to reduce investment compared to 2019. In 2021, only 26% of firms that thought uncertainty was a major obstacle to investment planned to reduce investment compared to 2020.¹ Furthermore, expectations of a recovery in 2021, aided by vaccination programmes and ample government support, reassured firms that postponing their investment plans for 2020 until the following year was a good strategy.

Figure 20
Investment and perceptions of uncertainty (in %)



Source: EIBIS 2020, EIBIS 2021.

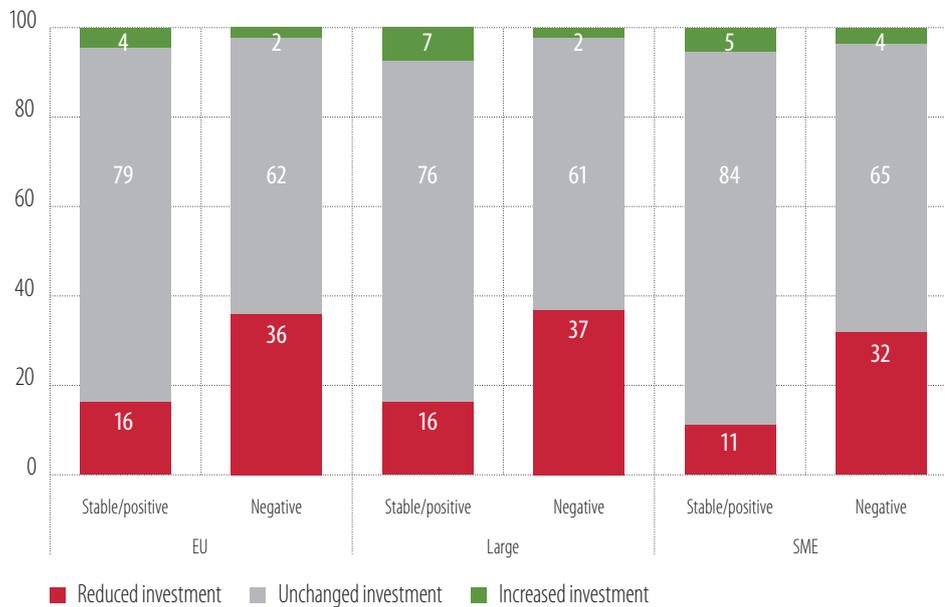
Base: All firms (excluding don't know/refusals to respond).

Questions: For the current financial year, do you expect your total investment spend to be more than last year, about the same or less? To what extent is uncertainty about the future an obstacle to your investment: a major obstacle, a minor obstacle or not an obstacle at all?

A drastic drop in sales made many firms worry that they could not finance investments internally, which led firms to reduce investment in 2020 to preserve their own funds and to avoid over leveraging. The effect the pandemic had on sales caused many firms to revise their investment plans (Figure 21). The share of firms that reduced investment is much higher among firms that saw sales decline (36%) than among firms whose sales were stable or even growing (16%). This dynamic can be seen across firms of different sizes. In addition, the effect the pandemic had on sales is positively associated with how firms viewed the availability of internal and external finance, business prospects and uncertainty about the future.

¹ For each wave of the EIBIS, we run ordered logistic regression analyses on the relationship between investment change and uncertainty as a major impediment, with controls for country, sector and firm size. The results confirm the exceptionally high effect uncertainty had on the likelihood that firms would change their investment plans in 2020, compared to other waves of the EIBIS.

Figure 21
The pandemic's effect on sales and investment (in %)



Source: EIBIS 2021.

Base: All firms (excluding don't know/refusals to respond).

Questions: What has been the impact so far of the COVID-19 pandemic on your company's sales or turnover compared to the beginning of 2020? Has your company taken any of the following actions as a result of the COVID-19 pandemic? You mentioned revising your investment plans due to the COVID-19 pandemic. Did you revise them upward or downward?

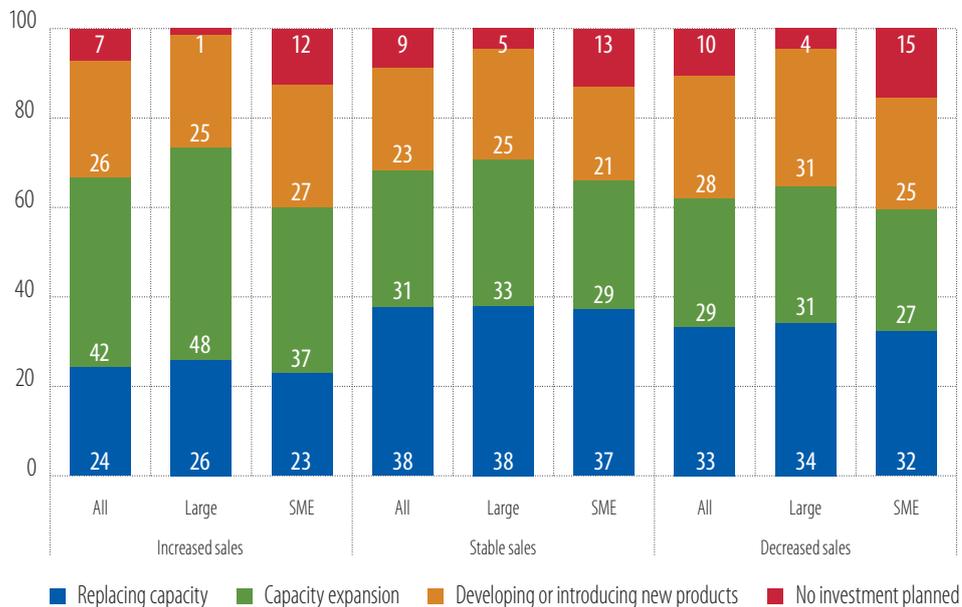
About 16% of all firms reduced investment in 2020, and either maintained the lower level or reduced it further in 2021. The share of firms reducing investment is significantly above EIBIS results in years before the pandemic (9%). Firms that cut investment have generally grown less over the past three years, and they are much more likely to report that they have not invested enough over the past three years to remain competitive. The worry is that these firms might not be viable, and rising number of such firms may lead to the inefficient allocation of resources in the economy and negatively affect productivity.

The pandemic's longer-term effects

COVID-19 affected not only firms' current investment plans, but also their plans for the medium term. Firms' investment plans for the next three years differ depending on the impact the pandemic had on their sales (Figure 22). The higher demand behind the increase in sales prompted some firms to plan to expand capacity (42%). Firms with declining sales were less likely to plan expansions (29%). However, firms with stable sales, thanks to established products generating stable demand, were less inclined to invest in new products (23%) than those with lower sales (28%). Firms with lower sales were looking to offset sales declines with new product lines, while those with increased sales (26%) were eager and able to capitalise on higher demand.

The differences in medium-term investment plans between large firms and small and medium-sized enterprises (SMEs) reflects the difficulties the European financial system has to support firm growth and innovation. Large firms (48%) were significantly more likely to plan to expand capacity during the pandemic than SMEs (37%). Differences, albeit smaller, in plans to expand capacity and invest in new products also exist among firms with stable or lower sales. The problem with growth and innovation finance in the European Union is well-known and largely due to the oversized role bank finance plays in most European economies (EIB, 2020).

Figure 22
Investment plans in the next three years and COVID-19's effect on sales (in %)

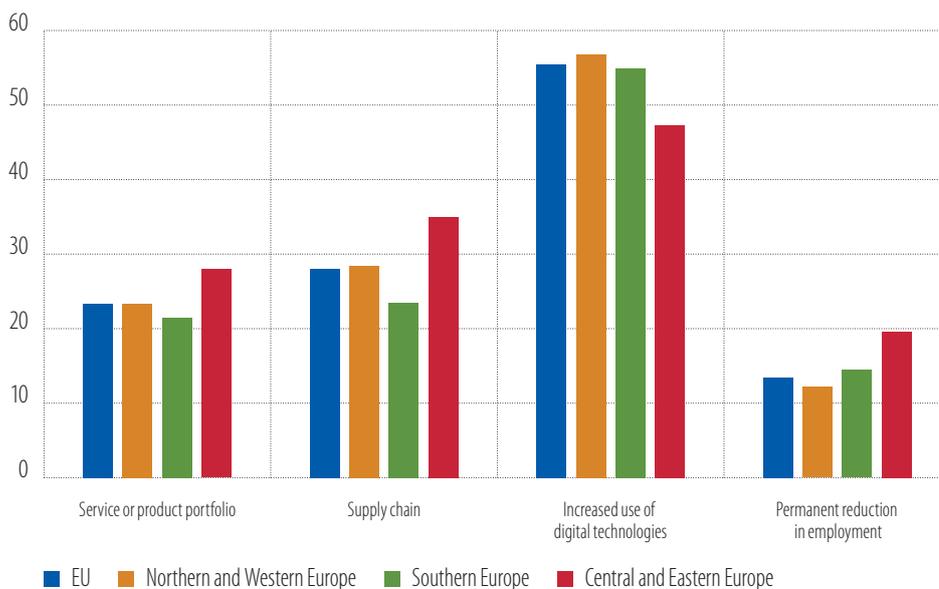


Source: EIBIS 2021.

Base: All firms (excluding don't know/refusals to respond).

Questions: What has been the impact so far of the COVID-19 pandemic on your company's sales or turnover compared to the beginning of 2020? Looking ahead to the next three years, which of the following is your investment priority: Replacing capacity; capacity expansion; Developing or introducing new product; No investment planned?

Figure 23
Long-term effect of COVID-19 (in %)



Source: EIBIS 2021.

Base: All firms (excluding don't know/refusals to respond).

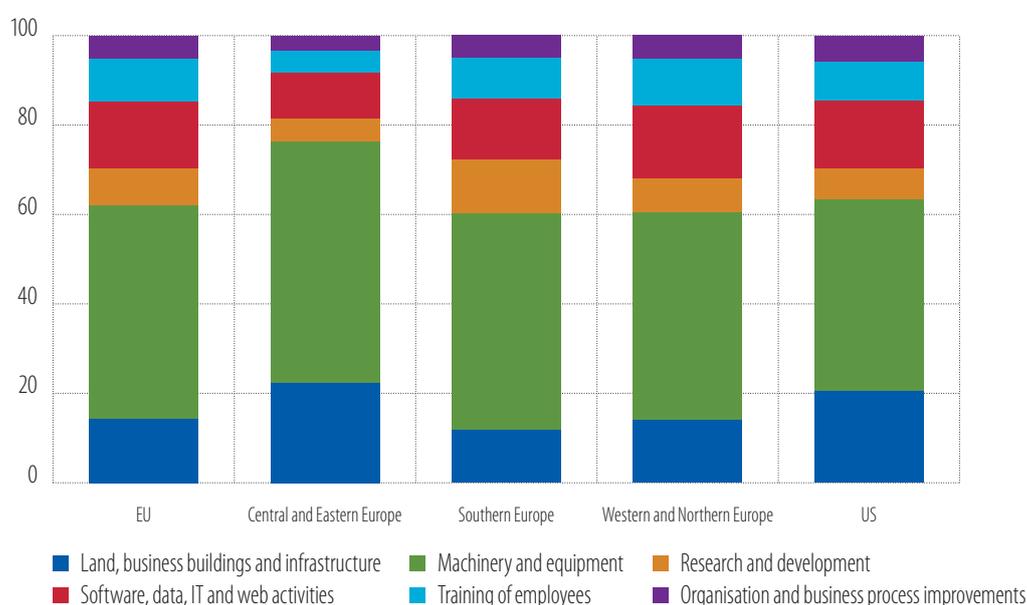
Questions: Do you expect the COVID-19 outbreak to have a long-term impact on any of the following: your service or product portfolio; your supply chain; increased use of digital technologies; permanent reduction in employment?

EU firms expect the pandemic to substantially change how they do business: 72% expect the pandemic to underscore the need for digitalisation, changes in global value chains, more innovation and a permanent decrease in employment. About 55% of EU firms see the increased use of digital technologies as a lasting effect of the pandemic. There is, however, a 10 percentage point difference between firms in Western and Northern Europe (57%) and those in Central and Eastern Europe (47%). Nearly 28% of firms expect the pandemic to prompt enduring changes in their supply chains, while 23% expect changes in their product portfolios as a result of the pandemic. The share of firms expecting these changes is significantly higher in Central and Eastern Europe than the EU average: 7 percentage points more for supply chain changes and 4.6 percentage points for changes in the product portfolio. About 13% of EU firms expect the pandemic to permanently reduce employment. The share of Central and Eastern European firms expecting reduced employment is 7.5 percentage points higher than the share of Western and Northern European firms.

Intangible investment and innovation

Intangible assets — such as R&D, software and databases, employee training and organisation and business process improvements — represents more than one-third of total investment. Intangible assets have become so important that they warrant a special focus in this chapter. According to EIBIS data, EU firms allocated 38% of their total investment to intangible assets in 2020, which is slightly above the US average of 36% (Figure 24). Within the European Union, the share of investment spent on intangible assets is lower in Central and Eastern Europe (24%) than in Western and Northern Europe (39%) or Southern Europe (40%).

Figure 24
Composition of investment (in %)



Source: EIB Investment Survey 2021.

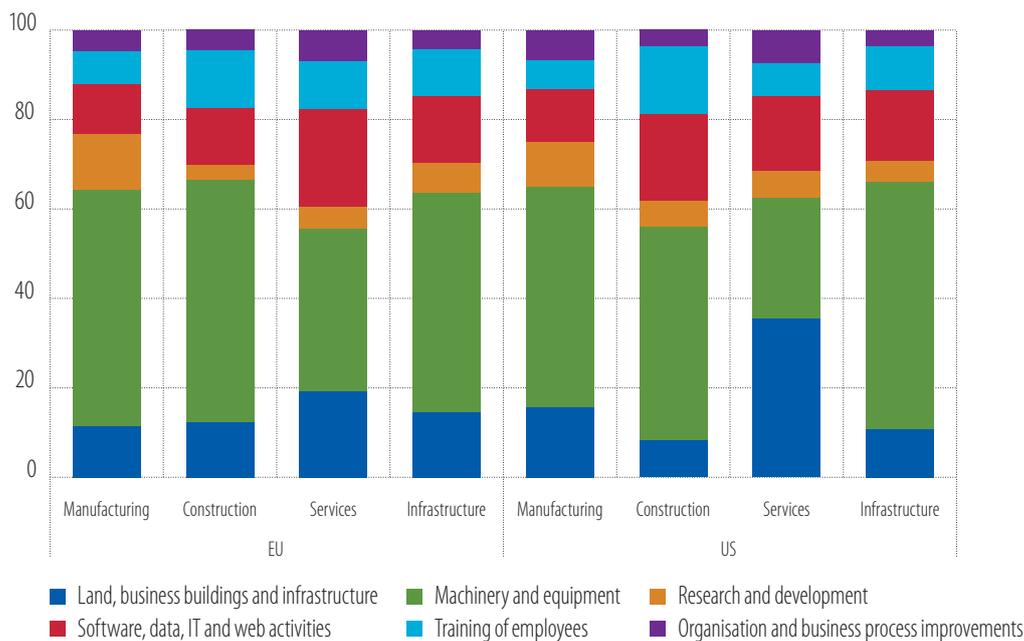
Note: Firms are weighted by value added.

Question: In the previous financial year, how much did your business invest in each of the following with the intention of maintaining or increasing your company's future earnings?

Manufacturing firms tend to invest more in R&D, while firms in services allocate a higher share of investment to software and data, IT and web activities. Manufacturing firms in the European Union allocated 13% of total investment to R&D and 11% to software and data in 2020 (Figure 25). During the same period, EU firms in services only allocated 5% to R&D but close to 22% to software and data. The pattern for US firms is very similar. Overall, machinery and equipment remains the most important investment area for all firms, even for those in services.

Figure 25

Composition of investment (in %), by sector



Source: EIBIS 2021.

Note: Firms are weighted by value added.

Question: In the previous financial year, how much did your business invest in each of the following with the intention of maintaining or increasing your company's future earnings?

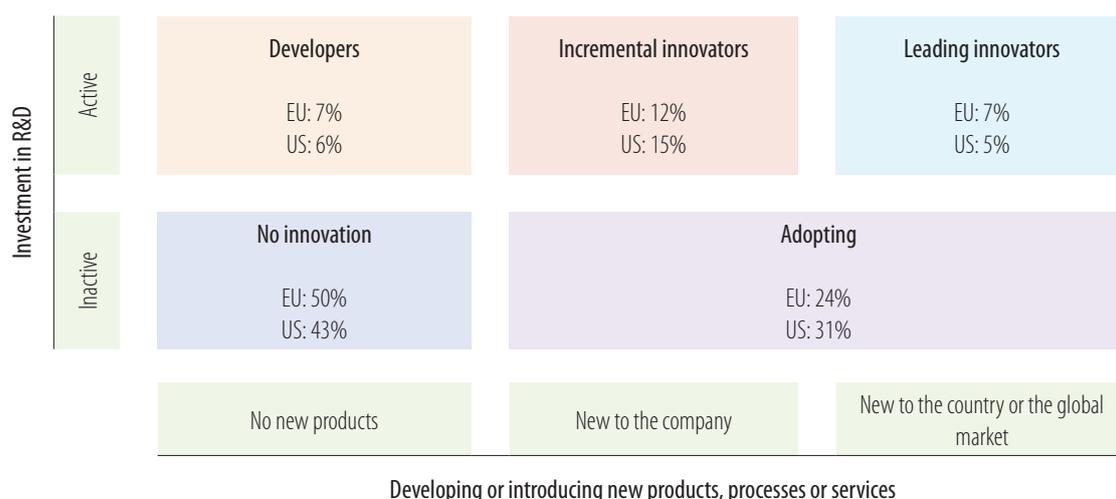
Firms that invest more in intangible assets tend to perform better. They are more likely than other firms to develop or introduce new products, processes or services, and are more likely to export their products or services. They also grow faster, are more competitive and have higher productivity (EIB, 2018). While R&D investment, including the acquisition of intellectual property, strengthens firms, investment in software and databases and in organisation and business processes is also important. Overall, the tendency of intangible assets to complement each other helps spur innovation (Haskel and Westlake, 2017; Brynjolfsson, Rock and Syverson, 2018; Thum-Thysen, Voigt and Weiss, 2021).

The European Union has a higher share of firms that do not innovate than the United States. Firms can be classified under five different innovation profiles based on R&D investment and innovation activities (Veugelers et al., 2019). The five innovation profiles are: firms that do not innovate, adopting firms, developers, incremental innovators and leading innovators (Figure 26). The share of firms that do not innovate — firms that do not invest in R&D and do not develop new products and services — is higher in the European Union than in the United States. A better-tailored innovation policy in Europe could help incentivise investment.

Within the European Union, the share of innovative companies that maintained their innovation activities during the pandemic is higher in Northern and Western Europe than in Southern Europe and Central and Eastern Europe. 41% of innovative firms in Northern and Western Europe report they

invested more in developing new products, processes or services in 2020 than they would have under normal circumstances (prior to COVID-19). Innovative firms in Southern Europe (30%) and Central and Eastern Europe (21%) report the same thing (Figure 27). In Central and Eastern Europe, the firms that innovated less in 2020 (or did not invest in innovation at all) expect their lack of attention to innovation to weaken their competitiveness (23%), compared with 13% in Southern Europe and only 5% in Northern and Western Europe (Figure 28).

Figure 26
Innovation profiles in the European Union and the United States

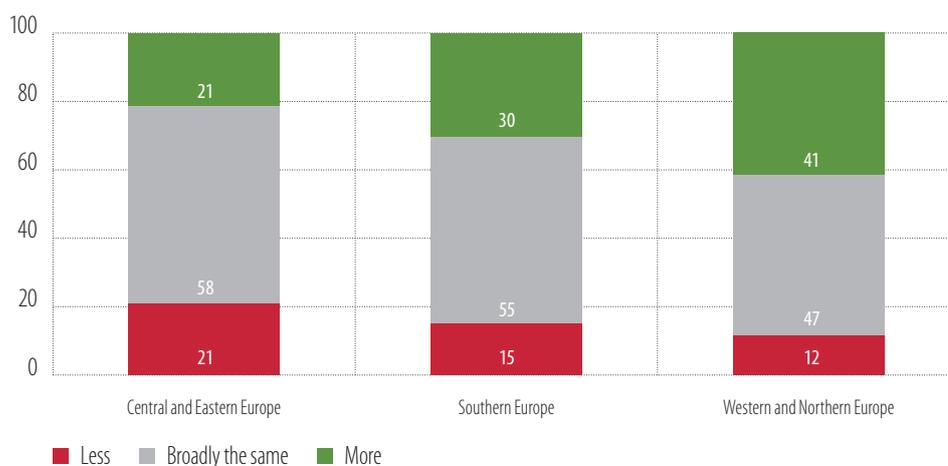


Source: EIBIS 2021.

Note: R&D inactive refers to firms with an R&D investment intensity (R&D investment divided by turnover) below 0.1%. Firms are weighted by value added.

Questions: In the previous financial year, how much did your business invest in each of the following with the intention of maintaining or increasing your company's future earnings? What proportion of the total investment in the previous financial year was allocated to developing or introducing new products, processes or services?

Figure 27
Investment by innovative firms in 2020, compared to before the pandemic (in %)

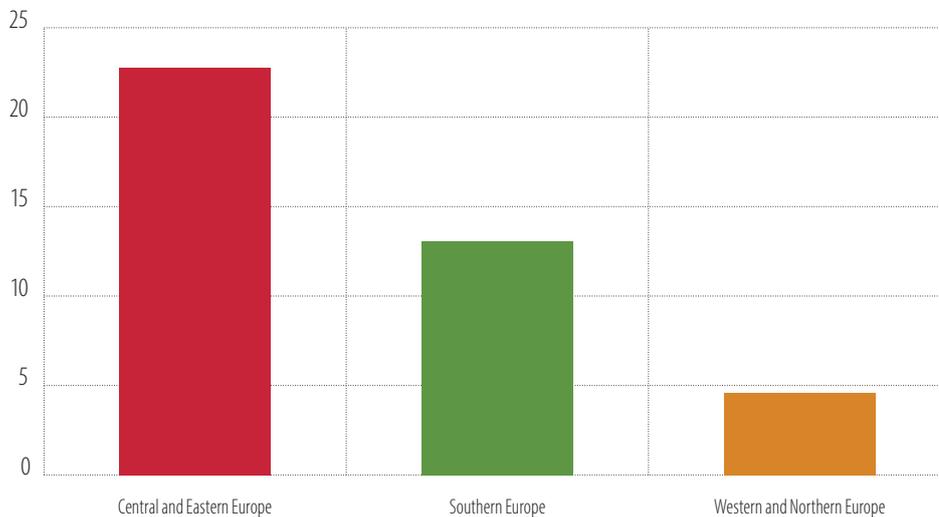


Source: EIBIS 2021 add-on module — sample of EU SMEs in manufacturing and services.

Note: The base only includes innovative firms.

Question Did you innovate less, about the same amount, or more in 2020 than you would have done under normal circumstances (prior to COVID-19)? By 'innovate' we are referring to developing or introducing new products, processes or services.

Figure 28
Firms (in %) expecting that less innovation in 2020 will hurt their competitiveness



Source: EIBIS 2021 add-on module — sample of EU SMEs in manufacturing and services.

Note: The base only includes firms that innovated less due to COVID-19 or did not innovate at all.

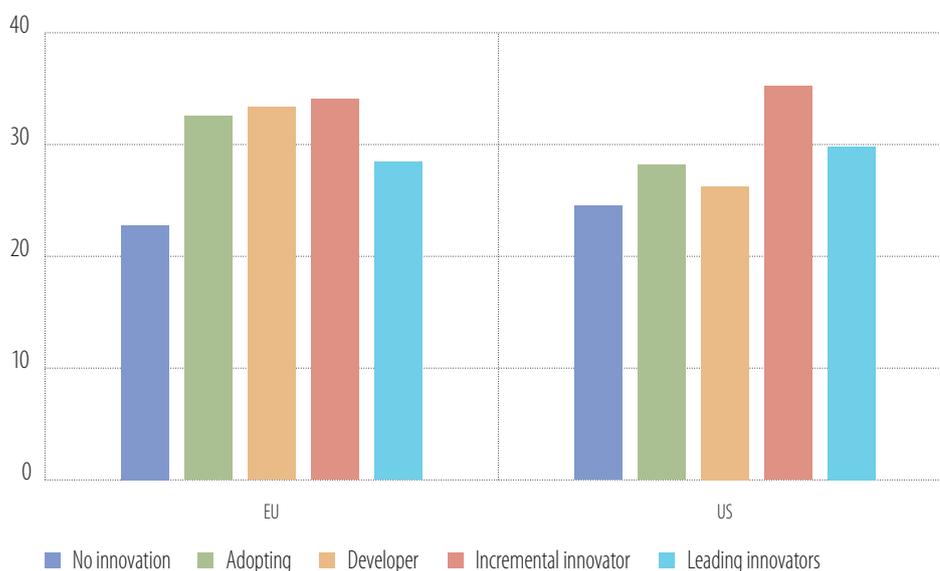
Question: Do you expect the fact that you innovated less in 2020 or did not develop or introduce new products, processes or services in 2020 to disadvantage your company's competitive position relative to others in your market?

Innovative firms are more likely to have increased their workforce during the pandemic. Due to the various policy measures rolled out across EU countries to support jobs during the COVID-19 crisis, employment has fallen less than in the United States (see also Chapter 1 of this report). On both sides of the Atlantic, however, innovative firms are more likely to have hired more staff since the beginning of 2020 (Figure 29). The share of non-innovative firms in the European Union that increased their workforce is 23%, compared with 32% for digital adopters and active innovators (developers, incremental and leading innovators). The difference across innovation profiles is similar for firms in the United States, where innovative firms also grew faster. This result is in line with previous evidence showing that low-skilled workers in the European Union have experienced the steepest falls in employment since early 2020 (Verwey, Licchetta and Zeana, 2021), as innovative firms tend to employ more high-skilled workers. Looking ahead, innovative firms are also less likely to consider that the COVID-19 crisis will lead to a permanent reduction their workforce.

As a response to the pandemic, innovative firms are more likely to invest in their digital transformation. A large share of firms took steps or invested to become more digital during the crisis. But this share varies across innovation profiles. While 42% of non-innovative firms in the European Union have invested in digitalisation, the share rises to 56% for digital adopters and 64% for leading innovators (Figure 30). Addressing barriers to digital infrastructure and skills, which are both major impediments to the adoption of digital technology, should be a priority if policymakers want to support the digital transformation and bridge the growing corporate digital divide observed between the European Union and the United States (Rückert et al., 2021).

Innovative firms are more likely to take steps to shorten their supply chain as a response to COVID-19. Close to 20% of active innovators in the European Union invested to bring more stages of their supply chain to the same location or closer to their domestic market, compared with only 7% of firms that do not innovate (Figure 31). The difference across innovation profiles is even more pronounced for firms in the United States. The trade disruptions caused by the COVID-19 crisis are the likely reason, and innovative firms tend to invest more to address or mitigate these issues. Note also that innovative firms are often more embedded internationally, which gives them more incentives or options to revise their supply chain.

Figure 29
Firms (in %) that increased their workforce during the pandemic

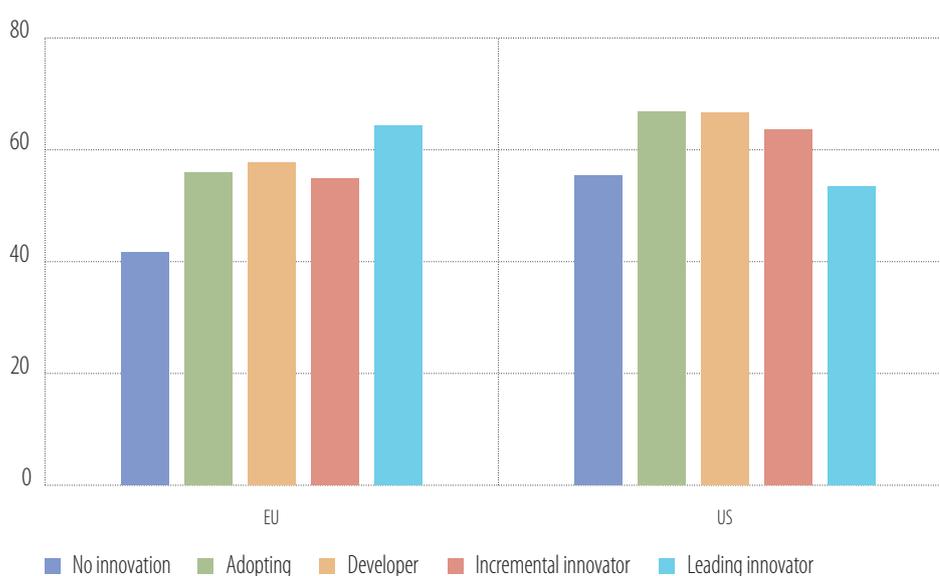


Source: EIBIS 2021.

Note: See Figure 26 for a definition of innovation profiles. Firms are weighted by value added.

Questions: How many people does your company employ either full or part-time at all its locations, including yourself? How many people did your company employ either full or part-time at all its locations at the beginning of 2020, before the COVID-19 pandemic?

Figure 30
Firms (in %) that have taken action or invested to become more digital

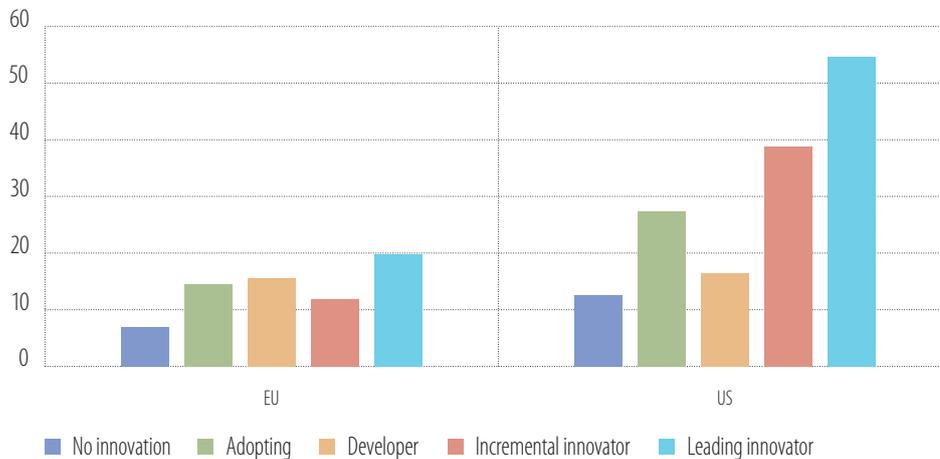


Source: EIBIS 2021.

Note: See Figure 26 for a definition of innovation profiles. Firms are weighted by value added.

Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)?

Figure 31
Firms (in %) that took steps or invested to shorten their supply chain



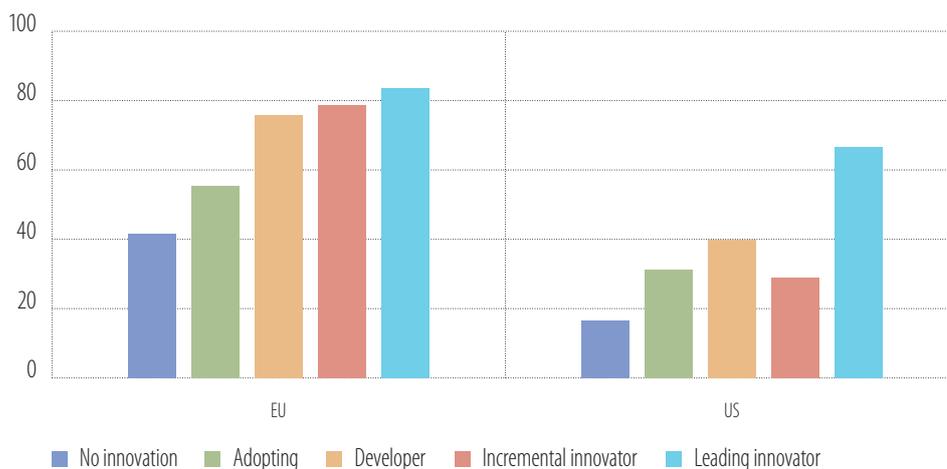
Source: EIBIS 2021.

Note: See Figure 26 for a definition of innovation profiles. Firms are weighted by value added.

Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to shorten the supply chain (bring more stages to the same location or closer to your business's home country)?

Innovative firms are more likely to export their products and services to other countries. Perhaps unsurprisingly, the share of exporting firms in the United States is lower due to the larger size of the domestic market. While 41% of non-innovative firms in the European Union directly export goods or services to another country, this share rises to 79% for incremental innovators and 84% for leading innovators (Figure 32). This result is also in line with studies stressing that exporters tend to be more productive and innovative because they have to compete in international markets and invest in new products to maintain their market share (Melitz and Redding, 2021). However, the correlation between innovation activities and firms' performance does not necessarily imply a causal link.

Figure 32
Firms (in %) that directly export goods and services to another country



Source: EIBIS 2021.

Note: See Figure 26 for a definition of innovation profiles. Firms are weighted by value added.

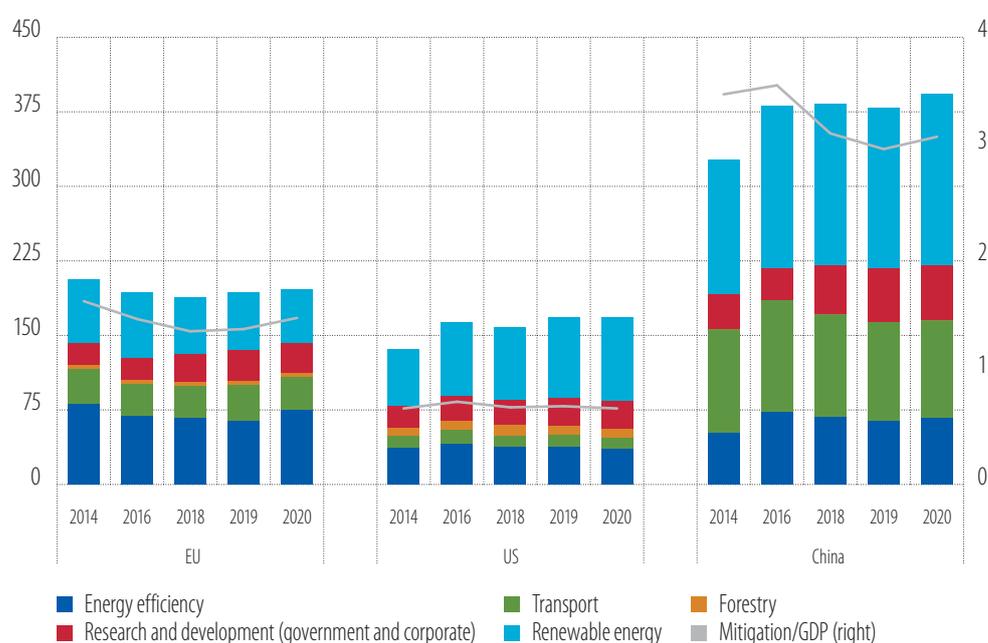
Question: In the previous financial year, has your company directly exported goods and services to another country?

Investment in climate change mitigation

Investment in climate change mitigation as a share of GDP remained stable at 1.5% in the European Union, which is half of the level of China and slightly higher than in the United States. China continues to dominate global clean energy investment, with high investment rates from 2014 to 2020. In 2020, China invested EUR 393 billion in clean energy, more than the European Union (EUR 196 billion) and the United States (EUR 168 billion) combined (Figure 33). China's climate change mitigation investment stood at 3% of GDP, whereas the European Union directed 1.5% of GDP and the United States slightly less with 0.9% of GDP. The investment shares have remained constant over the last five years for the European Union and the United States, while in China the share of GDP spending decreased by 0.5 percentage points in 2020.

Figure 33

Climate change mitigation investment (left axis: EUR billion in 2019; right axis: % GDP), per sector

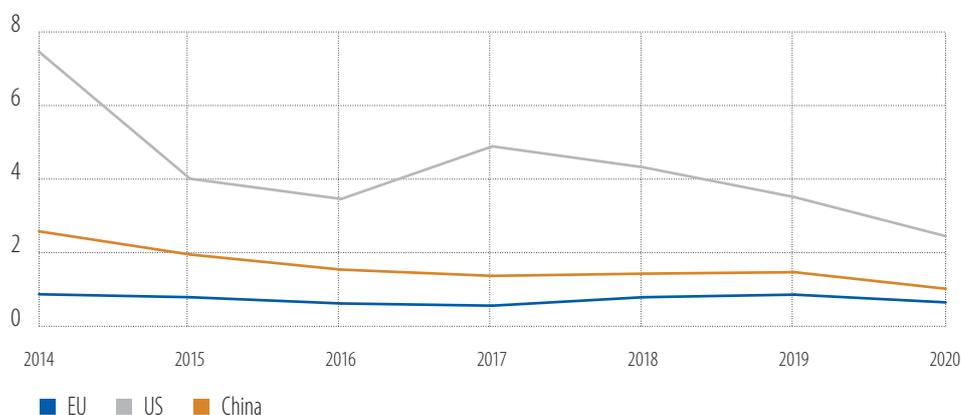


Source: International Energy Agency (IEA), Eurostat, Joint Research Centre (JRC) and authors' estimates.
 Note: Data for investment in forestry in China were unavailable.

In the European Union, investment in climate change mitigation increased modestly by 1.4% in 2020, with energy efficiency driving the upturn. Energy efficiency investment increased by 16%, driven by a consistent rise in spending on electric heat (residential heat pump investments, for example) and electric vehicles (BloombergNEF, 2021). However, investment in renewable energy technologies declined 7% in 2020 to EUR 54 billion. A similar downturn is observed in investment in the transport sector (6.5%), forestry (9%) and research and development (3%). Falling capital costs could explain part of the drop in investment in renewables, but the declines in transport, forestry and R&D appear to stem from the pandemic.

Investment in climate change mitigation in the United States remained stable, while China outperformed the European Union and the United States with a strong push in this area. US investment declined 4–5% in all climate segments, except for renewables (+5%). The upward trend in renewables was probably driven by the significant increase in investment commitments made in previous years. In contrast, all segments of climate investment increased in China, except for the transport sector. Investment in renewables saw the highest growth (7%).

Figure 34
The ratio of investment in fossil fuels to investment in renewables



Source: IEA.

Compared to the United States, the European Union and China seem more dedicated to tackling climate change by accelerating the switch to renewable energy. Investment in fossil fuels in the European Union has declined in the last five years, and was approximately one-third lower than total investment in renewable energy in 2020 (Figure 34). In contrast, investment in fossil fuels outperforms investment in renewables in the United States — it is two-and-a-half times higher — whereas in China the two energy sources are broadly balanced. Since 2014, the United States and China have been catching up with the European Union's ratio of fossil fuel to renewable energy investment, which could be considered a sign of increased climate action. These findings are in line with the European Union's climate ambitions and the level of carbon emissions generated by the European Union, the United States and China (EIB, 2021).

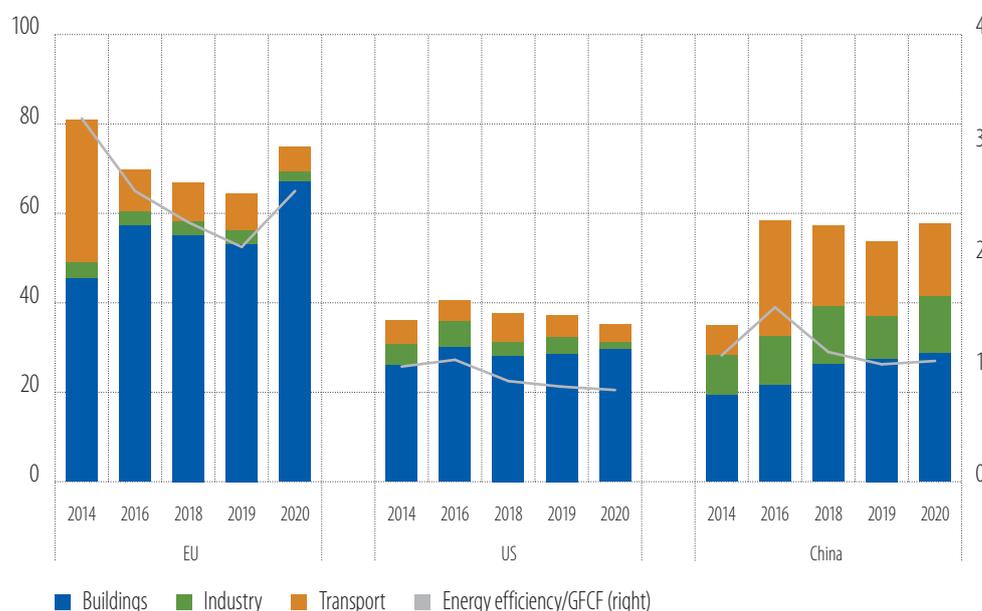
Energy efficiency

From 2014 onwards, the European Union's emissions reduction policies have supported a significant amount of investment in energy efficiency. As a share of total investment expenditure, Europe has spent on average 3.5% on energy efficiency from 2014 to 2020, much higher than the 1% in the United States and 1.5% in China (Figure 35). EU support schemes and funding programmes, specifically aiming to help businesses, regions and countries to implement energy efficiency projects, played a crucial role in determining the pace of investment (International Energy Agency (IEA), 2021).² The European Union is by far the largest investor in this area, accounting for almost a third of global investment, followed by China (25%) and the United States (15%).

² Construction and renovation programmes by the German development bank KfW amounted to EUR 30 billion in Germany. They were the main driver of energy efficiency investment in Europe (IEA, 2021).

Figure 35

Energy efficiency investment by sector (left axis: EUR billion; right axis: % of GFCF)



Source: IEA, Eurostat, OECD.

Buildings attract the lion's share of energy efficiency investments across the three regions.³ In 2020, the share of investment in energy efficiency in buildings was much higher in the European Union (90%) and the United States (85%) compared with China (50%), highlighting the importance of buildings in the European Union's decarbonisation strategy. In absolute terms, the European Union spent EUR 67 billion on energy efficiency in buildings, more than the United States (EUR 30 billion) and China (EUR 29 billion) combined. Moreover, Europe delivered an outstanding increase in investment (27%) in 2020 from the previous year compared to the United States and China, despite the uncertainty caused by the pandemic.⁴

Energy efficiency investments in China focus more on transport. Transport, primarily electric vehicles, makes up almost a third of energy efficiency investment in China — a much higher share than in the European Union (7%) or the United States (11%). China's "double control system" sets efficiency targets relative to a predefined cap (15% improvement in energy intensity and total energy consumption capped at 5 gigatonnes of CO₂ equivalent). To achieve these targets, China has monitored the energy consumption of enterprises, pioneered natural-gas-fuelled vehicles, implemented fuel consumption standards (Sino-Italian Cooperation Program for Environmental Protection, 2016) and established the world's largest electric vehicle market (BloombergNEF, 2021). Despite all this progress, China has a long way to go, as its economy's reliance on energy (energy intensity) remains well above the global average.

³ Investment in buildings includes the building envelope (walls, windows, etc.), heating and cooling systems, control systems, appliances and lighting.

⁴ Collectively, buildings in the European Union are responsible for 40% of our energy consumption and 36% of greenhouse gas emissions. This means that improving energy efficiency in buildings will help the European Union to achieve its ambitious goal of carbon-neutrality by 2050 and, in parallel, be less vulnerable to external energy price shocks.

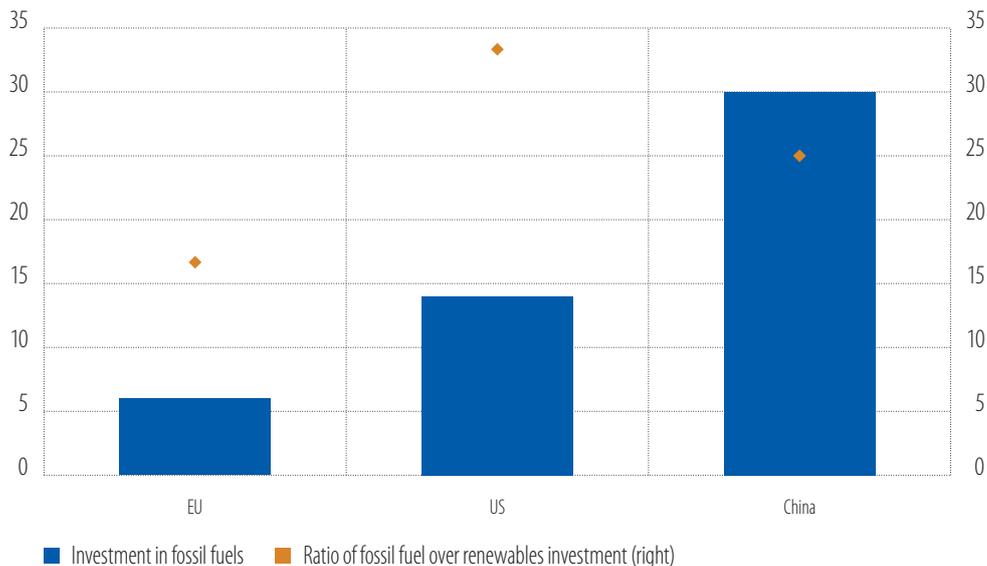
In Europe and in the United States, investment in energy efficiency in transport and industry fell significantly in 2020 due to the pandemic.⁵ In the European Union, these investments fell by a third. In the United States, industry investment was halved and transport reduced by 20%, pushed down by curtailed operations due to the pandemic and reduced output in energy-intensive industries following the economic downturn. Public support in China helped to sustain high levels of energy efficiency investment for industry, which increased 32% in 2020.

Renewables

In 2020, renewables and power grids continued to attract over 80% of power generation investments. The three blocs are decarbonising their power sectors, albeit at a different pace. From 2015 to 2020, the European Union invested on average six times more in renewable energy than fossil fuels. China was not far behind, as investment in renewable energy was four times higher than in fossil fuel-fired generation, and investment was three times higher in the United States. In absolute terms, China invested the most in fossil fuels (EUR 30 billion), mainly in coal-fired power plants, followed by the United States (EUR 14 billion) and the European Union (EUR 6 billion). The European Union invested in natural gas-fired plants to counter the problems of volatile energy supply inherent in the increasing deployment of renewables and the ongoing withdrawal from coal (IEA, 2021).

Figure 36

Comparing investment in fossil fuels and renewables (left axis: EUR billion; right axis: % of renewables), 2015-2020



Source: IEA.

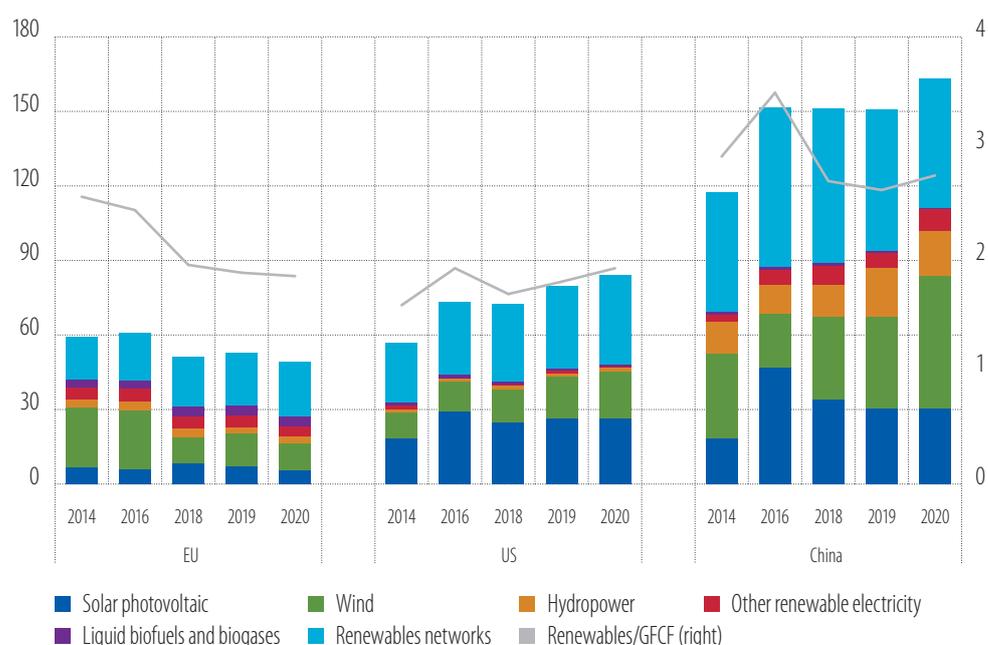
Investment in renewable electricity generation focuses on wind, solar photovoltaics and power grids, aiming to mitigate the volatile supply inherent in renewable energy. In 2020, these three investment categories accounted for 70% of total investment in renewables in the European Union and up to 95% in the United States (Figure 37). Investment in power grids in all three regions is increasing each year to facilitate the growing importance of renewable sources, whose output can be volatile. The

⁵ Industry efficiency investment is heavily affected by the enabling efficiency policies such as energy performance standards and incentive mechanisms for energy and emissions reductions (IEA, 2021).

European Union and China invested more in wind generation than in solar photovoltaics, whereas the United States invested more in solar photovoltaics.

Figure 37

Investment in renewables (left axis: EUR billion; right axis: % of GFCF), **by sector**



Source: IEA, Eurostat.

Investment in wind power generation boomed in the United States and China, but not in the European Union. In 2020 in particular, investment in wind power generation rose a sharp 44% in China and 9% in the United States, whereas in the European Union it contracted by 21%. A similar trend was observed in investment in solar photovoltaics, with a 21% drop in the European Union and a modest increase of 1% in the United States and China. However, investment commitments already made for solar generation show that investment in renewable energy will bounce back to high rates in the European Union next year (BloombergNEF, 2021).

The European Union invested twice as much in biofuels and biogas as the United States and China combined. The European Union is the global leader in this field. In 2020, investment amounted to EUR 4 billion, compared to EUR 8 billion globally and around EUR 1 billion in the United States and China. The European Union also invested heavily in hydropower, which accounts for 16% of renewable power generation, excluding grid-related investment. Hydropower also plays a significant role in China's power generation investments. China, however, invested five times more than the European Union.

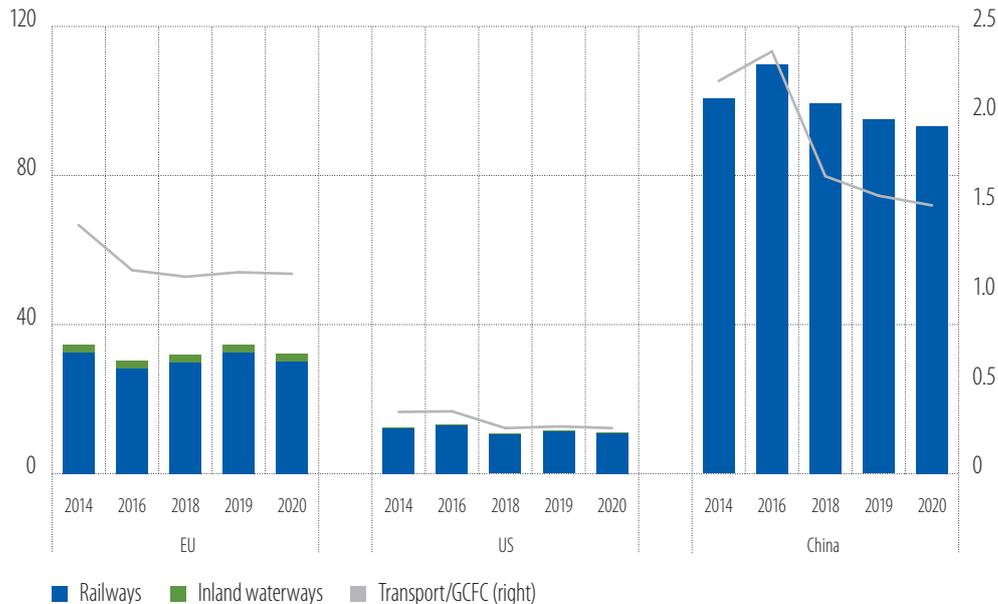
Transport

China is particularly focused on decarbonising its transport sector in the race to achieve net-zero emissions. In 2020, China invested EUR 94 billion (Figure 35) in clean transport infrastructure, which accounts for 1.5% of total investment in the economy. It has a leading position in high-speed rail technology, where it has far more capacity than anywhere else in the world. EU investment in rail and inland waterways is estimated to be EUR 32 billion (1.1% of GFCF) for 2020, while the US investment stood at EUR 11 billion. The US rail-freight system is almost entirely privately owned, unlike road, air and waterways where public

ownership is significant. Investment in railway infrastructure and rolling stock in the United States is financed by private freight companies, and investments ultimately depend on earnings from freight charges, which are regulated by the government.⁶

Figure 38

Transport investment (left axis: EUR billion; right axis: % of GFCF), by sector



Source: Eurostat, OECD.

Investments in clean transport infrastructure account for 17% of the European Union's total investments in climate mitigation. However, this figure is probably underestimated because it does not include all climate change mitigation projects in transport. More transport integration and city planning, better transport management and intermodal terminals would also help mitigate climate change. Nevertheless, investment in this sector is stagnating and efforts must be stepped up to facilitate the switch to less carbon-intensive modes of transport.

Forestry

Investments in forestry have increased steadily since 2014 in the European Union (except in 2020) in response to the urgent need to mitigate greenhouse gas emissions. Forestry investment hit a high of EUR 4.5 billion in 2019, and stood at EUR 4 billion in 2020 (Figure 35), representing about 0.15% of EU gross fixed capital formation. Almost 70% of EU land use, land-use change, and forestry spending is concentrated in three countries: Sweden, Germany and Finland. Sweden accounts for 25% of spending, while Germany makes up 15% and Finland 13%, with the remaining EU countries representing 1-5%. In the United States, forestry investment is stable at 0.2% of its gross fixed capital formation.

⁶ <https://railroads.dot.gov/rail-network-development/freight-rail-overview>

Research and development

Investment in climate-related R&D only suffered a moderate decline, despite concerns at the start of the pandemic. China is consolidating its position as world leader, investing EUR 55 billion in climate-related R&D in 2020, a figure that is almost unchanged compared to 2019. R&D investment in the European Union (EUR 30 billion) is broadly comparable with the United States (EUR 28 billion), but quite different from China. The European Union overtook the United States in 2017 and, despite a decrease of 4.3% in R&D investment for climate mitigation in 2020, is maintaining a small lead.

Figure 39

Public and private climate-related R&D spending (left axis: EUR billion; right axis: % of GFCF)



Source: JRC, IEA and author's estimates.

Note: * stands for projections; the spending concerns activities in line with the EU Energy Union priorities.

Private R&D spending for climate mitigation accounts for the bulk of total R&D expenditure. In 2020, private R&D spending for climate mitigations accounts for around 80% of total R&D expenditure and in China close to 90%. Despite the mild contraction, which is attributed to pandemic-induced budget cuts, the private sector's investment remained resilient from 2015 to 2020.

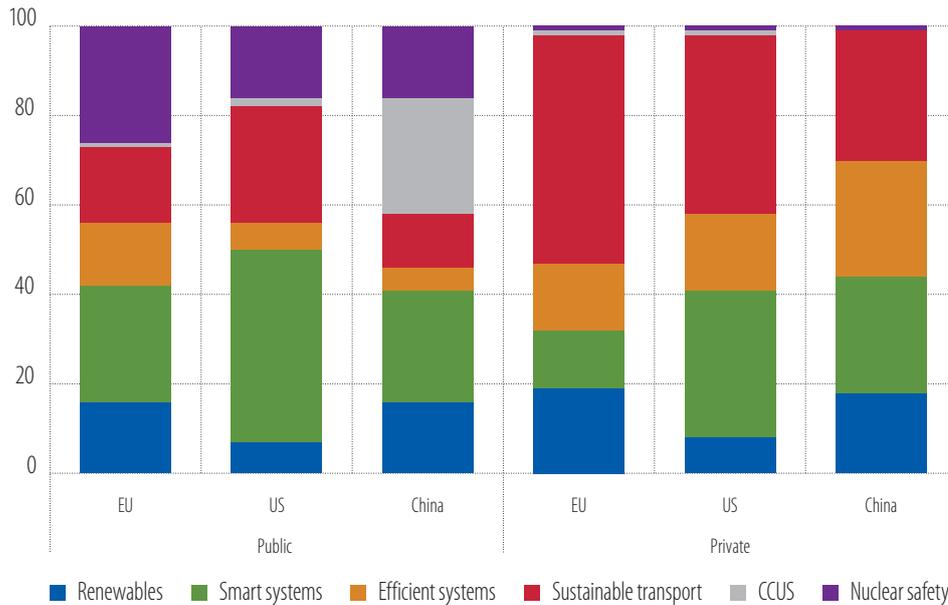
Since 2015, European private investment in sustainable transport has been growing extensively, at about 10% on average. A similar trend exists in China, while in the United States private investment in sustainable transport has increased a mild 3.4%. Government incentives supporting green transport have buoyed private R&D spending. The enthusiasm for sustainable transport contrasts with other climate investments. In 2020, private R&D investment in renewables declined 4.3% in the European Union and 4% in the United States, whereas it moderately increased in China. R&D investment in energy efficiency follows the same pattern as renewable energy.

China led government investment in R&D for climate change mitigation in 2020, spending EUR 5.5 billion. The European Union spent EUR 4.7 billion, placing it third after the United States at EUR 5.2 billion. Smart energy systems and carbon capture, utilisation and storage (CCUS) accounted for more than half of total public R&D investment in China. China's public spending on R&D in carbon capture, utilisation and storage was particularly outstanding compared to the European Union and the United States. Smart energy

systems also represented the main share of total government R&D spending in the European Union and the United States. From 2015 to 2020, public spending on innovation for efficient energy systems grew steadily, with EU expenditure increasing an average of 0.5% annually. However, investment in R&D for nuclear safety remained flat or decreased slightly throughout the five-year period.

Figure 40

Distribution of R&D spending (in %), by sector and energy priority



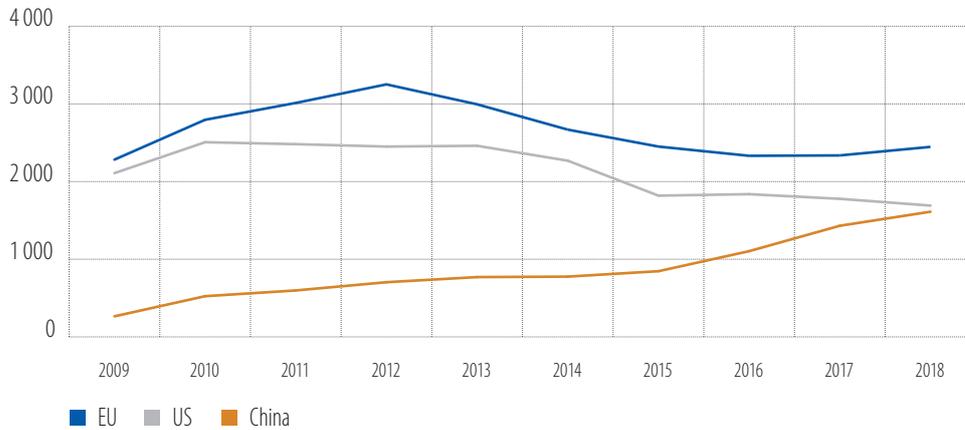
Source: JRC, IEA.

Looking at innovation globally, Europe performs fairly well — particularly for climate-change innovation. Overall, Patent Cooperation Treaty (PCT) applications (filed by applicants seeking international patent protection for their inventions) show that Europe is ahead of China and the United States in climate change innovation (see Chapter 5 for a brief analysis).

China is nevertheless making more headway on internationally oriented innovation. China is showing an impressive increase in international patent filings in climate change mitigation technologies for energy generation, transmission and distribution (Figure 41). China is therefore not only intensifying its R&D spending over time, but also its international presence by increasing the amount of innovation it produces. While energy patents are seeing a lot of activity, new patents are being issued more slowly for other sectors, such as transportation or carbon capture, utilisation and storage.

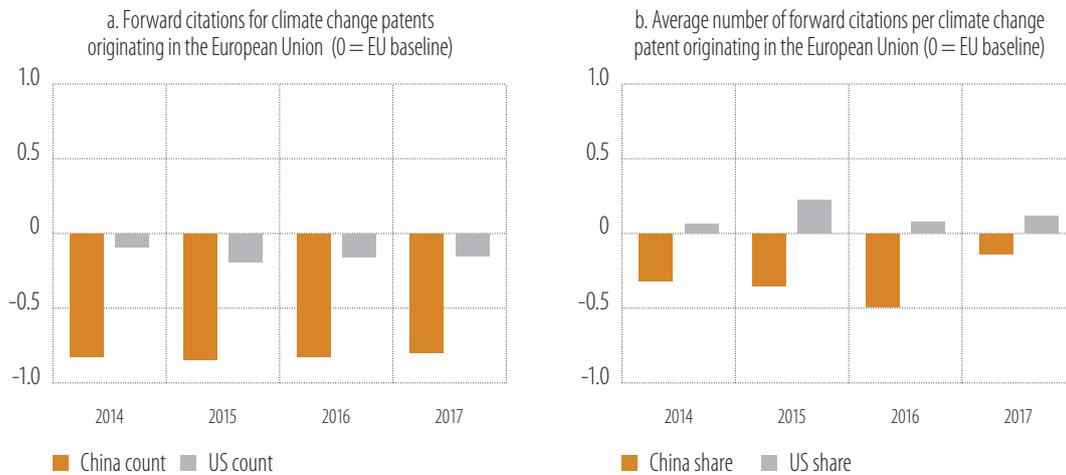
Europe receives the most citations of its climate patents, a measure of its knowledge impact, while China has less of an impact than the United States and the European Union. Figure 42a shows that the European Union creates most patents related to climate change that are actually being used in further development. For the number of forward citations received per cited patent, the European Union and the United States are in close competition, with the United States dominating slightly. In addition, while China was consistently lagging the European Union and the United States on climate patents until 2016, it appears to have changed course in 2017, although no clear trend has emerged.

Figure 41
Evolution of patent applications in climate change mitigation technologies for energy generation, transmission or distribution (patent count), 2009-2018



Source: PATSTAT (PCT) data prepared in collaboration with the Centre for Research and Development Monitoring (ECCOM).

Figure 42
Forward citation counts



Source: PATSTAT (PCT) data prepared in collaboration with ECCOM.

Note: The bars measure the count of patents with forward citations (providing an indicator of the "breadth" of the impact or the number of times knowledge is used) relative to the EU count. Only data until 2017 are shown because forward citations of patents take time to materialise.

Source: Authors' calculations based on PATSTAT (PCT) data in collaboration with ECCOM.

Note: The bars measure the average number of times a patent with forward citations gets cited in a three-year window relative to the EU baseline. This share is computed as the ratio of a patent's forward citations to the overall number of patents with forward citations (providing an indicator of the 'depth' of the impact an individual patent has). Only data until 2017 are shown because forward citations of patents take time to materialise.

Conclusion and policy implications

Gross fixed capital formation in the European Union declined substantially in the first half of 2020. Despite a record initial decline and the large fall in GDP, investment ultimately fell less than expected and rebounded swiftly. Lockdowns and other restrictions on movement, high uncertainty and decreasing cash flows all weighed on firms' investment plans. But timely government support and vaccination campaigns enabled many firms to simply postpone investment from the first half of 2020 to later in the year or to 2021. At the same time, governments maintained, and in some countries, increased their investment, providing an additional boost to the economy.

Corporate investment suffered the most during the pandemic. It declined the most and took more time to pick up again. Evidence in this report suggests that the decline would have been much greater without the massive support provided by governments. As the recovery advances, governments will have to begin phasing out and recalibrating support policies. While a significant number of businesses now enjoy booming demand, a minority of firms continue to experience difficulties, and those difficulties will be exacerbated when governments adjust their support.

The European Union's investment needs have grown since the start of the pandemic. The European Union has experienced a decade of low productivity growth and rising investment needs, particularly to meet the green and digital transition. At the same time, the gap between EU and US investment in machinery and equipment continues to widen, reaching about 3.5% of EU GDP. Furthermore, the green transition will require massive investment, as much as EUR 350 billion per year.

Both the private and the public sector require significant investment. The private sector is constrained by uncertainty, the availability of skills and regulation. For government investment, maximising delivery and impact remains crucial. Governments should use the valuable opportunity offered by the low cost of debt and suspended fiscal rules to continue investing in the transformation of their economies, but also to devise a credible plan for putting their finances on a sustainable path.

Box C

Volatility of gross fixed capital formation in Ireland

The Irish economy is an extremely open economy, with the value of imports and exports in 2020 amounting to 225% of Irish GDP. Foreign multinationals have long operated in Ireland, especially in the pharmaceutical and technology sectors. According to the Irish Development Agency, all ten of the world's top pharmaceutical companies have a significant presence in Ireland and the country is the third-largest exporter of pharmaceuticals globally. In technology, nine of the top ten global technology companies operate in Ireland, including Google, Microsoft, Intel, Apple and Facebook. The complex nature of these firms can make it difficult to say how much of the benefit of the economic activity taking place in Ireland is accruing to Irish residents vs. foreign residents.

Economic activity such as investment and GDP are measured according to the statistical principles set out in the European System of Accounts 2010 (ESA2010), which replaced a framework dating back to 1995 (ESA1995). ESA2010 updated rules for measuring the economy to take into account the increasingly global nature of production and the key role played by intangible assets, such as intellectual property and research and development (R&D) in modern economies. In addition, trade was measured according to a "change in ownership" principle⁷. These new statistical methods had a profound impact on the Irish national accounts.

⁷ The explanations of the statistical problems in Ireland in this box borrows heavily from the "Report of the Economic Statistics Review Group" (2016) from the Irish Central Statistics Office and from Fitzgerald, John, (2016), "Problems with the Irish National Accounts and Possible Solutions", *mimeo*, Trinity College Dublin.

Under the move to ESA2010, expenditure on intellectual property or R&D previously recorded as intermediate consumption became part of investment spending, pushing up investment and GDP. The scale of this spending is large and volatile in Ireland and mainly relates to assets owned and held by foreign multinational enterprises. These enterprises have increasingly relocated intellectual property to Ireland over the last decade. Total investment in Ireland was EUR 70 billion in real terms in 2015 (25% of GDP) but hit EUR 19 billion in 2019 (54% of GDP) before dropping to EUR 147 billion (39% of GDP) in 2020. In both 2019 and 2020, intangible investment accounted for more than 70% of total investment.

This volatility is compounded by a “contract manufacturing” issue. If a foreign multinational wishes to open a production facility in another country, the typical approach is to set up a legally separate subsidiary. In this case, all the operations of the subsidiary are included in the national accounts of the country in which the subsidiary resides. However, in certain industries, these enterprises prefer to have their products manufactured on contract by other companies. This is more common in the IT industry where significant intellectual property is involved in production but the parent company may be unwilling to transfer that intellectual property to a subsidiary in a country with weaker property rights. However, from a statistical viewpoint, the new rules mean the output of the foreign contract production company must be booked in the national accounts of the country where the multinational enterprise is residing. The output of a manufacturing plant in Asia contracted to produce goods or services for a US multinational operating in Ireland will therefore show up in the Irish national accounts.

The other well-known issue in the Irish data is the impact of the aircraft leasing sector. It is estimated that Ireland commands a 60% share of the global leasing market, with more than 50 aircraft leasing companies including 14 of the world’s top 15 leasing firms. HSBC Ireland reports the industry has more than USD 140 billion of assets under management. Aircraft that are purchased by an Irish resident, such as a multinational, are deemed to be Irish assets and this boosts investment in Ireland, even if the aircraft may be leased to overseas airlines and never enter Irish territory. Quantitatively, however, the non-tangible investment issue is more important than issues surrounding transport equipment. The share of this type of transport equipment in total real investment peaked at 18% of investment spending in 2018 but was less than 10% in 2019 and 2020, when Irish investment surged.

Figure C.1
Real investment in the European Union and the EU without Ireland (EUR billion), quarterly data



Source: Eurostat, Central Statistics Office of Ireland.

Figure C.2
Irish real investment (EUR billion), total vs. domestic



Investment in Ireland has grown to the point that it is significantly influencing overall European investment. Figure C. 1 shows real investment in the European Union including and excluding Ireland. The key role intellectual property and R&D from overseas companies plays in Irish investment has prompted the Irish statistical office to publish a modified estimate of investment, which seeks to take out, as far as is feasible, non-domestic intellectual property, R&D and aircraft leasing. As shown in Figure C. 2, domestic investment in Ireland has been relatively flat over the last six years, but total investment fluctuates strongly owing to the activity of multinational enterprises, driven by intellectual property and R&D.

The surge in this activity in Ireland means that EU investment growth in year-on-year terms is inflated in 2019. Comparing the second quarter of 2019 the first quarter of 2020, average real investment growth is 5 percentage points higher when Ireland is included compared to when Ireland is excluded. Investment in Ireland in 2020 remained very large by historical standards but it did not replicate the extreme numbers seen in 2019. Irish investment also fell sharply during the pandemic, and this decline pulled down average EU investment growth from the second quarter of 2020 to the first quarter of 2021 by 4.8 percentage points, meaning the Irish data are causing significant fluctuations in EU investment data.

Would it be better to exclude Ireland from the EU investment data? The data for the EU26, excluding Ireland, would be less volatile: the key question is whether the activity in Ireland is part of EU investment activity. Foreign direct investment in Ireland is dominated by the United States, which finances over 70% of it (Figure C. 3). However, even if the United States is the ultimate owner of many of the intellectual property assets, the inclusion of these assets in European investment would still be warranted if they were predominantly deployed to support European production. The more common practice among IT companies, however, seems to be that the intellectual property assets are used to support global, non-US production, of which Europe is just a part.

Accordingly, the Irish investment data overstate the amount of investment activity that is truly linked to European production. This means that the EU27 data (including Ireland) will overstate European investment but the EU26 data (excluding Ireland) will understate it. Using the EU26 data may be the more conservative approach, given that it is hard to determine how much of the volatility in EU27 investment data is actually tied to European production.

Figure C.3

Foreign-direct investment in Ireland (left axis: EUR billion) and investment coming from US firms (right axis: % of total foreign direct investment)



Source: Central Statistics Office of Ireland.

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PART II

Recovery from the COVID-19 pandemic, scarring and asymmetry

56%

of EU firms **received policy support**

36%

received subsidies

49%

of EU firms reported **a COVID-related drop in sales**

Annual flows in corporate investment in the second quarter of 2020 were

11%

below their 2019 level

4.7%

of EU firms are **finance constrained**, a lower share than before the crisis

In 2021, the **share of firms at risk of default** was **16%**

and the **share of firms at risk of insolvency stood** at

7%

around the peak after the financial crisis

Policy support raised the probability of **increased investment** by

2 to 3

percentage points

A lack of access to finance is an obstacle for **58%**
of firms in the poorest regions
vs. an average of **46%** in the European Union

19%

of firms in the poorest regions expect a lasting **decline in employment**

Business registration
in the European
Union declined

24%

in the second quarter of
2020, compared to the
previous quarter

COVID-induced school
closures **could reduce
students' lifetime
income**
by about **3.5%**
on average

In 2020, **44%**
of **online job ads sought
employees**
that adapt well to change

The share of EU firms **investing in training dropped**

10 percentage
points to **52%**

Firms investing in **digitalisation and climate** are **9 percentage
points more likely to invest in training**

Chapter 3

Firms: Policy support, asymmetry and risks of scarring

The COVID-19 crisis is unfolding very differently from the great financial and sovereign debt crises. This time, policy support — from central banks, financial supervisory agencies, governments and European institutions — is massive and prolonged. Corporate investment is taking a hit, but the impact is well below what was feared at the beginning of the crisis.

As the crisis has continued, it has affected countries and industries differently, and vulnerability has grown. When the pandemic struck, firms borrowed money as a precautionary measure to ensure that they could finance their inventories, costs and working capital. As the crisis went on, risks of defaults and insolvency rose as profits fell. Each successive lockdown has become more targeted. Vulnerability is increasing, but unevenly. Certain industries and types of firms have been hit harder, with smaller companies particularly affected. Because EU members are exposed to the hardest hit industries unevenly, the crisis is affecting them differently, and the risk of asymmetric recovery is growing. Efforts to repair the damage done to corporate finances are dragging down investment, but elevated cash positions and a strong capital base are enabling firms to weather the crisis, as is effective and protracted policy support.

Public support went to the firms most weakened by the crisis, those whose sales shrank the most. Government support was widely distributed, reaching the firms that sustained the steepest losses in revenue as a result of the pandemic. So far, the EIB Investment Survey (EIBIS) for 2021 has unearthed no evidence of public support being misallocated to zombie firms that will be unable to pay off their debts.

Public support has enhanced companies' ability to rebound from the crisis. Policy intervention has weakened the link between sales losses and the scaling down of investment plans. One example is investment in digitalisation. As firms realised how digital capabilities and services could help them weather the crisis, they began to put more emphasis on digital investment. Public support was especially effective in enabling firms to pursue digitalisation, despite the decline in their sales.

Policymakers must navigate the dangers of phasing support out too early, which would jeopardise the recovery, and phasing it out too late, which could weaken the economy in the long term. Several countries have already withdrawn measures that supported firms. Maintaining these measures must be weighed against the risk of hampering the process of creative destruction and possibly lowering economic growth in the medium term.

Introduction

This chapter focuses on corporate investment, and the policies deployed to support firms. It reviews the major developments in corporate investment and financing in the European Union since the beginning of the COVID-19 crisis. At the macroeconomic level, investment has not behaved in line with historical patterns, reacting less to the collapse in economic activity in 2020 than might have been expected. This chapter examines the resilience shown by firms, the economic implications of the crisis for them and the likely consequences for their decision-making. It shows that the overall positive picture masks uneven trends among sectors, and hides the degree to which some firms were weakened by the pandemic.

The first section details how and why the COVID-19 crisis has unfolded very differently from the global financial and sovereign debt crises. Thanks to the policy support deployed during the pandemic, financial conditions and lending terms have remained benign.

The second section analyses the rise in corporate vulnerability. As lockdowns have targeted more specific areas and become less synchronised across different countries, the impact on sectors and firms is increasingly uneven. This asymmetry is compounded by differences in the efficiency of insolvency procedures, posing a risk to a shared recovery across the European Union. Box A specifically focuses on the different trends of high-growth firms during the crisis.

The third section dissects the nature and allocation of public support. This section analyses the diversity of the support provided across European countries. It then shows that support has been allocated efficiently to the most vulnerable — smaller firms and the worst hit — and not tilted to zombie firms unable to do more than service their debt. Box B focuses on the national credit guarantee programmes and the **European Guarantee Fund**.

The fourth section focuses on the recovery. It examines the factors determining whether firms emerge from the crisis stronger. It first looks at the capacity of firms to move across productivity groups. It then reviews the impact of the crisis on their investment and digitalisation. Two boxes are included in this section. The first provides an overview of the literature on policy support. The second summarises the results of the latest venture capital and private equity survey.

The crisis so far vs. the global financial and sovereign debt crises

Access to finance has evolved very differently in this crisis. During the global financial and sovereign debt crises, the flow of credit to firms dried up in several European countries as banks tightened credit standards in response to tensions in bank funding markets and the European sovereign bond market. Companies were forced to deleverage under harsh conditions, and they therefore reduced their investment. During the COVID-19 crisis, firms first shored up their liquidity. Government guarantees allowed them to continue to borrow money, even though their indebtedness increased. The current low cost of debt makes stockpiling cash sustainable in the short term. Later on, however, firms will either have to pay back their debt or roll it over at potentially higher interest rates.

Investment financing conditions

The European Central Bank's policy has restored confidence and maintained benign financial conditions. The European Central Bank (ECB) reacted quickly and boldly to the crisis, effectively maintaining the flow of credit (Altavilla et al., 2020). Financial conditions tightened sharply in the first month of the crisis, but quickly eased and have remained at low levels since then (Figure 1). In the euro area, the yield spreads between EU members' sovereign debt remained narrow as ECB bond purchases largely held risk

premiums in check. The accommodative financial conditions are supporting access to finance and have helped keep the cost of borrowing low, partly compensating the uncertainty caused by the pandemic.

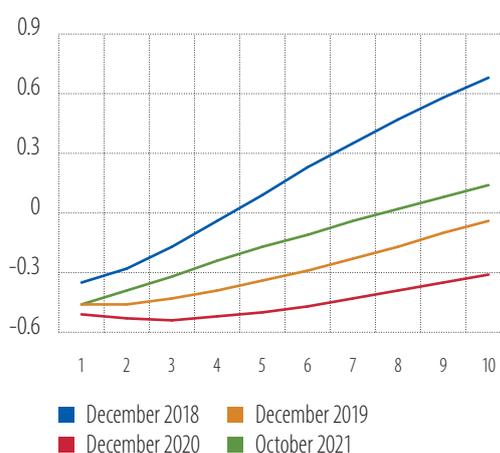
The euro swap curve, which acts as a benchmark for European bonds, reached record lows in December 2020 and has steepened somewhat since then. Figure 2 shows snapshots of the yield curve at various periods. The yield curve was already relatively flat before COVID-19 struck. But it flattened further during the first year of the crisis, with ten-year yields on the euro swap curve reaching -30 basis points in December 2020. Since then, several factors have contributed to a steepening of the curve. First, the vaccination rollout encouraged a gradual return to a form of normality. Second, the US and European economies bounced back strongly. Third, inflation expectations rebounded.

Figure 1
Euro area financial conditions index
(rise=tightening)



Source: EIB estimates based on Andersson et al. (2021).
Note: Last record is June 2021. An increase reflects tightening.

Figure 2
Snapshot of the yield curve
(percentage points per year)



Source: EIB estimates based on Refinitiv, a provider of financial market data.
Note: Snapshots of the euro overnight index swaps curve at various dates. The maturity in years is indicated on the x-axis.

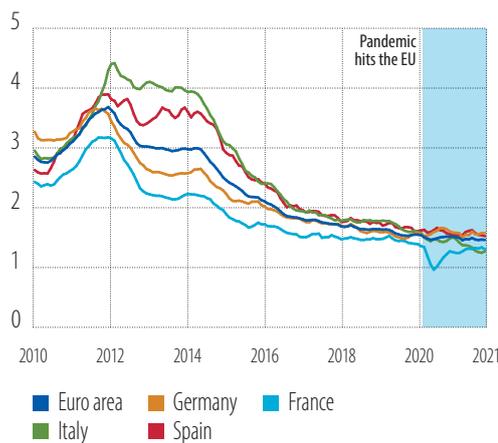
In the European Union, a further rise in bond yields cannot be ruled out, but it should remain contained as asset purchase programmes are gradually wound down. Short-term rates should remain at ultra-low levels until 2023, when the ECB could start raising rates, according to market expectations. The ECB's pandemic emergency purchase programme may well be phased out in the first half of 2022, possibly resulting in a steepening of the curve at its long end (longer maturities). The change should, however, remain limited, and it shouldn't spell the end of low interest rates.

The low cost of finance increases firms' ability to withstand shocks. Figure 3 shows trends in the cost of bank borrowing for firms in the euro area. Given the prominent role of bank finance, the rates charged by banks have a major impact on external financing costs. The cost of bank borrowing has remained almost unchanged since the start of the COVID-19 crisis, lingering at very low levels. Moreover, in contrast to the sovereign debt crisis, the spread between the cost of finance for firms in the more vulnerable countries, where public indebtedness is higher, and those in other countries has not increased. The same is true for risk spreads, with the exception of the very first months of the crisis, when they escalated before being compressed by the ECB's policy response.

In contrast to previous crises, the spread in rates charged for different types of loans has not widened. Borrowing costs for small loans, a good proxy for lending to small and medium-sized enterprises (SMEs), have continued to fall in recent months, in particular for short- and medium-term maturities. In the six

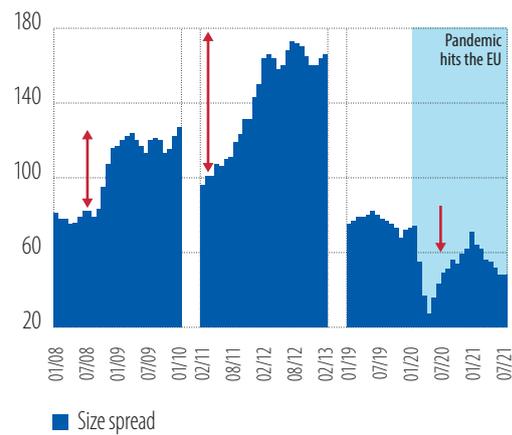
months before June 2020, these borrowing costs declined to record lows and the spread with large loans remained narrow. As shown in Figure 4, the reaction contrasts sharply with the global financial and sovereign debt crises.

Figure 3
Cost of corporate bank borrowing
(percentage points per year)



Source: EIB estimates based on Refinitiv.
Note: Last record is October 2021.

Figure 4
Rate spreads during economic crises
(from left to right: the global financial crisis, sovereign debt crisis and COVID-19, in basis points)



Source: EIB estimates based on the ECB.
Note: The difference between the cost of borrowing on small loans (below EUR 250 000) and large loans (above EUR 1 million) is expressed in basis points. New business volumes. The last record is October 2021.

Backed by government guarantee programmes, firms have borrowed at low costs. Figure 5 clearly shows the rise in cash and deposits as a percentage of gross domestic product (GDP) in the European Union. Following the global financial crisis, firms reduced their holdings of cash and liquid assets by about 2% compared to before the crisis. Since the beginning of this crisis, bank lending to EU firms has increased by 4%, which has swollen firms' cash holdings (Figure 5). The reimbursement of short-term debt is likely to be accompanied by a decrease in those holdings.

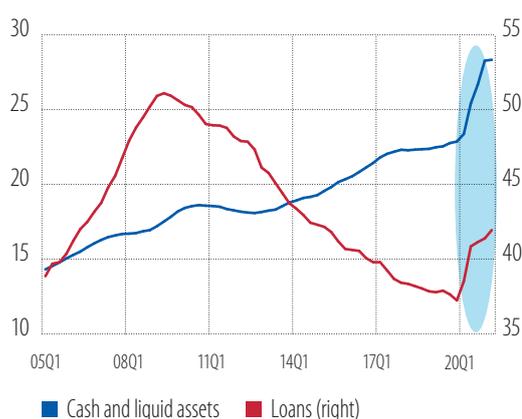
After a boom at the start of the crisis, corporate debt issuance has remained steady (Figure 5). While a similar trend was recorded during the sovereign debt crisis, the reasons are different. Andersson et al. (2021) show that during the previous crisis, debt was issued by large corporations to bypass the bottlenecks that prevented them from accessing bank loans. This time, however, debt was backed by government guarantees and issued as a form of insurance to ensure firms had the liquidity they needed to wait out lockdowns. Gonzalez (2021) points to other differences, such as the larger issuance of high-yield bonds during the COVID-19 crisis and the different industries issuing debt.

Fewer firms face difficulties accessing credit than before the crisis, illustrating that the availability of finance is not a major issue. After increasing in the first year of the crisis — from 4.9% in 2019 to 5.6% in 2020 — the share of finance-constrained firms decreased to 4.7% in 2021, below pre-crisis levels and the lowest level recorded in the history of the EIBIS.

Investment financing conditions are uneven, with easing in Western and Northern Europe and Central and Eastern Europe, but tightening in Southern Europe. In Figure 6, we correlate two results from the EIBIS: the financial constraints indicator and the willingness to use internal financing. Financial constraints are likely to impact investment when firms are less dependent on outside funds. The top or the left of Figure 6 therefore shows that investment financing conditions have improved. In 2021, the

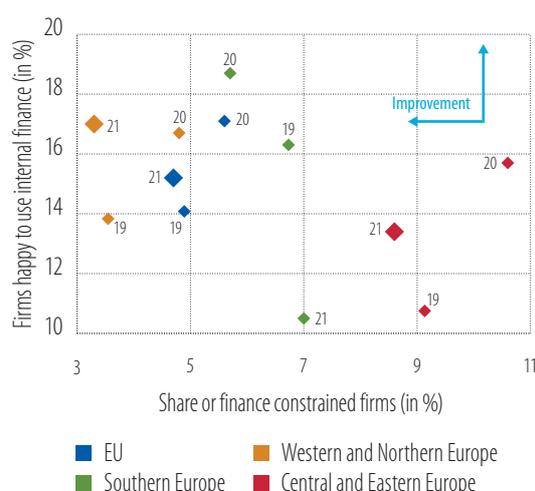
credit conditions eased in Central and Eastern Europe, but they nonetheless remain structurally tighter. Western and Northern Europe show improvement, and the region continues to have some of the best credit conditions. In 2021, however, firms in Southern Europe saw credit tighten. Their willingness to rely on internal financing declined and the share of finance-constrained firms increased.

Figure 5
Loans, debt and cash position of firms
(EU firms, % GDP)



Source: EIB estimates based on Eurostat.
Note: The latest record is the first quarter of 2021. Four quarter moving average.

Figure 6
Share of credit constrained firms by country vs. share of firms that could rely on internal financing



Source: EIBIS, 2019-2021.
Note: The numbers indicate the year.

Employment support policies and profit trends

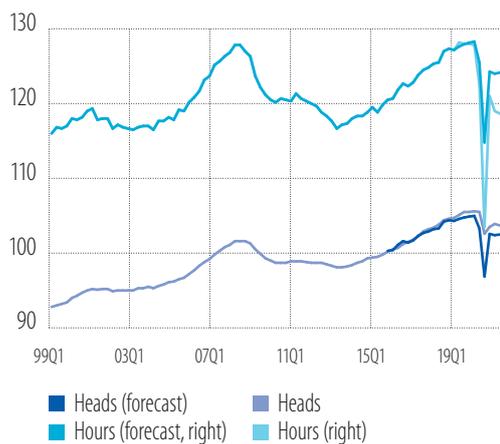
Employment support policies, in the form of widespread furlough schemes, enabled firms to hold on to their employees. Contrary to the United States and previous crises, the reduction in employment in Europe mostly involved cuts to the number of hours worked. Consequently, the unemployment rate rose less and the number of hours worked declined more than during past crises because companies were able to adjust their workforce through furlough schemes. While EU GDP fell 6%, the unemployment rate only rose by 1.2 percentage points in the first year of the crisis. In the first year of the global financial crisis, it increased by 2 percentage points, while GDP contracted much less.

Without government schemes to support the labour market, the number of hours worked would have declined 10% less, but the drop in employment per head would have been 5% greater. In Figure 7, we isolate employment and hours worked. These data are available over a long period, so that single error corrector models can be estimated. In the model estimated, employment adjusts to a long-term trend determined by productivity and real value added by firms. The models perform very well over the estimation period. The models are then used out of sample to predict trends from the fourth quarter of 2019 onward. As shown in Figure 7, historical patterns suggest that employment should have declined by more, and employment per hours worked by less. The policy for supporting employment protected jobs and avoided the long-term effects of laying off employees. In terms of costs, the policy increased the elasticity of costs to activity by 50%.

As expected, the share of profitable companies fell sharply in 2020, with smaller firms suffering more. Figure 8 reports the share of profitable companies surveyed in the EIBIS. In normal times, when economic output grows at around its potential, approximately 77% of European companies are profitable, and the number is usually around 3% higher for larger firms than for small and medium firms. During the first year of the COVID-19 crisis, the share of profitable companies fell by 10 percentage points for small and medium firms and 6 percentage points for larger firms.

While corporate profits have fallen substantially, they declined less than sales because government support dampened the impact of lower sales on profits. In the first four quarters of the global financial crisis, corporate real value added in the European Union fell by 4.2%, and the share of corporate profits¹ receded by 2.4 percentage points (third quarter of 2008–second quarter of 2009 vs. fourth quarter of 2007–third quarter of 2008). Compared with 2019, real value added fell by 5.9% in 2020, about 1.5 times more than during the global financial crisis, while the share of profits declined less, contracting 1.6 percentage points. Applying the same elasticity as during the global financial crisis, the decline in the share of profits should have been twice as great — a contraction of 3.2 percentage points.

Figure 7
Actual employment and the counterfactual simulation (2015=100)



Source: EIB estimates based on Eurostat.

Note: The dark-coloured line indicates actual developments. The light-coloured line indicates a counterfactual simulation based on a single error corrector model.

Figure 8
Share of profitable firms (in %)



Source: EIBIS, 2016–2021.

Corporate investment

Bank lending has continued, but it has not fuelled capital expenditure. The ECB Bank Lending Survey contains a question regarding demand for loans. The responses indicate that inventories and working capital drove the surge in demand for bank credit in 2020. At the same time, corporate investment was lower and therefore demand for loans to fund projects was also lower. The reduced demand for capital acted as a drag on demand for credit and continued to do so until the second quarter of 2021, at least.

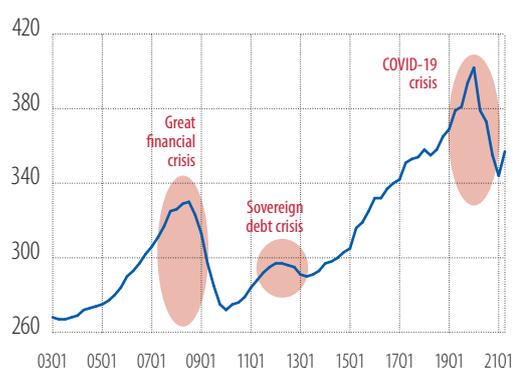
While support has placed a massive strain on public finances, it did prevent a full blown liquidity crisis. The public sector stepped in to prevent an economic shock from feeding through to corporate and household finances and triggering a recession. As discussed in Chapter 1, these policies resulted in sharp increases in public debt in advanced economies. Arena et al. (2021) show how financial support for firms and households has shifted the burden to the public sector.

¹ Measured as entrepreneurial income over gross value added for non-financial firms.

Corporate investment was responsible for the fall in total investment, and it has started to recover. At the low-point of the crisis, total investment in real terms dipped to levels seen 12 years earlier, before the global financial crisis in 2008. In real terms, annual flows in corporate investment were 20% higher in the fourth quarter of 2019 than in the third quarter of 2008, before the great financial crisis. In the first quarter of 2021, corporate investment was only 5% higher (Figure 9). Meanwhile, public and household investment have remained almost unchanged during the crisis. Corporate investment has started to recover, but by the second quarter of 2021, annual flows were still 11% below their level in the fourth quarter of 2019.

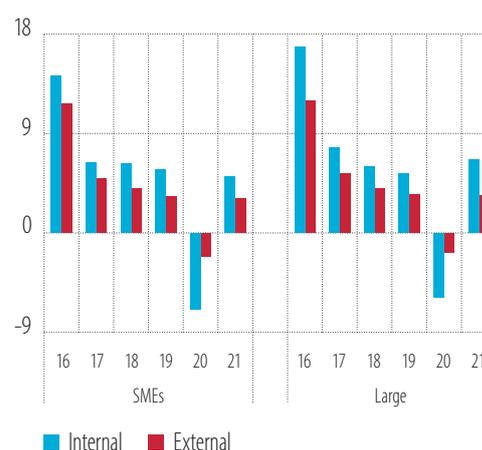
In nominal terms, corporate investment has fallen to the same extent as during the global financial crisis, even though the fall in GDP was much bigger. Since the start of the crisis, corporate investment has declined by EUR 166 billion annually. During the global financial crisis, it fell by almost the same amount, EUR 164 billion, which was a larger drop relative to GDP at the time. The decline during pandemic was also smaller than anticipated, reflecting the effectiveness of strong policy support (Box A).

Figure 9
Real corporate investment
(2005 euros in billions)



Source: EIB estimates based on Eurostat data.
Note: The most recent record, for the second quarter of 2021, was partially estimated. Four-quarter moving average of non-seasonally adjusted data.

Figure 10
Expectations of internal and external
financing conditions (% of respondents)



Source: EIBIS, 2016-2021.
Note: Net balance of replies, improvement vs. deterioration.

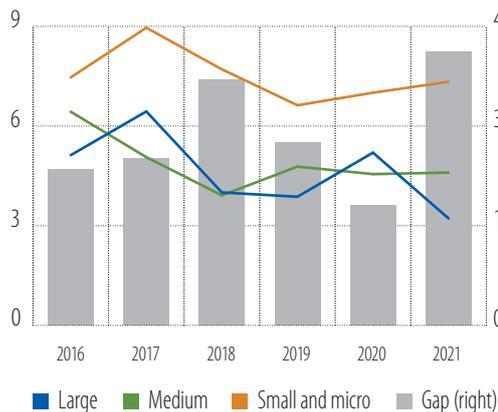
In the EIBIS 2021, firms report that their financial resources were improving. Figure 10 shows that in the current financial year, the net balance between firms expecting an improvement and those expecting a deterioration is clearly tilted towards an improvement. This comes after a sharp deterioration during the first year of the COVID-19 crisis.

Firms' are shoring up internal resources more than taking on external finance, but they still haven't made up for the damage done by the pandemic. While government policies bolstered firm's profits through direct subsidies or furlough schemes, the support did not fully offset the fall in demand or the drop in sales. Internal finances therefore deteriorated much more than external finance. The rebound in internal financing is sharp but does not fully cancel out the deterioration recorded last year.

Smaller firms are experiencing more financial constraints. Figure 11 shows overall financial constraints by firm size. Small and micro enterprises are more likely to face such constraints. The financial gap between large and small firms varies over time. It was at its highest in 2021, when 6.1% of small and medium businesses reported financial constraints, compared with only 3.2% of large firms. The profits of small and medium firms have sunk more during the crisis (Gourinchas et al., 2020) with 50.3% of those

firms reporting that the pandemic negatively affected sales. A lower share of large firms are experiencing such constraints (47.2%). The latest SME barometer shows that micro and small firms have lagged behind medium ones in the recovery over the last half-year (SME United, 2021).

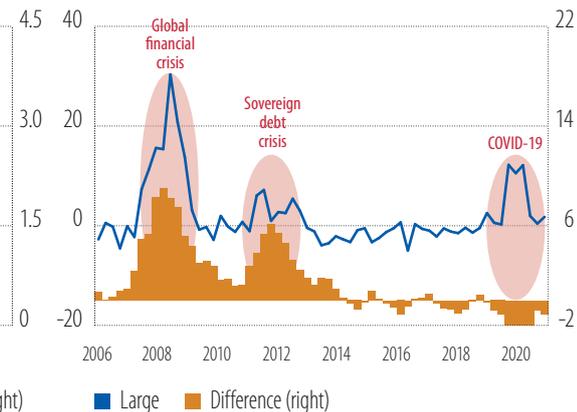
Figure 11
Firms facing financial constraints (in %),
by year and size



Source: EIBIS, 2016-2021.

Note: The gap reports the difference between the proportion of small and micro firms that are financed-constrained and that of large firms.

Figure 12
Credit standards on corporate loans (index)



Source: EIB estimates based on the ECB Bank Lending Survey October 2021.

Note: An increase reflects a tightening in credit standards. Net balance of banks reporting a tightening and those reporting a softening, in %.

Government loan guarantees helped to keep credit affordable for firms, but a possible rise in non-performing loans could cause credit to tighten (Figure 12). According to the ECB's Bank Lending Survey for July 2021, credit conditions remain favourable for firms. The impact of the end of state guarantee programmes is very uncertain. In the previous economic upturn, non-performing loans declined in most European countries, but they are still a source of concern. At the start of the crisis, banks reported that an increase in non-performing loans was adversely affecting the terms and conditions for all types of loans.

Box A

High-growth enterprises during the crisis

This box delves into the crisis's impact on high-growth enterprises. It shows that these enterprises have reduced their investment plans by more than other firms, but are also more optimistic regarding their internal financing. In the long term, they are less likely to reduce staff permanently and more likely to digitalise compared to other firms.

During the COVID-19 crisis, high-growth enterprises have revised their investment plans downwards more, aligning them with other firms. From 2020 to 2021, the share of high-growth enterprises expecting to invest more in the current financial year dropped by 14 percentage points, which is 4 percentage points steeper than the decline for other firms. Coad et al. (2021) use difference-in-differences methodology to analyse the change in the responses of these enterprises during the COVID-19 crisis. The results depicted in Figure A.1 suggest that high-growth investors adopted a more cautious attitude during the crisis and were less likely to have optimistic investment plans compared to peers.

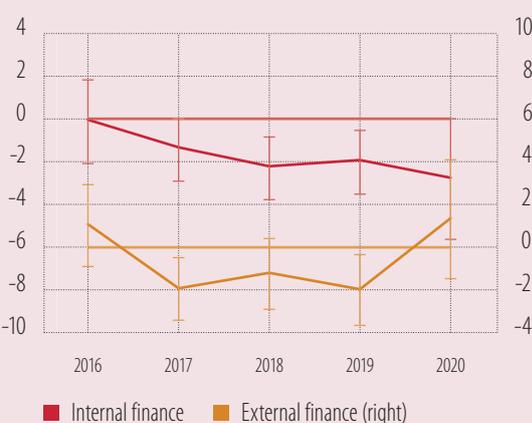
Over the period, high-growth enterprises remained more optimistic about their internal financing. In general, the EIBIS suggests that high-growth enterprises are also more optimistic about their ability to find external finance. They are less likely to expect a deterioration in their cash flow. A possible explanation could be the strong expansion of these enterprises, with strong sales growth generating greater cash flows. As shown in Figure A.2, the internal financing of high-growth enterprises does not seem to be more affected than other firms. Despite the hit firms took to their internal cash flow during the crisis, high-growth enterprises continued to maintain a more optimistic view of the future. The difference remains significant.

Figure A.1
High-growth firms' relative optimism about expected investment (in percentage points)



Source: Estimates based on ORBIS–EIBIS matched database.
Note: See Coad et al. (2021). The higher the coefficient, the more optimistic the high-growth firms are compared to other firms. The vertical lines portray the 95% confidence interval.

Figure A.2
Deterioration in high-growth firms financing capacity (in percentage points)



Source: Estimate based on ORBIS–EIBIS matched database. See Coad et al. (2021). A lower number indicates that high-growth firms are relatively less likely to report a deterioration. The vertical lines portray the 95% confidence interval.

Nevertheless, high-growth enterprises have gotten more pessimistic regarding their external financing conditions. Figure A.3 shows that high-growth enterprises tend to be more optimistic regarding external finance. However, the difference is not always statistically significant at 5%. During the crisis, these enterprises shifted from relative optimism to relative pessimism. The shift was significant but not that different compared to other firms.

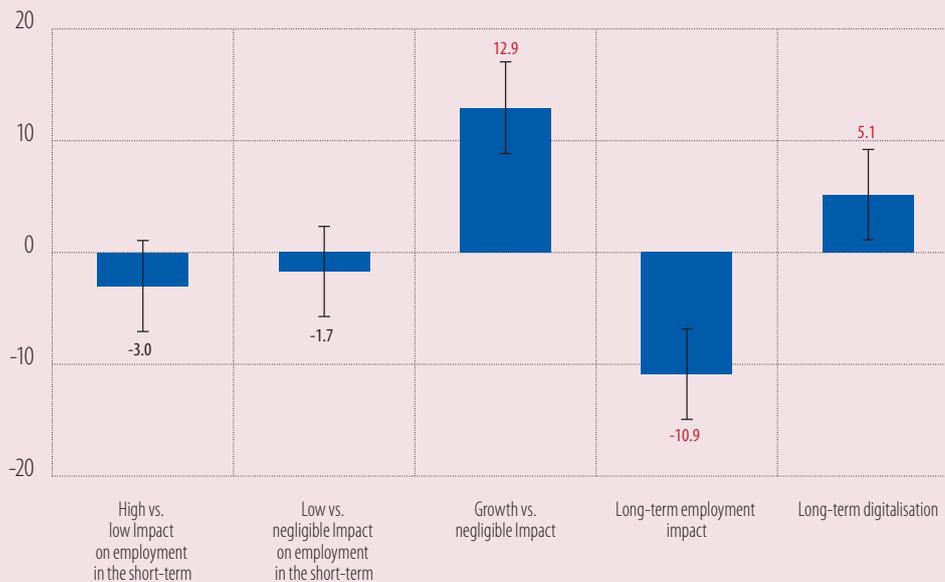
In the short term, high-growth firms do not have a higher probability of reducing their workforce. Figure A.3 shows the difference between high-growth firms and others regarding the impact of the COVID-19 crisis. The data in the figures are estimated by Teruel et al. (2021) with probit regressions controlling for country, sector, and firm characteristics. High-growth enterprises are more likely to increase their workforce in the short term compared to other firms, suggesting that high-growth firms are adjusting fast and benefiting from new demand created by the crisis. However, the coefficients are not statistically significant.

In the longer term, high-growth enterprises are less likely to reduce employment permanently, but they are more likely to digitalise and therefore need new kinds of employees, those with more digital skills. Figure A.3 also depicts the impact of COVID-19 in the long term. Interestingly, high-growth

enterprises show a lower probability of reducing their workforce permanently in the long term because of the pandemic. Additionally, Figure A.3 presents the impact on the expected probability of digitalising in the long term because of the pandemic. The results show that these enterprises are more likely to increase their digitalisation in the long term.

Figure A.3

Estimated impact of being a high-growth firm on employment, growth and digitalisation (in percentage points, lower numbers means less likely)



Source: Teruel et al. (2021).

Note: Based on probit regressions controlling for age, country and sector, number of employees, and being a subsidiary. Bold red numbers represent statistically significant coefficients (at 5%). The first three bars refer to the short-term adjustment to their workforce because of COVID-19, while the last two bars refer to the long-term impact.

Vulnerability and asymmetry

The economic effects of the pandemic are increasingly uneven, partly because subsequent lockdowns have been more selective. Because the economies of EU members differ in the size of firms and in the importance of different industries, the overall impact of the pandemic varies widely. Bankruptcies have been surprisingly low so far, but they could rise in the next few years. The risk is that pockets of vulnerable firms remain. Differences in the swiftness of insolvency procedures in various EU countries mean that an increase in bankruptcies could still jeopardise the recovery. These potential legacies from the crisis would pose a threat to a European Union-wide recovery.

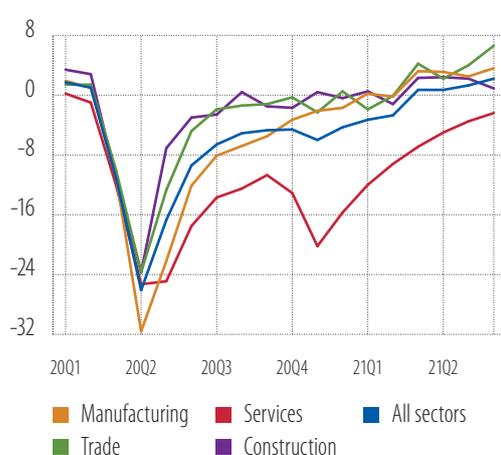
Sales losses across firms

The COVID-19 crisis caused sales to plummet as much as 30%. The trough reached in May 2020 was comparable across the four major sectors of the economy portrayed in Figure 13, reflecting the indiscriminate nature of the first lockdown. As lockdown policies became more selective, the recovery started to be uneven. Trade and construction almost returned to pre-crisis levels in the third quarter of 2020, while sales for services were still 12% lower. In the second quarter of 2021, services were the only

sector not to have returned to its pre-crisis level, with a gap of around 5%. A more detailed breakdown is needed because the sub-sectors of services have been affected very differently.

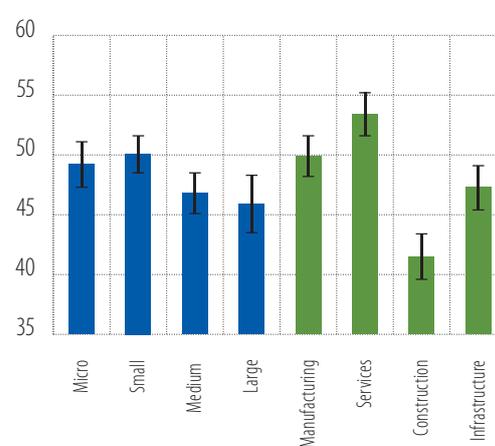
The sales decline has been uneven across firms. Figure 14 reports the impact of certain firm characteristics on the likelihood of record sales losses. Using a probit model, the occurrence of sales losses being recorded, as reported in EIBIS 2021, is projected based on certain firm characteristics, after controlling for the country. Some firm characteristics seem to have an impact on the probability of experiencing sales decline, while others do not.

Figure 13
Sales trends in four main sectors
(% deviation from pre-crisis level)



Source: EIB calculations based on Eurostat.
Note: Monthly data, seasonally adjusted. The last record is June 2021.

Figure 14
Corporate sales losses, using size and sector
as important factors (probit estimate in %)



Source: EIB estimates based on EIBIS 2021.
Note: Probit models controlling for the country are used. The thick bar reports the impact of each characteristic on the probability of recording sale losses. The thin lines report the 95% interval surrounding this impact.

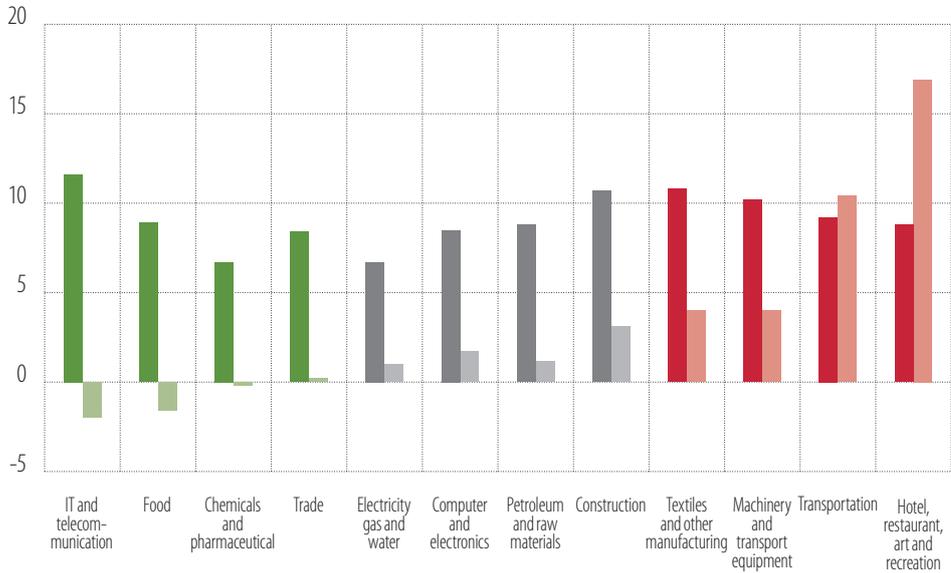
Sector and size appear to be key factors affecting sales. Figure 14 shows how the probability of recording a decline in sales changes depending on the sector. Firms operating in services are most affected, while construction firms are less affected. Micro and smaller firms were most likely to lose sales. According to EIBIS 2021, 50.3% of small and medium businesses reported that the COVID-19 crisis had a negative impact on sales, more than 3 percentage points above the share of large firms (47.2%). During the first year of the COVID-19 crisis, 19.5% of small and medium businesses saw sales drop, more than 1 percentage point above the share of large enterprises (18.4%).

In the absence of firm-level data for the full period, we have estimated firms' profits for the first two years of the crisis to assess the impact on various sectors. When sales contract, firms cut their spending, mainly by reducing their consumption of supplies and by laying off staff. However, costs do not fully react to changes in sales in the short-to-medium term for various reasons, and profits are procyclical. We have estimated the cost elasticity specific to 12 separate sectors and simulated the impact of a specific change in sales.² The shock to sales is based on the decline in turnover observed on Eurostat from the beginning of 2020 to the end of June 2021. To account for the widespread use of furlough schemes, we have increased labour elasticity by 50% compared to the historical basis. Forbearance³ is also considered by suspending the payment of financial costs in 2020.

² We use the EIBIS-ORBIS matched dataset, which comprises more than 45 000 European firms. Changes in profits correspond to changes in sales minus changes in costs. Costs are broken down into the four main items: employee costs, material costs, financial costs and other costs. $\Delta\text{Costs} = \alpha\Delta\text{Sales}$, with $0 < \alpha < 1$. See Maurin and Pal (2020).

³ A special agreement between the lender and the borrower to delay the payments of debt obligations.

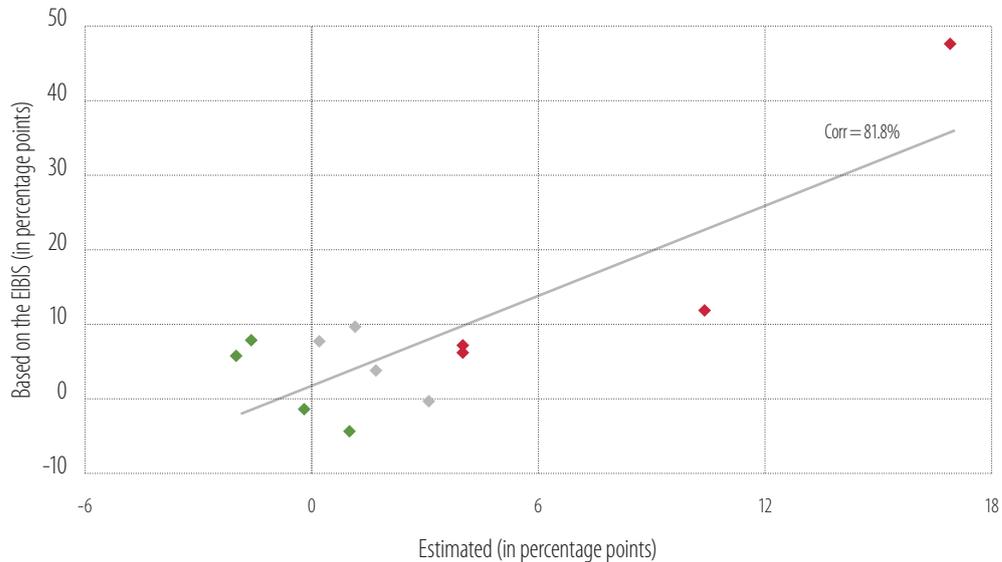
Figure 15
Firms (in %) recording losses vs. normal times



Source: EIB estimates based on EIBIS-ORBIS historical matched database and Eurostat sales statistics.

Note: EU results, see Maurin and Pal (2020 and 2021). The dark-coloured bars indicate the percentage of firms recording losses in the sector in normal times. The light-coloured bars indicate the estimated change in the share of firms recording losses during the COVID-19 crisis. Red, grey and green indicate the sectors experiencing the greatest, median or lowest impact.

Figure 16
Estimated and reported change in the share of firms recording losses



Source: EIB estimates and EIBIS 2021.

Note: The estimated changes are those reported in Figure 15. Red, grey and green indicate the sectors experiencing the greatest, median or lowest impact.

During the crisis, the share of firms reporting losses increased from 9% to 13%. Figure 15 plots the share of firms recording losses before the COVID-19 crisis along with the estimated change from 2020 to 2021, which covers both the collapse in activity and the start of the recovery. In normal times, a significant share of firms lose money, ranging from 6% to 12% depending on the sector. Interestingly, no correlation is identified between the pre-COVID-19 share of firms posting losses and the size of the increase in sector vulnerability. Also, while most sectors have seen an increase in the share of firms that lost money, some, such as IT and telecommunications, or chemicals and pharmaceuticals, have actually shown a decrease in the share of firms reporting losses.

It is becoming clear that the crisis's impact was uneven. Along with transport, hotels and restaurants were the worst hit, with the share of firms losing money more than doubling during the crisis. On the other hand, IT and telecommunications, food, chemicals and pharmaceuticals were the least affected, with a lower share of firms reporting losses than normally. In Figure 15, the sectors are ranked according to the increase in the share of firms losing money. The most affected sectors are at the top, and the least affected ones at the bottom. The 12 sectors considered are grouped into three categories, with the least affected in green, those in the median range in grey, and the most affected in red.

The estimates correlate well with the results obtained from the EIBIS. For each sector, Figure 16 correlates the profit simulation with the answer received from the EIBIS, where a specific question asks firms if they have lost money in the current financial year. The elevated correlation suggests that the estimates track the differences among sectors well.

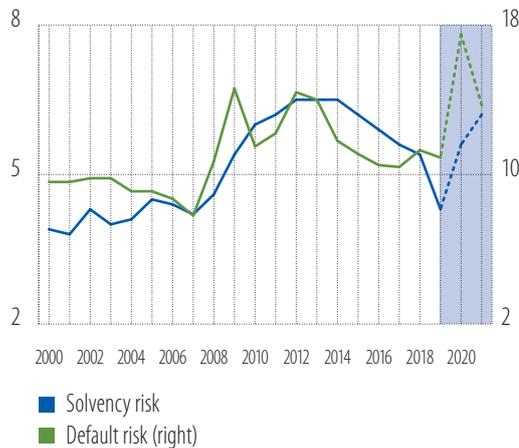
Increased vulnerability

We have built a vulnerability indicator based on solvency and default risks. We linked the estimated trends in firms' profits to financial and balance sheet characteristics. We then derived the implied interest rate coverage ratio (which measures how well companies can pay the interest on their debt) and the change in equity implied by the simulated profits. Next we compiled two indicators. The first is a default risk indicator that represents the proportion of firms with an interest rate coverage ratio below one, suggesting that their post COVID-19 net revenues are not sufficient to cover their financial costs. The second is a solvency risk indicator, with firms considered at risk if their losses wipe out their equity base.

Lower profits reduce a firm's capacity to repay its debt, and therefore increase its risk of defaulting. Figure 17 shows the proportion of firms at risk of defaulting (the share of firms whose interest coverage ratio is below one). The proportion is shown over time, starting with the beginning of 2000, with estimates used for 2020 and 2021 (information on firms' balance sheets is still scarce for those years). Before 2020, the proportion is derived from a simple calculation based on the financial statements. In normal times, when GDP is around its potential, 10% of EU firms do not earn enough to pay their financial costs. The proportion increased to 16% during the global financial and sovereign debt crises, before falling back to normal until the start of the COVID-19 crisis. The share of EU firms unable to pay their financial costs increased sharply to 18% in 2020, before receding to 16% in 2021 when demand partly returned to normal.

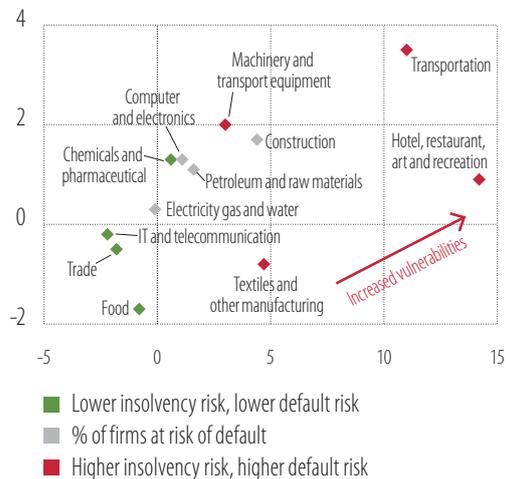
Higher losses also imply higher insolvency risks, and more firms with depleted capital. Figure 17 shows the trend in the proportion of firms in negative equity since 2000. A small share of firms are always technically insolvent. The ratio was below 5% prior to the global financial crisis, slightly decreasing as the economy strengthened. The global financial and sovereign debt crises pushed the share up to around 7%. Interestingly, the share of firms at risk of insolvency took several years to fall back to pre-crisis levels, showing that the impact was more sustained than on the risk of default. During the COVID-19 crisis, insolvency risks have been more contained, but also more persistent, with risks growing in 2021. Profits improved, and fewer firms lost money. But while some firms have returned to profit, others are continuing to lose money, so that for them, the equity base continues to shrink overall.

Figure 17
Corporate risk indicators: historical perspective (% of firms at risk)



Source: EIB estimate based on the EIBIS.
Note: See Maurin and Pal (2021).

Figure 18
Insolvency and default risks: a sector-based view (deviation in 2021 from the pre-crisis average, measured in percentage points)



Source: EIB estimate based on EIBIS-ORBIS matched database.
Note: See Maurin and Pal (2021). The colour code is identical to that used in Figure 15. It is based on the estimated increase in the share of firms recording losses.

The two risk metrics provide an indication of sectors' vulnerability, and confirm that sectors were affected differently by COVID-19. Figure 18 shows the two risk indicators in 2021, with a deviation from the average witnessed from 2000 to 2019. The two dimensions are clearly correlated, although the same profit forecasts are linked to different balance sheet or financial characteristics. Figure 18 shows that the increase in risks has varied by sector.

During the crisis, public support shielded firms from short-term liquidity problems, but the fall in profits and the rise in debt have driven up the share of vulnerable firms. Blanco et al. (2020) simulated the impact of the COVID-19 crisis on firms in Spain. Their simulations show that the crisis significantly increased firms' liquidity needs in 2020. The rise is more pronounced among small and medium businesses and among sectors hardest hit by the pandemic. The results also suggest that the proportion of firms whose existence is threatened by persistent losses through 2023 would rise 2 to 3 percentage points. Likewise, the proportion of firms that will remain viable but will struggle to repay their debts is expected to rise by 3 to 4.7 percentage points.

The percentage of firms going bankrupt is countercyclical and lags behind economic activity. Under normal economic conditions — when GDP is around its potential — 10% of firms typically record losses above the book value of their equity base, thereby becoming technically insolvent.⁴ While those companies are at a very high risk of insolvency, they can continue operating if they are able to tap into sufficient sources of new external financing, which depends on whether they can show financiers that their business is sustainable.⁵ Each year, on average, around 7.6% of EU firms stop operating (Figure 19).⁶ The ratio fluctuates with economic activity: more firms go bankrupt after a period of weak economic activity, and the converse also holds true. When the EU economy goes through periods of recovery, the rate of firms ceasing to operate declines, with some lags.

4 By definition, a corporation is technically insolvent if it has zero or negative equity. Nevertheless, a technically insolvent corporation might be still able to fulfil its payment obligations.

5 The new financing source can take the form of a new equity injection, bank loans, intra-trade credit or debt securities.

6 Bankruptcy is the main reason for exiting but not the only one. A more precise breakdown is not available at the EU level.

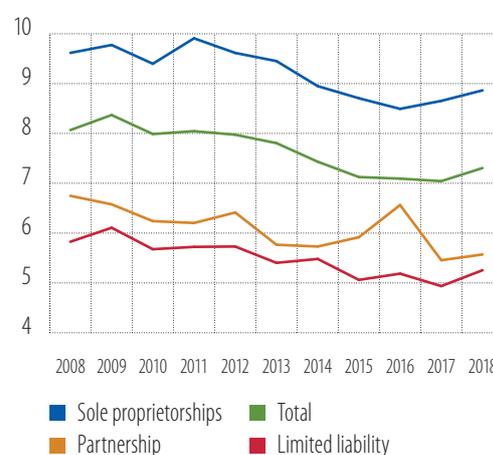
Figure 19
EU firms ceasing to operate (in %)



Source: EIB estimates based on Eurostat.

Note: The horizontal line reflects the historical average over the period.

Figure 20
Bankruptcies (% of EU firms), by firm size



Source: EIB estimates based on Eurostat.

The exit rate is higher and more cyclical for smaller firms. Figure 20 shows the movements in the exit rate (the rate of businesses ceasing to operate) across cohorts of firms. Over time, larger firms with a limited liability structure have a lower exit rate than smaller firms, such as partnerships. In turn, partnerships have a lower exit rate than sole proprietorships that tend to be the smallest firms. Econometric evidence also suggests that bankruptcies are more cyclical for smaller firms.⁷ As the structures of the countries' ecosystems differ in size and composition, bankruptcies may be higher in economies where more small firms operate. These differences could potentially lead to an uneven recovery among the various EU economies.

Taken together, all those elements suggest that the share of corporate bankruptcies might rise despite the recovery. Preliminary evidence points to a decline in bankruptcies in Europe since the start of the COVID-19 crisis. Debt moratoriums and the closure of courts in several jurisdictions during lockdowns may have created a backlog of insolvent firms.⁸ Estimates indicate that after the exceptional public support is withdrawn, up to 3% additional EU firms could stop operating. The increase in the ratio corresponds to about one-third to one-half the average share of firms exiting each year since 2008. The ratio is below the number of excess bankruptcies recorded between the onset of the global financial crisis and the start of the recovery from the sovereign debt crisis (Figure 19).

Inefficient insolvency regimes support zombie lending. Becker and Ivashina (2021) recall that bank lending to less productive firms at subsidised rates can help banks in the short run, but it can also deepen and prolong economic crises. The authors argue that inefficient mechanisms to deal with insolvency supports zombie lending (lending to firms that cannot repay). At the firm level, cheaper credit is more common in bad times because banks try to prevent clients from going bankrupt. Reforming insolvency regimes could therefore help contain zombie lending, along with increases in bank capital requirements and reinforced supervision.

The varying efficiency of insolvency regimes could further exacerbate differences in the recovery among firms and countries. Organising corporate exits takes longer in less efficient jurisdictions. This

⁷ Maurin and Pal (2021) estimate ordinary least squares (OLS) regressions explaining bankruptcy rates with lagged indicators of firm performance at the country level, such as gross value added. The response is stronger for smaller firms and for firms located in less efficient jurisdictions.

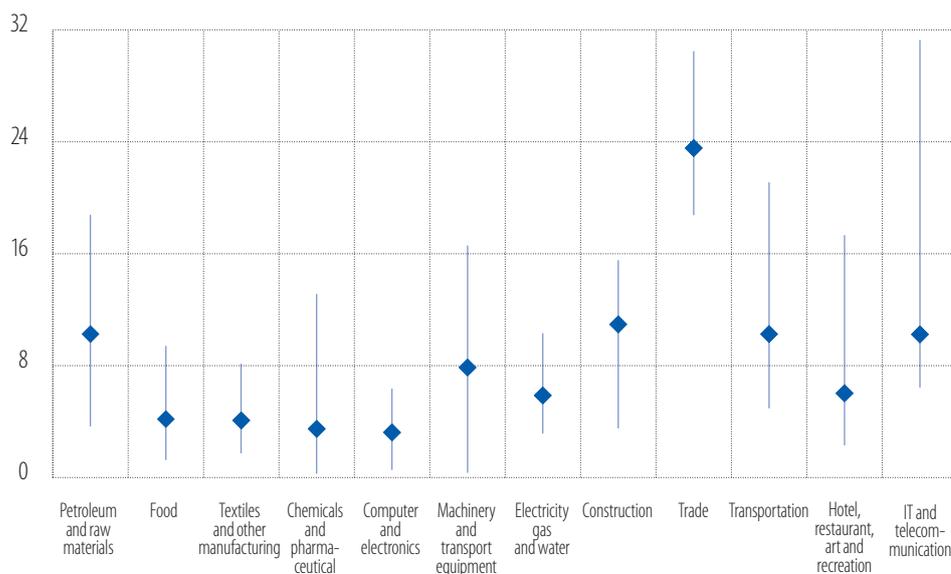
⁸ The European Banking Authority (EBA) suggests that 7.5% of the volume of overall loans have benefited from moratoriums, which automatically delays the effect of the crisis on firms. Filings for insolvency procedures have been suspended for a long period in most EU jurisdictions.

means that the possible rise in bankruptcy rates would happen at different times and to differing extents across the European Union. The reason is not just the uneven impact of the COVID-19 crisis on different members' economies, but also the wide variety in insolvency regimes and judicial capacity. According to World Bank data, an insolvency procedure in the European Union takes on average less than 1.5 years in countries representing 18% of EU GDP, from 1.5 to 2.5 years in countries representing 70% of EU GDP, and more than 2.5 years in countries representing 12% of EU GDP.⁹

Country exposure

The composition of economic sectors differs across EU members. As shown in Figure 21, the share of each of the 12 sectors considered varies widely within and across economies. For example, IT and telecommunications accounts for 6% to 7% of non-financial corporate value added in Latvia, Portugal and Greece, and more than 14% in Luxembourg, Sweden and Ireland. Hotels and restaurants account for less than 3% in Poland, Latvia and Denmark, and more than 13% in Croatia, Greece and Cyprus.

Figure 21
Sector shares in EU countries (in %)

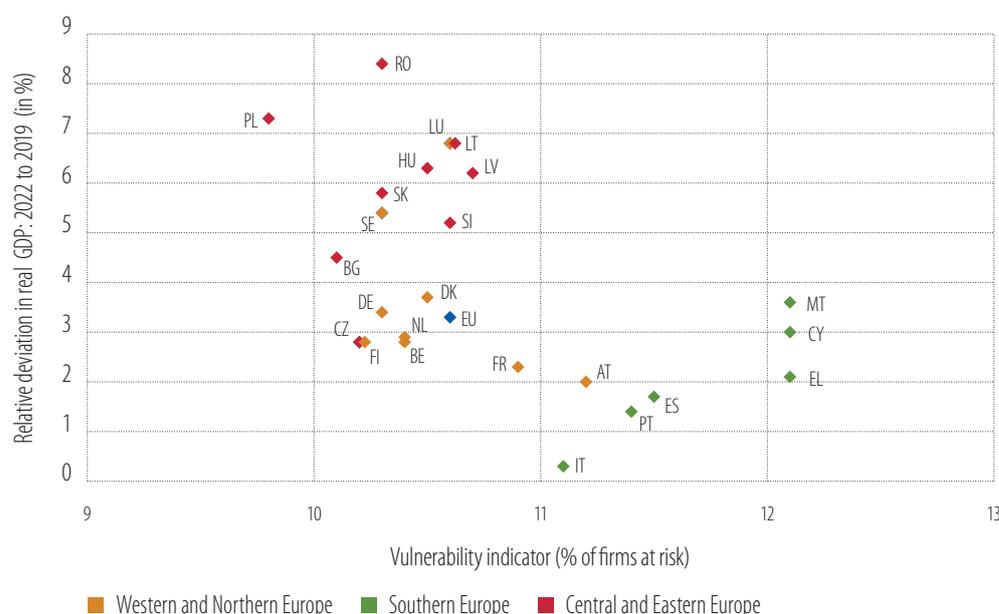


Source: EIB estimates based on Eurostat.

Note: The dot reflects the average while the vertical line reflects the range in the share of each sector across the 27 EU economies.

⁹ Less than 1.5 years: Austria, Belgium, Cyprus, Denmark, Finland, Ireland, the Netherlands and Slovenia. 1.5-2.5 years: Czech Republic, France, Germany, Hungary, Italy, Latvia, Lithuania, Luxembourg, Spain and Sweden. More than 2.5 years: Bulgaria, Croatia, Greece, Malta, Poland, Portugal, Romania and Slovakia.

Figure 22
Expected GDP rebound and country exposure



Source: EIB estimates based on Eurostat, EIBIS-ORBIS database.

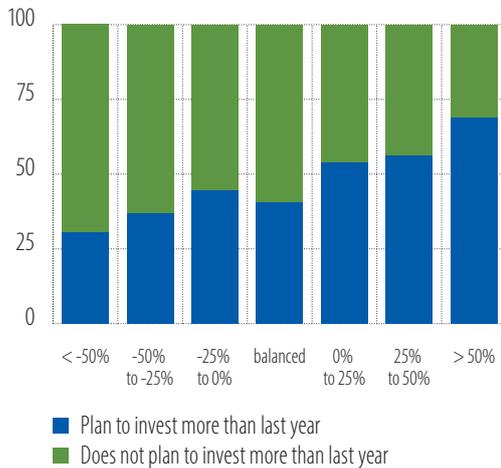
Note: The vulnerability indicator is obtained as the average of the default and solvency risks. Those risks are obtained as the average across the 12 sectors of the related risk estimated at the EU level.

The varying importance of sectors in EU members' economies heightens the risk of an uneven recovery, with countries in Southern Europe more at risk. In Figure 22, the y-axis shows the relative deviation in real GDP forecast in 2022 vs. 2019. On the x-axis, the vulnerability indicator shows the percentage of firms at risk, calculated as the sum of the average of the two risk indicators for each sector, weighted by that sector's contribution in each country. In all EU economies, real GDP is projected to surpass its pre-crisis level in 2022. Figure 22 shows that the lower cumulated GDP growth over three years is associated with greater increases in corporate vulnerability. Countries from the south, indicated in green, tend to be more affected. To some extent, this greater impact reflects their higher exposure to sectors that demand social interaction. Lockdowns hit those sectors harder.

Steeper sales losses are associated with a weaker rebound in investment. As explained in the first section, investment took a hit. The EIBIS also suggests that internal financing capacity is important. Figure 23 reflects the answers to the question on the change in the volume of investment planned for the current year compared to last year, depending on the sales decline. Between 28% and 68% of firms expect to raise investment. The share tends to increase with the change in sales. The worse the sales decline, the weaker the rebound in a firm's investment. This trend does not bode well for a rebalancing of investment, as the firms that saw a bigger sales decline also reduced their investment by more. Their tendency to raise investment more slowly suggests that they are focusing on repairing their balance sheets.

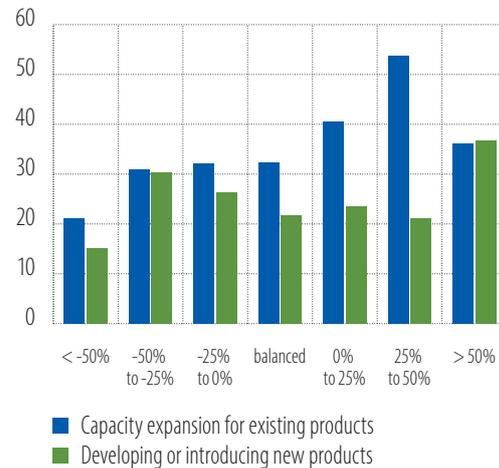
The nature of investment is also affected by the decline in sales. Figure 24 shows the results of the question on the type of investment foreseen in the next three years. As expected, the greater the decline in sales, the lower the investment in capacity expansion. The relationship differs for investment in developing new products. Firms that have been hit, but not hit the most, tend to invest more than firms that are marginally hit, not hit or hit more. Firms may have realised that their products and services are no longer suited to the post-COVID-19 world and need to take their offering in a new direction. Firms can change direction if the hit was contained. When the hit was major, they have little scope to adjust.

Figure 23
Firms (in %) planning to invest more this year



Source: EIB estimates based on EIBIS 2021.
Note: The x-axis indicates the change in sales.

Figure 24
Type of investment planned over the next three years (% of firms)



Source: EIB estimates based on EIBIS 2021.
Note: The x-axis indicates the change in sales in 2020.

Firm-level support

In the current crisis, firms have received massive direct public support from governments and the European Commission. Policy support has been vast and diverse, reaching companies weakened by the crisis. An overview of the literature on the impact of policy support is provided in Box B, confirming that the measures have played a major role in stabilising the economy and bank lending during the pandemic.

The EIBIS 2021 offers a unique source of data to assess how policy support has affected firms. We have used the information collected during the sixth EIB Investment Survey to analyse the nature of the support in detail. The EIBIS considers four types of support: (1) new subsidised or guaranteed credits (such as loans, overdrafts or credit cards from a bank or another finance provider) that will need to be paid back in the future but may have preferential or reduced interest rates and/or an extended repayment plan; (2) deferrals of payments which still leave a liability to be paid by the company in the future (for instance, deferral of tax payments, deferral of rents or mortgages on commercial property, or the suspension of interest payments); (3) subsidies or any other type of financial support that the company will not have to pay back in the future — job retention policies fall under this category; and (4) any other type of financial support.

Policy support for firms within and across economies

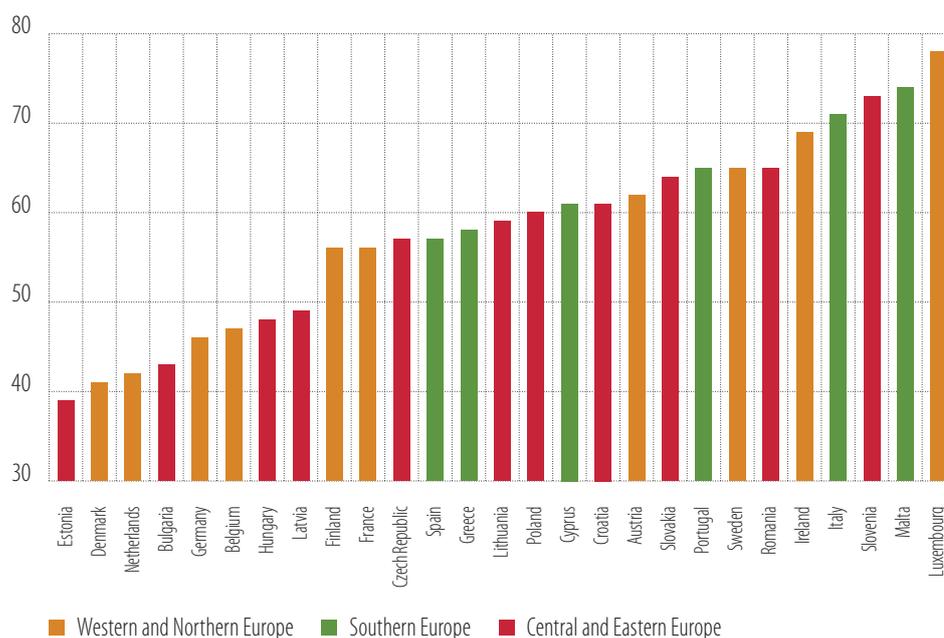
We are focusing on the policy support that was actually implemented. To take up policy support, firms needed to be both eligible and willing. The choice not to apply is likely indicative of certain firm characteristics or strategies. For example, France Stratégie (2021) shows that the take-up rate decreases with business size and that certain measures were not taken up systematically. It also shows that if a firm did not use the measures, it was probably because the firm chose not to do so. The EIBIS 2021 survey information does not enable us to determine whether a firm did not receive support because it was not eligible or because it did not want to participate.

Other factors besides eligibility influenced whether firms accepted support. The design of the programmes and how the administrative processes were set up are cited as explanations for the low take-up at the beginning of the crisis. Two key bank characteristics facilitated loan disbursement: size and information technology. Core and de Marco (2021) show that these factors were important because of the high volume of online applications and low interest margins on guaranteed lending. Pre-existing relationships also had a bearing on how guaranteed credit was allocated, as banks lent more in their core markets and where they have a larger local market share (Degryse and Ongena, 2005).

While the support measures implemented are relatively similar, comparing them across countries is still complicated due to a variety of factors. First, eligibility, the size of the support and the time frames differ substantially. Second, the volumes of financial support initially budgeted in the programmes differ from the amounts that were later disbursed. Third, the COVID-19 policy support measures coincide with other accommodating policies affecting the corporate sector, such as the recovery programme **NextGenerationEU**, the ECB's pandemic emergency purchase programme, national support programmes for households as well as automatic stabilisers (such as unemployment benefits and housing subsidies).

56% of firms received some kind of support. Figure 25 reports the share of companies that benefited from public support across the European Union. 56% of EU firms received support, with the rate varying from 78% in Luxembourg to 39% in Estonia. This ratio is somewhat lower in Southern Europe.

Figure 25
Intensity of policy support across European economies (% of firms)



Source: EIBIS 2021.

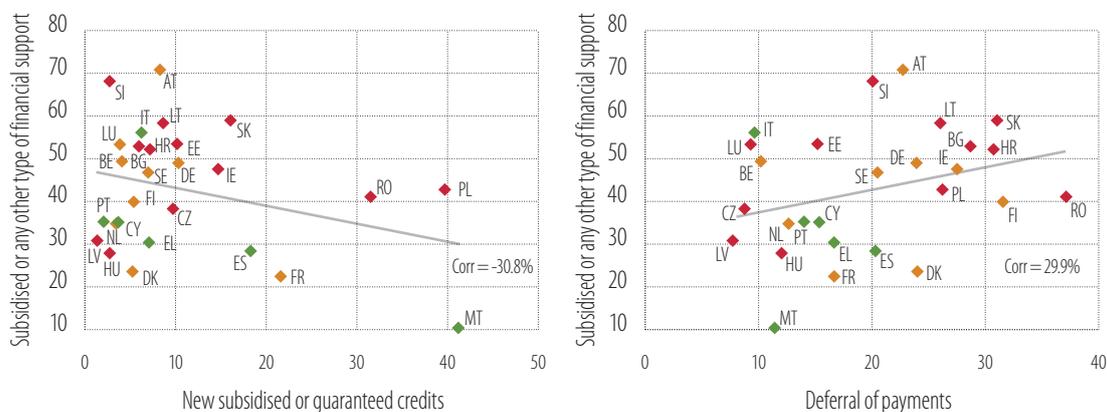
Note: Percent of firms having benefited from at least one type of support.

Most of the time, firms received one type of support, most likely subsidies (support for labour costs is included). Of all the types of policy support, subsidies (which include measures to bolster employment) were used the most, by 36% of firms in Western and Northern Europe, and in Central and Eastern Europe. Deferrals of payments and credit support represented almost the same share, coming to 16-17%. In some cases, companies benefited from two types of support (12% of EU firms overall), or even three (4%).

If combined with other types of support, payment deferrals tended to be used with other subsidies. Figure 26 plots the share of firms benefiting from two types of support by country. In the left panel, the

intensity of new subsidised or guaranteed credits (type 1) is correlated with the intensity of subsidies or any other type of financial support (type 3). The negative relationship suggests that these two types of policy do not tend to be used in combination with one another. In countries where firms benefit more from subsidies or any other type of financial support, these firms benefit less from new subsidised or guaranteed credits. The negative correlation amounts to -31%. Box B focuses on guarantee schemes and shows that the European Guarantee Fund has complemented the national programmes. In the right panel, deferrals of payments (type 2) are correlated with subsidies or any other type of financial support that does not need to be paid back (type 3). With a correlation of 30%, the allocation of both policies is positively linked; countries where firms benefit more from one policy also tend to benefit more from the other. This correlation suggests that most of the measures that fall under the category of subsidies or any other type of financial support (type 3) are likely to be labour support policies, as this support is associated with the deferral of social contributions or tax payments.

Figure 26
Relationship between types of policy support



Source: EIB estimates based on EIBIS 2021.

Box B

Recovery funds being allocated by governments and the European Guarantee Fund

As part of the policy response to the COVID-19 crisis, the euro area finance ministers agreed on 9 April 2020 to establish the European Guarantee Fund (EGF). The EGF was set up at the initiative of the EIB Group, which is also responsible for its management. EU members are expected to contribute up to €25 billion in guarantees. The fund is intended to provide additional financing to EU enterprises, particularly small and medium-sized businesses, to enable them to withstand the economic shock and to subsequently grow.

The fund provides financial support through guarantees and related risk-sharing products, as well as direct support channelled through instruments like venture debt and quasi-equity financing. The guarantees protect banks and their loan portfolios from losses on certain existing or new transactions. The guarantees therefore enable financial intermediaries to lend more money, which in turn facilitates firms' access to finance by reducing interest rates, providing loans with longer maturities or lowering collateral requirements. When the guarantees support new transactions, their role in supporting additional investment is fairly direct, sometimes by shifting risk from commercial banks or public

financial intermediaries to the EGF. For guarantees or counter guarantees on existing transactions or portfolios, the potential effect on investment is more indirect.

Extensions of national credit guarantee programmes

Various national credit guarantee programmes were already available in EU member countries, but the scope was often expanded during the pandemic and many new programmes were created, mostly around March 2020. Similar to previous major shocks that increased uncertainty, governments effectively took on the role of domestic guarantor of last resort. While the contours of that role differ across countries, a common feature is that governments provide support to firms through publicly supported credit guarantees. Publicly-supported guarantees for bank credit are one of the main types of policy used to respond to the COVID-19 shock.

The demand generated for any specific guarantee programme reflects its overall features and conditions and, obviously, the size of the total budget. National governments handle the standard trade-off between effectiveness and limiting moral hazard by building certain features into their programmes. Such features include eligibility criteria, coverage ratios, interest charges and guarantee fees. Table B.1 shows that the main features of national emergency credit guarantee programmes do not differ substantially across the four larger EU countries, even if there is some variation in coverage ratios, interest charges and fees (France *Stratégie*, 2021). The take-up of national programmes — in actual committed amounts — rose sharply from March 2020 to mid-2020 in all four countries. It then flattened, except for Italy where demand continued to grow (Bruegel, 2021).

Table B.1
Contours of emergency credit guarantee facilities in the four larger EU economies

	France	Germany	Italy	Spain
Body or programme (headline envelope)	Ministry of Economy and Finance, via Bpifrance (€300 billion)	Ministry of Economy and Finance (€460 billion) and KfW Sonderprogramm (€150 billion)	Fondo Centrale di Garanzia (€100 billion) and SACE export credit agency (€200 billion)	Instituto de Crédito Oficial (€144 billion)
Guarantee coverage rate	70-90%; Higher for small firms	80-100%	80-100%	80%
Maturity of loan	6 years	6 years; Alternatively 10 years for 100% cover	6 years; Alternatively 10 years for 100% cover	5 years
Interest rate on loan	0.25% first year, then 1-2.5%	3% for 100% cover; otherwise 1-2.1%	2% for 100% cover; otherwise market rate	NA
Guarantee fee	Charged to borrower	Charged to borrower	Subsidised	Charged to lender
Eligibility conditions	Non-financial corporates, with more restrictions and less favourable conditions applied in the case of larger firms (and separate programmes for exporting firms).			

Source: EIB staff estimates based on domestic websites and France *Stratégie*, 2021 and Bruegel, 2021.

Funds approved per country under the EGF

The EGF started operating in October 2020. At the end of August 2021, more than EUR 18 billion in EGF operations covering all 22 participating countries had been approved. Assessing the allocation of EGF funds to intermediaries or counterparts in participating countries can be done simply by comparing the amounts approved with the size of the initial shock in a given country. Here, the results of simple ordinary least squares (OLS) regressions shown in Table B.2 suggest that EGF demand per country is closely related to the size of the loss of GDP, and that more funds were disbursed in countries that

experienced a greater decline in GDP in 2020. Three different measures of the take-up of EGF funds are considered, as described in the notes below Table B.2. By contrast, the size of national guarantee budgets is not significantly related to any of the three measures considered here.

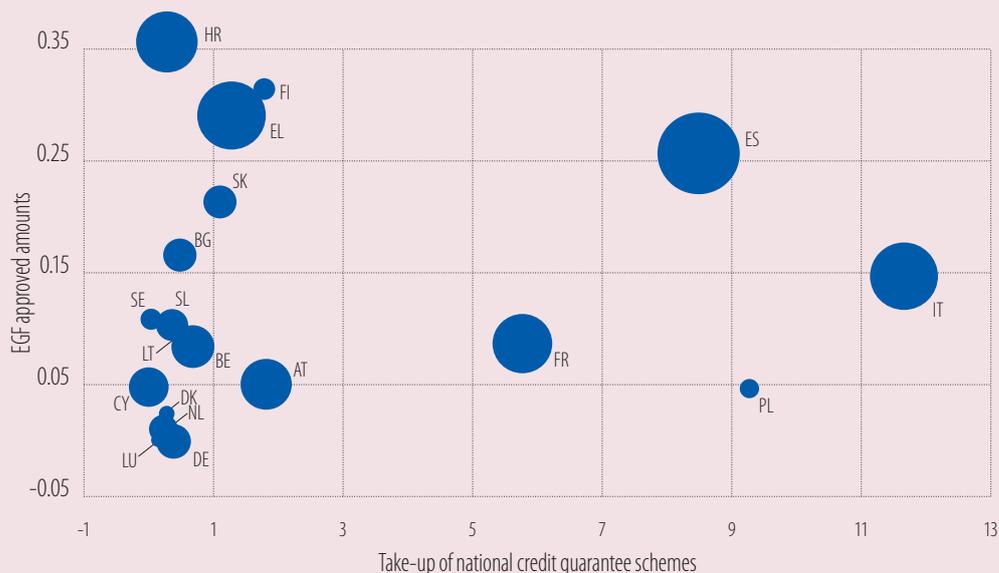
Table B.2
Determinants of the EGF rollout by country

	Total approved amounts (i)	Total approved amount involving some form of guarantee (ii)	Total approved amount involving some form of guarantee and a private counterparty (iii)
Take-up of national emergency credit guarantee	-0.003	-0.006	-0.005
GDP decline	-0.02*	-0.03**	-0.02**
Constant	0.08	0.07*	0.03
Number of observations	21	19	19
Adjusted R-squared	0.21	0.26	0.26

Source: EIB staff estimates based on data from the EIB, ESRB and Eurostat.

Note: Data at end-August 2021 for total approved EGF amounts (excluding multi-country deals) and at end-September 2021 for the take-up of national emergency credit guarantees. Explanatory variables expressed as a percentage of GDP. *significant at 10% level and ** at 5% level. EGF funds are analysed as follows: i) the total approved per country, ii) total approved amounts in the form of guarantees (capped and uncapped guarantees and linked risk-sharing), and iii) total take-up per country of measures including guarantees with private counterparties (excluding transactions with national development banks of public financial intermediaries). The results are robust to the inclusion of the total size of national guarantee budgets instead of their take-up.

Figure B.1
Rollout of funds under EGF and take-up of national emergency credit guarantee schemes



Source: EIB estimates based on data from the EIB, ESRB and Eurostat.

Note: Approved EGF amounts (excluding multi-country deals) as of August 2021 and take-up of national emergency credit guarantees as of September 2021, both as a percentage of domestic GDP. The size of the bubble reflects the annual percentage change decline in GDP in 2020 (with Ireland excluded for representational purposes here, as it did not register a decline in activity), based on the data for October from the 2021 Eurostat database.

Figure B.1 plots the rollout of EGF funds by country (expressed as a ratio to domestic GDP) against the take-up of national guarantee schemes (also expressed as a ratio to domestic GDP), with the size of the GDP decline in that country in 2020 illustrated by the size of the bubble. The chart shows that both the take-up of national credit guarantees and the rollout of funds under the EGF have been relatively high in Italy and Spain, whose output was hit particularly hard by the COVID-19 shock. The European Systemic Risk Board (2021) finds that the actual take-up of the announced national emergency credit guarantee budgets was higher in countries where the GDP shocks were more severe.

Overall, the analysis suggests that the country-specific allocation of funds under the EGF is largely related to the magnitude of the shock during the first year of the crisis. At this stage, it is difficult to determine the impact of these programmes, especially in the longer term. The programmes are part of broader policy frameworks that themselves reflect country-specific economic and financial conditions (Ebeke et al., 2021).

Support allocation across firms

A debate has emerged on the possible side-effects of public support, including the risk of misallocating resources. As support was mostly unconditional, some concerns have been raised that public funds might have been misallocated to keep afloat certain firms that would otherwise have ceased to operate, even if the crisis had never taken place. If funds have been misallocated, that misuse of those resources could weigh on long-term economic prospects (Archarya et al., 2020).

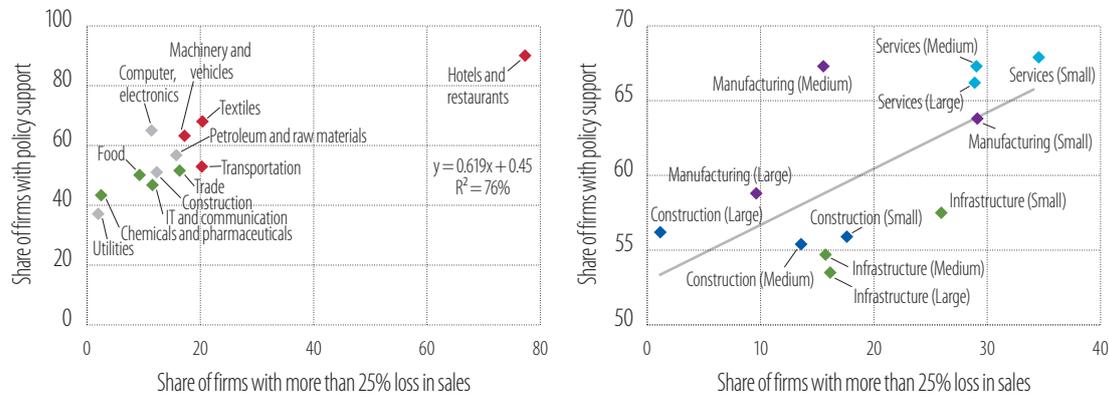
Public support was aimed at shielding firms, to prevent further pressure being put on demand. As such, this support was not designed to foster long-term growth. Public support was warranted because firms ran into difficulties due to government measures to restrict the spread of the virus, not because of fundamental issues with their businesses. Laeven et al. (2020) show that moral hazard is probably less of a problem than in earlier crises because many of the firms requiring short-term support were structurally healthy.

The massive public support deployed in Europe came after a long period of low rates, which favoured the survival of weak firms. Persistently low interest rates have probably facilitated the granting of new loans to borrowers on the verge of defaulting on their existing ones, contributing to the “zombification” of parts of the economy. Conversely, the environment might not have been very conducive for new, innovative competitors entering the market. Creative disruption has not taken place, and as a consequence, productivity growth has remained lacklustre.

No evidence has emerged of public support being misallocated across various industries. Figure 27 considers differences among sectors using two breakdowns (by sector and by firm size). In the left panel, we compare the share of firms receiving policy support against the share of firms posting large sales declines (of more than 25%) for 12 broad sectors.¹⁰ The panel confirms that services was one of the hardest hit areas, with hotels and restaurants suffering, while other sectors either were not affected or were positively affected. With a fairly accurate R-square reading of 76%, the positive relationship with the prevalence of policy support suggests that, across sectors, support was strongly linked to changes in revenue. The stronger the decline in sales in a sector, the higher the intensity of public support. When the types of public support are investigated separately, subsidies or other financial support (type 3) are strongly related to sales declines. A common type of public support is furlough schemes, which helped offset lost sales.

¹⁰ While the EIBIS sampling is not designed to be representative of these 12 sectors, each is populated by at least 350 firms throughout the European Union.

Figure 27
Policy support allocation (% of firms)



Source: EIB estimates based on EIBIS 2021.

Note: Any type of policy support. In the left panel, the colour (green, grey and red) refers to the sub-sectors experiencing the most positive, the median, and the most negative effects.

Smaller firms recorded steeper sales declines and therefore received more support. The four-sector breakdown used in the EIBIS (construction, manufacturing, services and infrastructure) is further analysed by firm size (small, medium or large) in the right-hand panel of Figure 27. For each of the four sectors considered separately, smaller firms were more affected, which is confirmed in the literature (Gourinchas et al., 2021). They are positioned to the right of their peers in the same sector as they are more likely to have seen significant sales declines compared to large firms: 29% vs. 9% in the manufacturing sector, 35% vs. 29% in the services sector, 18% vs. 1% in the construction sector, and 26% vs. 16% in the infrastructure sector. Consequently, small firms are also more likely to receive support, as shown by their position above their peers in the same sector.

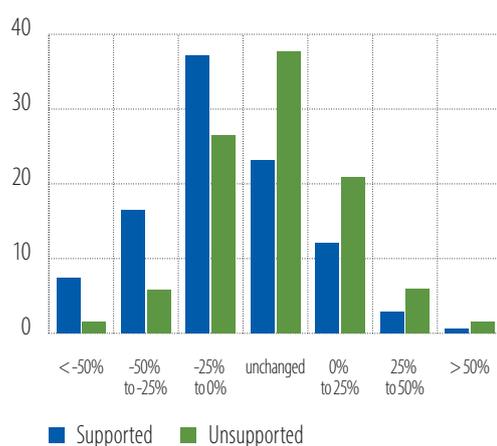
Overall, support went mainly to firms booking steeper sales losses. Figure 28 shows the distribution of the change in sales for firms that received support and those that did not. The distributions clearly differ. The distribution of firms receiving support is clearly tilted to the left, showing that on average, their sales losses were greater. The mode of the distribution corresponds to a decline of 0 to 25% while the mode for unsupported firms is around 0. One-quarter of the supported firms recorded sales declines of more than 25%, compared to 7% for unsupported firms. However, Figure 28 also shows that 15% of the supported firms recorded sales growth, while 9% of the unsupported firms recorded sales losses.

The type of policy support also matters. The link between a firm's drop in sales and the policy support it received was especially strong for subsidies and other financial support and somewhat lower for credit guarantees. Figure 29 shows the share of companies that received support from each of the three types of policy. Again, the larger the sales decline, the higher the intensity of the support. The difference is especially marked for subsidies and financial support, as it reaches 30% between companies with no sales decline and those posting major declines. The magnitude of this difference is consistent with the nature of the support, which mostly includes measures to maintain labour, and is therefore tied even more closely to demand. Conversely, subsidised or guaranteed credits tend to be less popular. At the beginning of the crisis, the uncertainty prompted firms to tap cheap available credit to insure against possible future liquidity shortfalls. However, once certainty was restored and firms were reassured that they could continue to access financing, demand for precautionary liquidity fell. Ultimately, the availability of credit guarantees in most countries outweighed their actual use.

We estimate how a firm's characteristics influence whether it receives policy support. Separate probit models are estimated, each time controlling for country, sector, size and sales loss, with each factor then added one by one. Figure 30 plots the change in the predicted probability of getting policy support (of

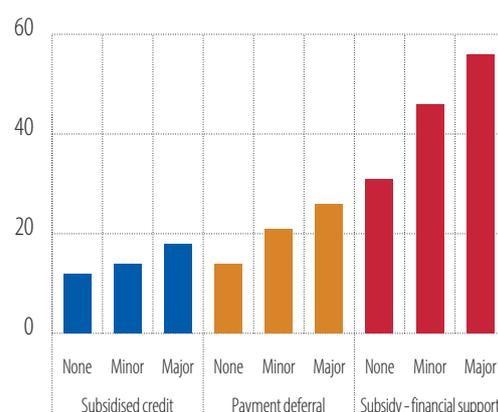
any type). When the characteristic is binary, its presence or absence is reported as “yes” or “no.” When it is continuous, “high” refers to being in the last decile and “low” in the first decile. The vertical line reports the 95% confidence interval of the probability. When the two lines overlap, the factor does not alter the probability of receiving support significantly.

Figure 28
Distribution of the change in sales and public support (% of firms)



Source: EIB estimates based on EIBIS 2021.
Note: Change in sales reported on the x-axis.

Figure 29
Public support by sales decline and policy instrument (% of firms)



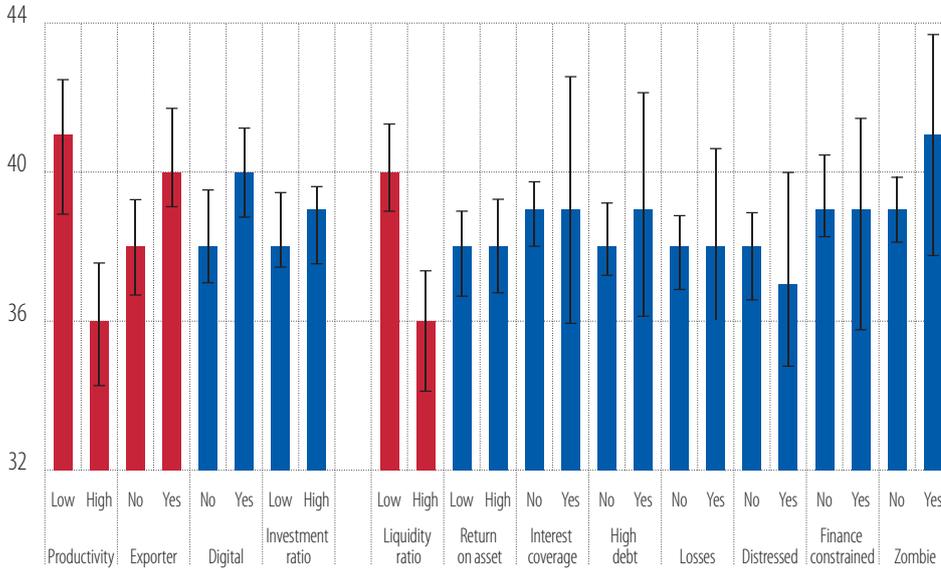
Source: EIBIS 2021.
Note: None, minor and major refer to firms not recording sales declines, firms recording sales declines of less than 25% and firms recording sales losses of more than 25%.

More productive firms and those that didn't export were less likely to receive public support, which probably illustrates how the crisis affected some sectors more than others. Beyond the control variables, real firm characteristics are not taken into account, except for productivity and whether a firm exports. A firm's productivity appears to be an important factor when the top and bottom deciles are considered. The most productive firms did not avail themselves of support and for the three first quartiles, no distinction is detected. This finding mainly reflects the greater impact the crisis had on less productive sectors. Being an exporter is also significant, albeit to a lesser extent. Exporters were more likely to accept public support. The other real characteristics do not seem to have an impact.

Only firms with low liquidity ratios were more likely to receive public support. While firms exhibiting financial distress, low returns on assets, losses and high indebtedness are more likely to receive support, the difference is not significant. Conversely, firms that have lower liquidity ratios or fewer cash buffers are significantly more likely to receive policy support. The primary objective — preventing liquidity from drying up and averting a sharp rise in insolvencies — therefore appears to have been met (Hadjibeyli et al., 2021). Overall, we have not found evidence that support was tilted towards firms that were already weak before the crisis, such as financially distressed or zombie firms. In fact, policy support in several countries specifically incorporated features intended to prevent this outcome. Focusing on firms located in Croatia, Finland, Slovenia and Slovakia, Bighelli et al. (2021) also conclude that employment subsidies and direct subsidies have only been marginally directed towards zombie firms.¹¹

¹¹ Zombie firms are defined in the literature as old firms that have persistent problems meeting their interest payments but that often survive thanks to bank forbearance, prolonged monetary stimulus or other firm-specific policy support (McGowan et al., 2018). We define zombie firms as firms that are older than ten years and whose interest rate coverage ratio was below one in the year before the pandemic (2019 or 2018 when the 2019 data are not available).

Figure 30
Predicted probability of receiving public support (% of respondents), by firm characteristics before COVID-19



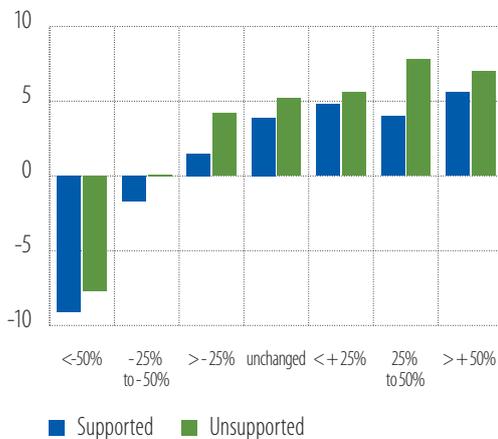
Source: EIBIS 2021.

Note: Red indicates the cases where the difference is significant. Based on the preliminary matched database.

The short-term impact of support

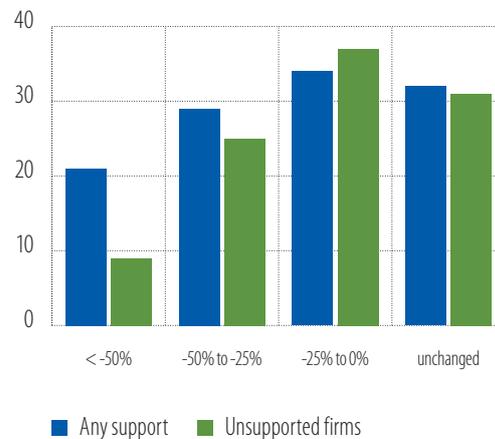
Despite the efforts, the profitability rate of firms benefiting from policy intervention lag behind 2019 figures. Figure 31 shows that the profit distribution of firms without (or not needing) support has shifted towards the right. The margins of supported firms have shifted below those of firms not receiving support.

Figure 31
Profit rate by sales decline (in %)



Source: EIBIS 2021.

Figure 32
Policy support and investment plans (% of firms), by loss of sales



Source: EIB estimates based on EIBIS 2021. Note: the y-axis reports the share of firms planning to increase investment.

The estimates confirm that sales declines caused by the pandemic were a factor in pushing down investment. Table 1 reports the estimated results of several linear probability models explaining the likelihood of investment being reduced. In all cases, a change in sales, measured at the level of the country and sector, is negatively related to the probability of scaling down investment. The impact is significant at 5% and very stable across all the 12 sectors.

Pubic support allowed firms to preserve investment, as it reduced the impact of lost sales. Figure 32 plots the percentage of firms planning to invest more in the current financial year, depending on the sales declines they recorded during the first year of the COVID-19 crisis. The figure distinguishes between firms having received support and those that have not. The share of firms planning to invest more increases as the decline in sales decreases. Firms receiving support plan to raise investment more than firms with similar sales declines. The difference is especially pronounced when the loss in sales is large. The estimates confirm that large sales declines lead to lower investment, and that public support partly compensated for this impact. We used a probit model to explain the probability that a firm will increase investment in the current financial year. The estimates confirm that a sales decline of above 25% reduces the probability of increasing investment by 5 to 8 percentage points. At the same time, obtaining public support, of any type, significantly increases the probability of raising overall investment by 2 to 3 percentage points.

Policy support shielded investment in IT and business processes, but not in training. Looking across investment types, public support cushioned investment overall, but the effect was very different depending on the asset type. Investment was positive and significant for software, data, IT networks and website activities, and for organisation and business process improvements. The crisis forced firms to try out new ways of working. Remote working, IT, digitalisation and the necessary reorganisation of working models and processes were a clear priority. Policy support did not, however, manage to shield investment in training employees.¹²

Financial constraints, sales mark-ups and the utilisation of existing capacity also influenced investment plans. Besides a change in sales, the models also consider capacity utilisation, mark-ups and financial constraints as factors that influence investment. Considered separately or together, the three factors have a significant influence that is consistent with expectations. For the same decline in sales, financially constrained firms tend to reduce investment by more, as do firms working under capacity. Conversely, firms that operate with higher mark-ups and show a greater likelihood of accumulating more internal financing tend to reduce investment less.

Table 1
Firms planning to reduce investment: Cash holdings and equity-influenced decisions

	Without mitigating factors					Capital to assets				Cash to assets			
	Linear		Rectangular		Linear		Rectangular		Linear		Rectangular		
Turnover change*	-0.62***	-0.62***	-0.70***	-0.64***	-0.69***	-0.65***	-0.71***	-0.63***	-0.71***	-0.64***	-0.71***	-0.63***	-0.62***
	(-0.05)	(0.05)	(0.06)	(0.05)	(0.06)	(0.06)	(0.07)	(0.06)	(0.07)	(0.06)	(0.07)	(0.08)	(0.09)
under.	3.81***		2.61**		4.28***		4.27***		3.534***		3.53***		
	(-1.03)		(1.19)		(1.11)		(1.11)		(1.126)		(1.13)		
mark-ups			-2.17**		-1.91**		-2.24**		-2.24**		-2.01**		-2.02**
			(0.86)		(0.88)		(0.92)		(0.92)		(0.92)		(0.92)
Fin. Const.			4.38**		6.06***								
			-1.91		(2.26)								

12 Policy support is accompanied by a 2 percentage point increase in the share of investment in digital equipment, and a 1.3 percentage point increase in organisation and business process improvements. Both effects are significant at 5 percentage points. Conversely, policy support is accompanied by a non-significant increase in the share of R&D by 0.5 percentage points and a non-significant decrease in the share of training by 0.2 percentage points.

Part II Recovery from the COVID-19 pandemic, scarring and asymmetry

	Without mitigating factors				Capital to assets		Cash to assets						
					Linear	Rectangular	Linear	Rectangular					
Capital					-2.97 (1.47)*	-2.29 (3.10)	-3.98 (2.65)	-2.22 (3.98)					
Capital* turnover						-0.18 (0.16)	0.01 (0.24)						
Cash							-8.94** (3.32)	-7.30* (3.75)					
Cash* turnover								-9.68** (4.26)					
								-0.12 (0.32)					
								-11.15*** (0.35)					
Observations	9 535	9 484	7 372	9 298	7 251	8 179	6 399	8 179	6 399	7 985	6 243	7 985	6 243

Sources: EIB estimates.

Note: Linear probability model with 1 when the company plans to lower investment. Size is 1 for small and medium-sized firms, 0 for large firms. Under reports capacity utilisation: 1 for firms working below production capacity prior to COVID-19. Mkup signifies mark-ups. *: sales change at the sector-country level. Constants are included. Both cash and capital position are considered as a share of total assets. Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Cash holdings and strong capital positions lessened the impact of lost sales. Table 1 also reports the estimated results of the model that includes capital to assets and cash to assets ratios. These two characteristics, associated with a stronger balance sheet, limit how much a lost sales result in a cut in investment. More capital and cash cushion how debt taken on during the crisis affects investment. Non-linearity for cash is also indicated, as hoarding cash is an effective way of offsetting a decline in sales.

The recovery in investment

In this section, we analyse the factors that would enable firms to come out of the crisis stronger, and improve their productivity. We also examine the impact of public support on investment plans, controlling for sales losses and balance sheet structure. Firms that benefited from policy support tend to be more optimistic regarding their investment plans. The impact is especially pronounced for investment in digital technologies. In some cases, the impact is also strengthened because public support allowed firms to recapitalise.

It will take time to evaluate the impact that public support ultimately has on firms. While the data reported by listed firms are more up-to-date, firm-level data are generally known to have a lag of around two years. Moreover, some of the policy measures have automatically postponed firms' bankruptcies. However, the literature suggests that crises triggered by pandemics have a bearing on medium-term growth. Aguirre and Hannan (2021) take a long-term perspective and analyse the aftermath of five pandemics. The authors show that so far, the pandemic's adverse effect were limited in countries that provided greater public support.

The COVID-19 crisis has affected productivity and business dynamics in euro area countries through four main channels: (i) workers changing sectors as they change jobs, (ii) creative destruction and workers changing jobs within the same sector, (iii) the adoption of digital technologies and (iv) teleworking. Criscuolo (2021) shows that the shifts in the labour force are sizeable and are tilted towards high-productivity sectors. Firms have also accelerated the ongoing digital transformation and have adopted remote working. However, not all firms went "digital and remote" to the same extent. Firms that were already more digital before the crisis adopted even more advanced technologies, with implications for productivity and business dynamics in the aftermath of the crisis. Box C presents an overview of the literature on the impact of firm-level policy support.

Box C**An overview of public support's impact**

The analysis of COVID-19 support builds on a vast literature of microeconomic impact assessments. The impact of loan guarantees for firms in normal times is well documented. EU evidence finds that loan guarantees have a significant positive impact on firms' size, revenues, employment, investment and survival (Asdrubali and Signore, 2015) and innovation (Bertoni et al., 2019; Brault and Signore, 2019).

Likewise, past subsidised loan programmes for small and medium-sized firms have been found to have positive effects on job creation, investment and productivity in Bulgaria (Erhardt, 2017) and Hungary (Horvath and Lang, 2021; Endresz et al., 2015). Finally, firm-level evidence shows that job retention schemes prevent layoffs and safeguard firms' survival: for instance Lydon et al. (2019), Kopp and Siegenthaler (2019) and Guipponi and Landais (2020).

Although the available data are still limited, early evidence indicates that firms are positively affected by public support at the national level during the pandemic. A selection of model-based simulation exercises helped to inform policymakers from an early stage of the pandemic. Gourinchas et al. (2020), Lopez-Garcia (2020), Blanco et al. (2021), Demmou et al. (2021a,b), Díez et al. (2021), Ebeke et al. (2021) and Maurin and Pal (2020) highlighted the potential of support measures to reduce liquidity shortfalls, bankruptcies, and output and employment losses compared to a non-intervention scenario. Nevertheless, the true impact can only be gauged when detailed firm records become available.

More than a year and a half into the pandemic, firm-level evidence is emerging. Hadjibeyli et al. (2021), for example, perform a microsimulation exercise using data on French firms up to December 2020. The simulations show that, thanks to furlough schemes, direct subsidies and tax relief, the increase in illiquidity is 12 percentage points lower, and the increase in insolvencies 5.3 percentage points lower relative to a scenario without such policies. Building on a similar yet smaller database for 2020, Bureau et al. (2021) simulate a reduction from 60% to 47% in the share of firms that faced a negative shock to their cash flow, thanks largely to support measures in France (not including loan guarantees). France Stratégie (2021) extends the simulations to data available up to March 2021, showing that the support measures (including loan guarantees) reduced by 13 percentage points the share of firms that faced a drop of more than 25% in the value they added. Lalinsky and Pal (2021) use firm-level data from Slovakia from March to June 2020 to investigate government wage subsidies. They find significant drops in the probability of firms facing illiquidity (3.5%) and insolvency (3.5%) when they are granted support. Both studies find stronger effects for smaller firms.

The positive short-run impact of public support does not preclude medium-term risks for governments. While pandemic-related loan guarantees have the benefit of spreading around exposure to the pandemic, the guarantees issued in response to COVID-19 tend to be concentrated among the most vulnerable firms and the hardest-hit sectors. For example, recent firm-level evidence from Italy finds that financially fragile firms — in particular smaller, less liquid, more leveraged firms and/or firms classified as zombies — are more likely to have received public guaranteed loans during the pandemic (Core and De Marco, 2021). Interestingly, firm-level evidence for four other EU countries (Croatia, Finland, Slovakia and Slovenia) suggests that this does not hold for employment subsidies and direct subsidies, with support distributed to firms with medium levels of productivity, and only marginally to zombies (Bighelli et al., 2021).

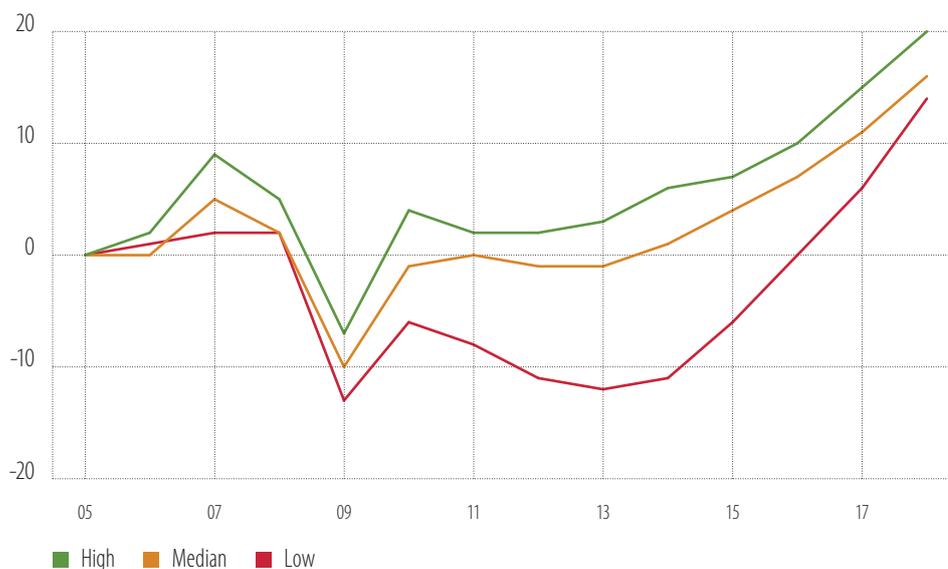
National public support measures have played an important role in stabilising the economy and bank lending during the pandemic. Preliminary firm-level evidence shows a decisive role for the support measures in limiting insolvencies and safeguarding employment. The public support schemes that were introduced in response to the pandemic — in particular state-backed loan

guarantees — however, also constitute sizeable contingent liabilities for governments, therefore raising concerns about the potential medium-term risks they may face. Moreover, corporate indebtedness is rising, as loans were issued to help firms whose capital had been worn away by losses. That indebtedness increases the risk of insolvency and of lower investments in the medium term (Maurin and Pal, 2020).

Crises and productivity gaps among firms

Major crises tend to be associated with a widening of the productivity gap. In Figure 33, European firms are split into three groups depending on the estimated level of total factor productivity in 2005: low, median and high productivity groups.¹³ The productivity gap between the high and the low groups started to widen substantially from 2009 to 2011 in the aftermath of the global financial crisis. The gap widened even further during the sovereign debt crisis, albeit less significantly. It was only during the upturn after 2014 that firms with the lowest productivity levels were able to recover. Overall, their productivity rose by close to 15% from 2005 to 2018, at the same rate recorded by the firms in the two other groups. These broad trends are relatively robust (Delanote et al., 2018; Andrews et al., 2017).

Figure 33
Pre-crisis productivity trends (total factor productivity estimated with Wooldridge -Levinsohn-Petrin technique, 2005=100)



Source: EIBIS 2020.

Note: Estimates based on ORBIS using the Wooldridge -Levinsohn-Petrin (WLP) technique, controlling for sector and country fixed effects. Results reported for the manufacturing sector.

We split firms into seven groups based on their initial productivity level and the change recorded. In Figure 34, we report the breakdown. Firms with low productivity can remain in the low segment, “Stuck” or move to a higher productivity group, becoming “Reachers.” Firms in the medium segment can remain there, “Platoon,” shift down, “Fallen platoon,” or climb the productivity ladder and reach the top group,

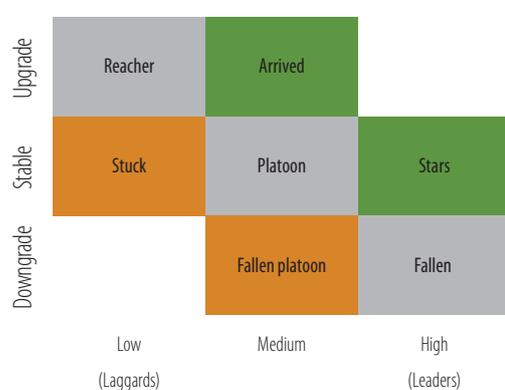
¹³ The allocation is achieved after controlling for macro-wide differences in countries’ total factor productivity. Many caveats and methodological choices are associated with Figure 38. First, the underlying sample: here the manufacturing firms available in ORBIS over a long period of time. Second, the method used to estimate total factor productivity: here the WLP technique. Third, the dependency on initial conditions: here we split firms based on their total factor productivity in 2005, the first year of the upturn in the European Union.

becoming “Arrived.” Finally, firms at the top can remain there, “Stars,” or move down, “Fallen.” We use this breakdown to analyse the mobility of firms in the three European regions over the recent period, since the beginning of 2005.

On average, movement among firms is more pronounced in Western and Northern Europe. Figure 35 depicts the average probability of moving up from a low or median level in the three regions, over three periods: 1) before the global financial crisis, from 2005 to 2008, 2) during the global financial and sovereign debt crises, from 2009 to 2013 and 3) post crises (but prior to the COVID-19 crisis) from 2014 until 2018. In Western and Northern Europe, the probability of climbing the productivity ladder is structurally higher. Conversely, it tends to be lower in Southern Europe.

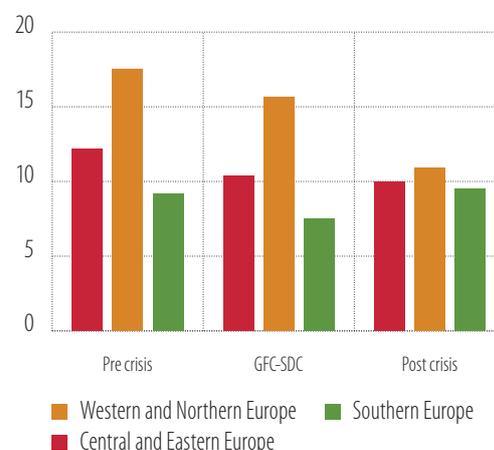
Over time, the probability of climbing the productivity ladder has evolved differently for the three regions. Figure 35 also shows that for Western and Northern countries, the probability has been declining over time, and has fallen sharply over the most recent period. At the end of the recent period, the probability is only slightly higher than for other European regions. Conversely, the likelihood of moving up has recently recovered in the Southern Europe. It declined before the current crisis and during the global financial crisis-sovereign debt crises as these economies suffered major credit disruptions and much tighter access to external finance. But as the region’s economies continued to recover from these crises (before COVID-19), the transformation of firms resumed, and the probability of moving up reached levels slightly below those of EU peers. Finally, the probability has somewhat declined in Central and Southern Eastern Europe as these economies have continued along the path to convergence, narrowing the gap with the more advanced EU economies.

Figure 34
The ladder (in %, European Union)



Source: EIB estimates.

Figure 35
Likelihood of moving up (in %)



Source: EIB estimates based on ORBIS.

Note: Pre-crisis is 2005-2008, global financial crisis-sovereign debt crisis is 2009-2013 and post-crisis is 2014-2017. The probability of moving from the low to median or high and from the median to high, rescaled by three.

Firms’ characteristics and mobility on the productivity scale

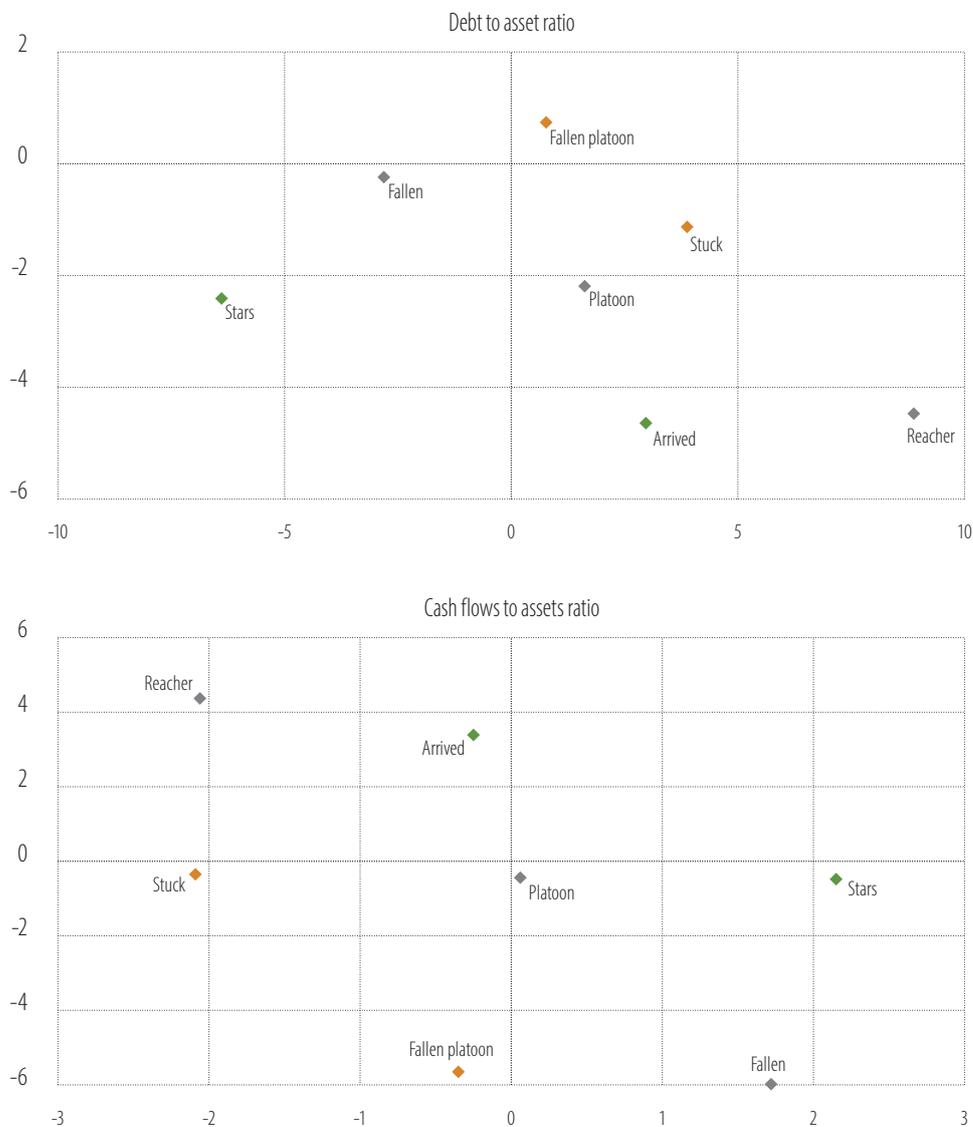
Certain characteristics influence the likelihood of moving up the productivity scale. Looking separately at three balance sheet ratios (debt to assets, cash flow to assets and the investment ratio), Figure 36 positions the seven types of firms in a quadrant. The firms are allocated to each of the seven groups over periods of three years. For each group, the x-axis indicates the deviation between the average ratio for the firms in the group and the overall average. The y-axis indicates the change, three years later. The

three colours reflect the productivity level, consistently with Figure 34: green for high productivity, light grey for median productivity and brown for low productivity. Each group of firms is shown distinctly in the quadrant.

Investment and its financing appear to highly influence mobility on the productivity ladder. Compared to firms with the same productivity level, firms that move up start with higher investment rates, resulting in higher indebtedness and lower cash positions. Thereafter, once they have reached higher productivity levels, they record a higher increase in the cash flow to assets ratio and lower change in the debt to assets ratio. The trend is symmetric for firms that drop down the productivity ladder: because they invest less, they have higher cash ratios and lower indebtedness. However, once they have moved and become relatively less productive, cash positions erode and debt ratios increase more than peers.

Figure 36

Firms' fundamentals and movements within the group (x-axis: deviation from the mean; y axis: change. Both axes are in percentage points)



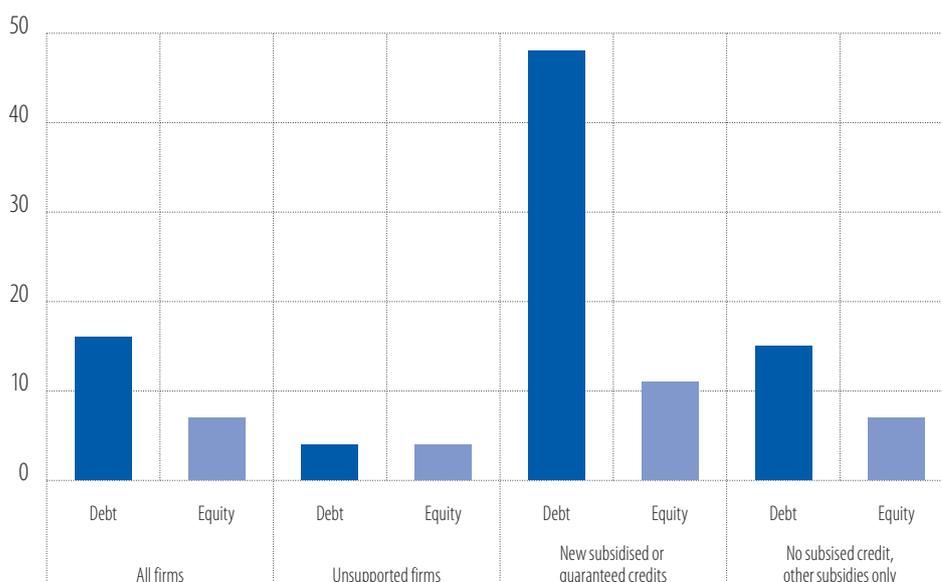


Source: EIB estimates based on ORBIS.

Note: The green, grey and orange colours indicate firms in the high, median and low productivity range.

During the crisis, leverage increased for 17% of firms. The increase was greater for small and medium-sized enterprises than for large enterprises. 17.5% of SMEs vs. 15.2% of large enterprises increased their debt as a response to the pandemic. As shown in Figure 37, the increase was somewhat stronger for firms receiving support, particularly in the form of subsidies or guaranteed credit. Receiving this form of policy support automatically raised these firms’ leverage. The firms were more likely to preserve their investment plans and used credit to finance them.

Figure 37
Policy support and balance sheet expansion



Source: EIB estimates based on EIBIS 2021.

Public support raises the likelihood of firms' increasing their equity. Firms that recorded sales declines were more likely to increase their equity and to receive public support. The combination of these two effects may suggest that recapitalisation needs resulting from large losses were more likely to be fulfilled by firms receiving policy support. Receiving such support might increase the probability of a firm attracting other equity investors. This interpretation is borne out by the estimated impact of firm characteristics. The higher the financial leverage and the lower the capital ratio pre-COVID-19, the likelier the increase in equity. The change in the financial structure possibly corrects weakness on the balance sheet.¹⁴ Overall, 7% of supported firms have raised equity, above the ratio of non-supported firms.

There has been a strong recovery of the venture capital market. Focusing on the venture capital, Box D details the results of the 2021 venture capital survey conducted by the European Investment Fund (EIF). The survey points to a strong recovery of the European venture capital market, following a slump in the first half of 2020.

Box D

The EIF VC Survey and the EIF Private Equity Mid-Market Survey

The 2021 wave of the EIF VC Survey includes anonymous responses from 479 venture capital fund managers (from 379 venture capital firms), some of whom are EIF counterparties.¹⁵ The majority of the respondents are chief executives or managing/general partners, which suggests that their responses reflect the views of decision-makers in venture capital/private equity firms.

The latest survey waves mainly covered market sentiment and the impact of COVID-19, investments in the environment and climate, as well as gender diversity. The results of the market sentiment section of the EIF VC Survey are published in Botsari et al. (2021). Responses were received from 2 July to 4 August 2021. The results of the 2021 survey point to a strong recovery of the European venture capital market, following an initial slump when the the COVID-19 crisis started to weigh on the economy in the first half of 2020.

According to the EIF VC Survey, venture capital fund managers are once again optimistic. The current market situation is perceived to be even better than before the crisis. Expectations for the market through mid-2022 are very positive across several categories (as regards the fundraising environment, for instance, or the ease with which co-investors can be found and the number of new investments). These expectations are at the highest level since the survey was introduced in 2018. After a strong decline in the fall of 2020, venture capital fund managers' perception of business opportunities is back to the levels reached in the previous four survey waves. Expectations regarding opportunities in the next 12 months are generally positive. The perception of the fundraising environment has reached an all-time high. Expectations for the future fundraising environment are more optimistic in 2021 than they were in the fall of 2020.

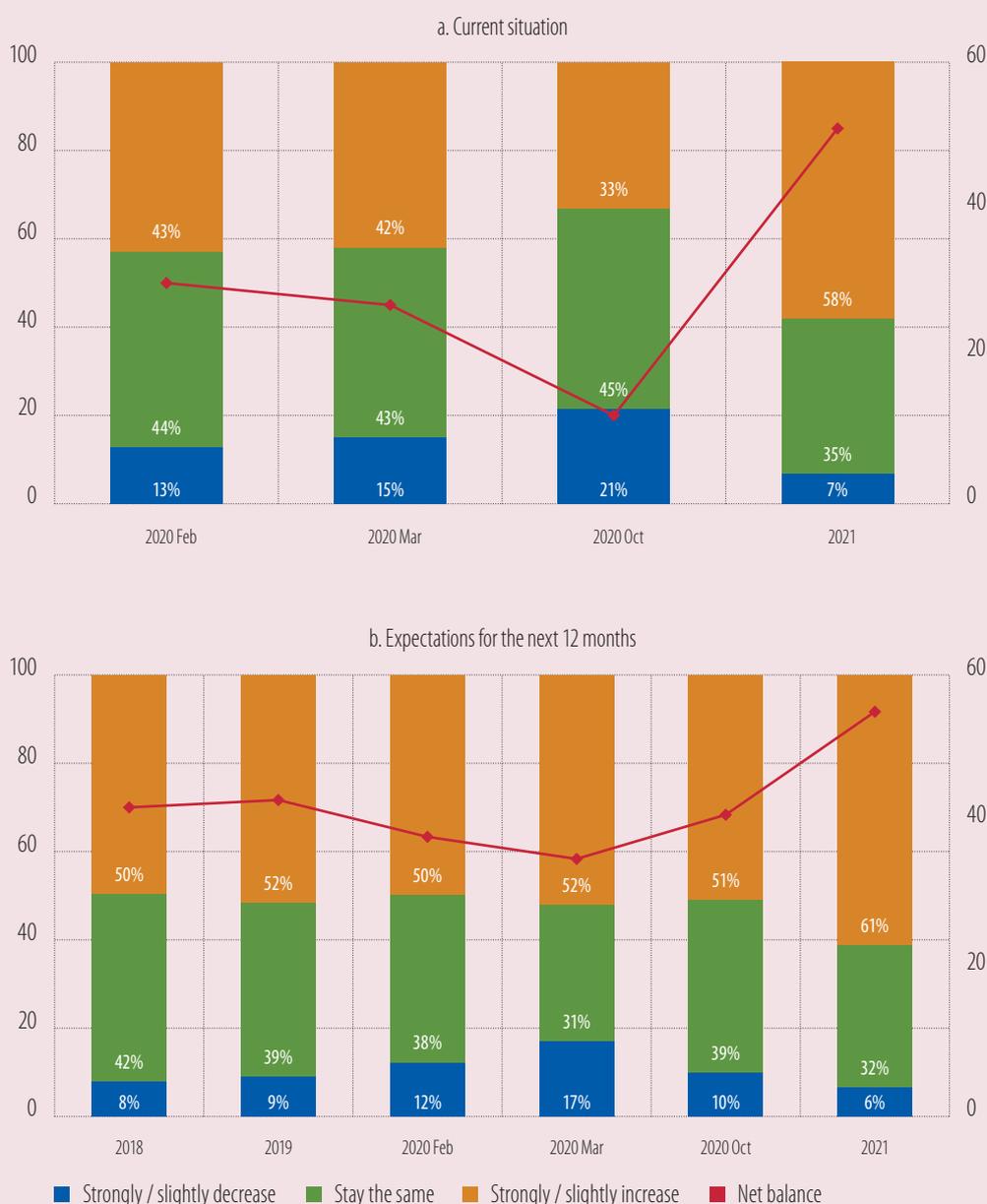
The percentage of respondents reporting an increase in their number of new investments is larger than before the COVID-19 crisis (Figure D.1). Most respondents reported more investments, and a further increase is expected. Venture capital fund managers can select from an increased number of incoming investment proposals, and the number is expected to rise even further. Fewer venture capital fund managers invested exclusively in follow financing for portfolio companies, and finding co-investors has become less difficult. During the COVID-19 crisis, investment expectations showed only a small slump. In 2021, expectations for the next 12 months even reached record-high levels (Figure D.2).

¹⁴ See Maurin and Pal (2020) or Carletti et al. (2020) for the need to increase the capital base of firms after the sharp fall in profits during the COVID-19 crisis.

¹⁵ With the EIF Private Equity Mid-Market Survey, the EIF VC Survey currently represents the largest regular survey exercise among general partners in Europe.

The environment for exiting investments has recovered since last year. Expectations have improved, but are below 2018 levels. In 2021, insolvencies/liquidations decreased from relatively high levels, while initial public offerings (IPOs) have gained more prominence. A large part of exits happened outside the European Union, through IPOs or sales of listed stocks.

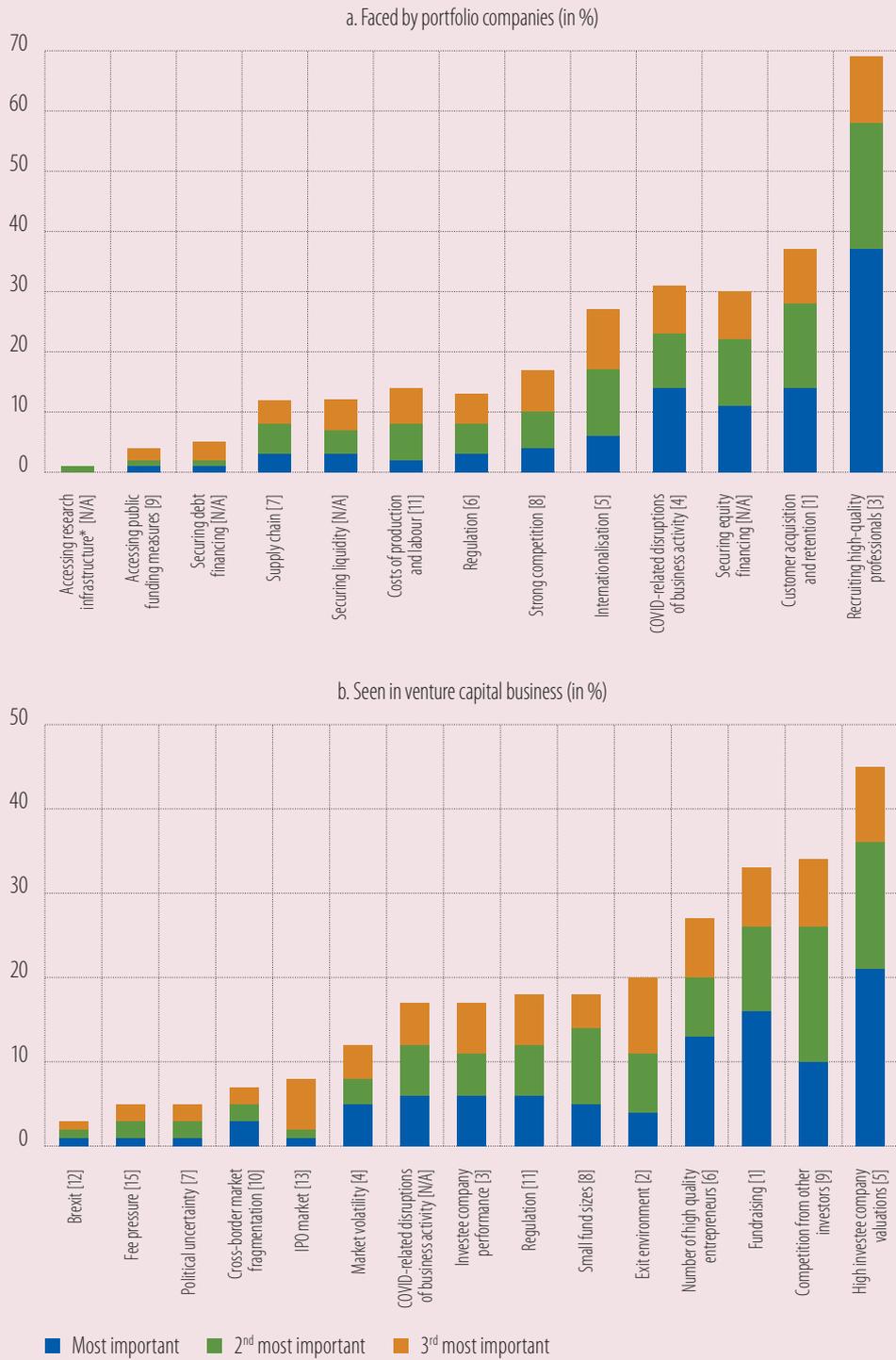
Figure D.1
Number of new investments



Source: Botsari et al. (2021).

Following a slump during the pandemic in 2020, valuations and exit prices have increased again. The majority of venture capital fund managers expect a further increase in exit prices over the next 12 months. These fund managers report that competition for investee companies has increased recently and expect this development to continue.

Figure D.2
Biggest challenges currently



Source: Botsari et al. (2021).

Portfolio companies developed better than expected for most venture capital fund managers. A large majority of respondents expect further improvement. An even larger majority (compared to autumn 2020) of venture capital fund managers do not expect any insolvencies because of COVID-19. Portfolio companies' access to finance is at a record high and expected to (at least) stay high in the near future. "Recruiting high quality professionals" has remained the biggest challenge faced by portfolio companies through 2021 except in the autumn of 2020, when more immediate challenges were cited because of the COVID-19 crisis (Figure D.2, panel a). The impact of the crisis was uneven for firms receiving venture capital, and was positive or negative depending, for example, on the economic sector of the portfolio company. The largest share of respondents view the impact of COVID-19 on the current performance of their fund(s) or portfolio as neutral. For the impact of COVID-19 on the expected final performance of their fund(s) or portfolio, respondents are even more positive. More respondent expected net asset value to grow in 2021 than in 2020.

"Fundraising," "high investee company valuations" and "number of high quality entrepreneurs" are consistently cited as the most significant challenges in the venture capital business. In 2021, "high investee company valuations" have become the biggest challenge (Figure D.2, panel b). Despite these challenges, venture capital fund managers are confident in the long-term growth prospects in Europe and in their own markets.

Impact of the crisis and public support for the digitalisation of firms

More productive firms have been digitalising more, with an effect on the digital divide. Our analysis shows that firms with higher productivity are more likely to invest in digitalisation. This result is shown in the breakdown by sector and country in which firms operate. In the same country and sector, therefore, the more productive firms are more likely to digitalise further. This dynamic may widen the productivity gap as digitalisation is likely to foster productivity.

Firms receiving policy support are able to mitigate the impact of lost sales, which shields their investment in digitalisation. Table 2 explains the likelihood of strengthening digitalisation, with financial expansion, debt and equity also factored in.¹⁶ In all the estimates reported in Table 2, lost sales affect digitalisation negatively, reducing the likelihood that a firms will digitalise further by 5 to 10 percentage points. However, the effect is compensated by the allocation of policy support. Firms that received this support are across the board 4 to 5 percentage points more likely to digitalise. Firms that received policy support and suffered large sales losses are 5 percentage points more likely to digitalise than firms that experienced sales losses but did not receive policy support. Finally, stronger firms, firms not in distress and firms with lower leverage or a higher capital base are more likely to digitalise, although these effects are only significant at 10%.

¹⁶ For more details, see Harasztosi et al. (2021). We estimate the following equation:

$$q_{i,c,t} = \alpha.Sales_i + \beta.Pol_i^k + \gamma.Sales_i \times Pol_i^k + \delta.Fin_i + Z_i + \theta_{sec} + \theta_{size} + \theta_c + \epsilon_i$$

Where *Fin* relates to financial expansion, whether the firm has raised equity and/or debt. *Sales* is the dummy variable indicating if the firm reported a decline of more than 25% in its sales. *Pol* indicates that the firm has benefited from at least one policy support measure. Each dummy takes the value one when the answer is positive, and zero otherwise. *Z* is a set of firm characteristics, related to its balance sheet structure or profit and loss statement. Labour productivity is always incorporated in the equations, as a standard determinant of investment.

Table 2
Likelihood of becoming more digital

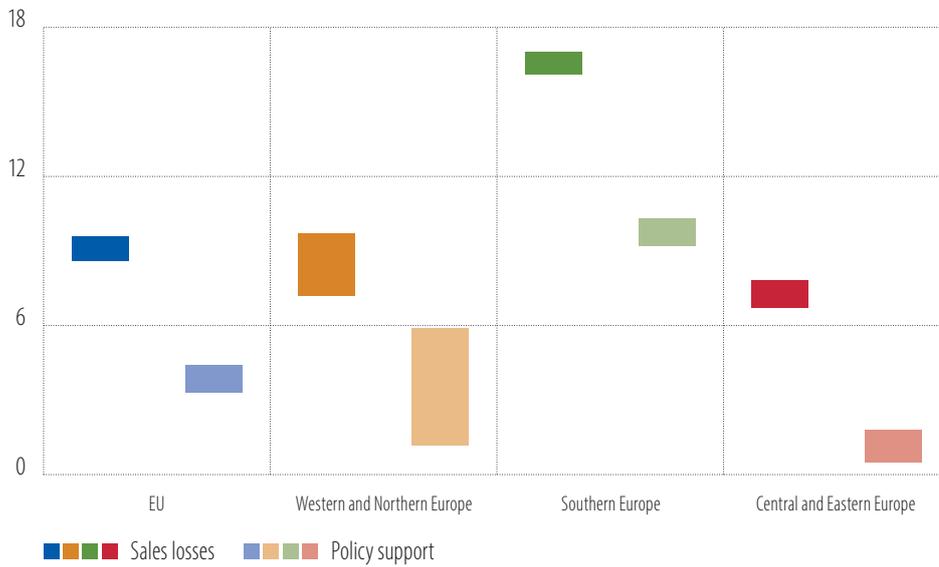
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Policy support	0.046*** [0.011]	0.053*** [0.011]	0.055*** [0.011]	0.052*** [0.013]	0.052*** [0.011]	0.045*** [0.012]	0.047*** [0.013]	0.045*** [0.014]	0.043*** [0.012]
COVID-year sales loss above 25%		-0.060*** [0.013]	-0.055*** [0.014]	-0.051*** [0.016]	-0.058*** [0.013]	-0.092*** [0.020]	-0.088*** [0.022]	-0.085*** [0.027]	-0.094*** [0.021]
COVID-year sales loss above 25% X policy support						0.047* [0.025]	0.049* [0.027]	0.048 [0.032]	0.053** [0.026]
Pre-COVID productivity	0.043*** [0.007]	0.042*** [0.007]	0.038*** [0.007]	0.031*** [0.008]	0.038*** [0.007]	0.042*** [0.007]	0.038*** [0.007]	0.031*** [0.008]	0.038*** [0.007]
Debt increase	0.050*** [0.015]	0.058*** [0.015]	0.062*** [0.016]	0.050*** [0.017]	0.060*** [0.015]	0.058*** [0.015]	0.062*** [0.016]	0.050*** [0.017]	0.060*** [0.015]
Equity injection	0.036* [0.021]	0.041** [0.021]	0.048** [0.023]	0.044* [0.026]	0.041* [0.021]	0.042** [0.021]	0.049** [0.023]	0.044* [0.026]	0.042* [0.021]
Financial leverage			-0.010* [0.005]				-0.010* [0.005]		
Firm in distress				-0.024 [0.016]				-0.024 [0.016]	
Capital ratio					0.018 [0.021]				0.018 [0.021]
Observations	8 823	8 823	7 796	6 091	8 545	8 823	7 796	6 091	8 545
R-squared	0.067	0.070	0.076	0.072	0.070	0.070	0.076	0.073	0.070
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Estimates based on EIBIS 2021 matched with firm-level ORBIS information (see Harasztosi et al., 2021).

Note: Linear Probability Model estimated with firm size dummies and firm age dummy. FE means fixed-effects. Constant not reported. Robust standard errors in brackets, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The coefficients reported in bold are significant at 10% or below

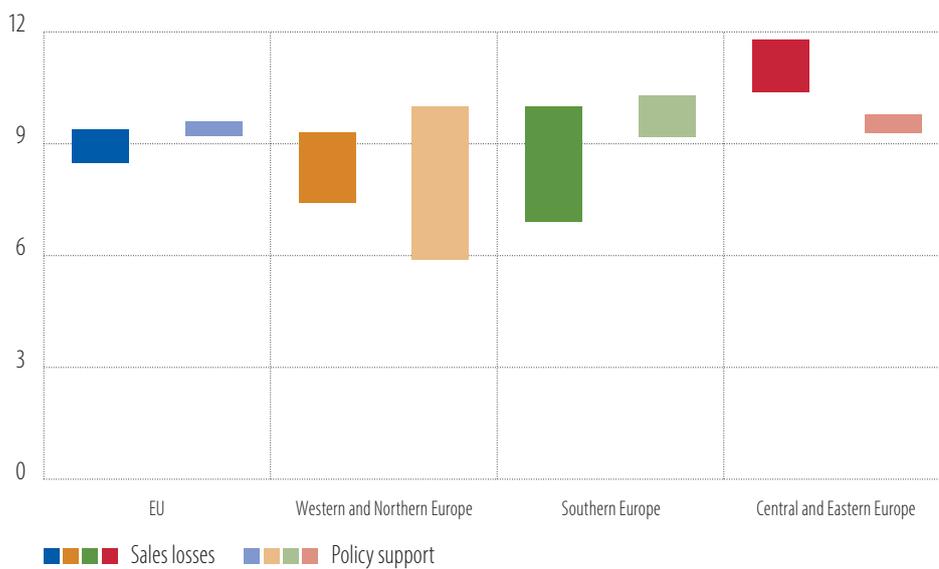
The availability of finance allowed firms to anchor their digitalisation. Interestingly, in all cases, firms more likely to digitalise have increased their external financing, an effect that is always significant at 10% at least. Increased equity therefore raises the probability of a firm digitalising more by 4 to 5 percentage points. A slightly stronger effect is found for debt. When considered jointly with the factors explaining a stronger equity base, this finding suggests that the public support rolled out during the crisis helped crowd in investors and sped up the digital transformation of European firms.

Figure 38
Estimated impact on the likelihood of increasing investment (in percentage points)



Source: EIB estimates based on EIBIS 2021 and ORBIS.
Note: The bars indicate the impact range estimated through a suite of models. See Harasztosi et al. (2021). The impact of sales declines (of above 25%) is always negative and is reported in absolute terms.

Figure 39
Estimated impact on the likelihood of increasing digitalisation (in percentage points)



Source: EIB estimates based on EIBIS 2021 and ORBIS.
Note: The bars indicate the impact range estimated through a suite of models. See Harasztosi et al. (2021). The impact of sales declines (of above 25%) is always negative and is reported in absolute terms.

Public support differs across the various regions. Public support was deployed widely, but it differed in the various countries. Eligibility, measures and conditions were not the same, so firms were not provided with the same incentives. Figure 38 and Figure 39 summarise the results of the models used to assess the impact of public support on the change in firms' investment plans and digitalisation efforts. Different models are used, so the figures depict a range of estimates (Harasztosi et al., 2021). The estimates for the European Union and the EU macro regions are reported separately. The first result is common to the European Union and all sub-regions. Lost sales from COVID-19 always have a negative impact on investment, which is never fully compensated by policy support. The uncompensated effect of sales on investment is especially large in Southern and Central and Eastern Europe. The picture is somewhat brighter for investment to advance digitalisation. For this form of investment, policy support has, to a certain extent, countered the negative effect of lost sales in the European Union overall, and in Western and Northern and Southern Europe, but not in Central and Eastern Europe.

Some firms have not started to digitalise, despite the pandemic and having received public support. The share of firms that were not digital and have not started to digitalise varies widely across the 12 sectors considered throughout this chapter, from less than 10% in computers and electronics, IT and telecommunications, and chemicals and pharmaceuticals, to more than 30% in hotels and restaurants and construction.¹⁷ No clear pattern emerges among those firms as weak firms are independently distributed. Across sectors, the proportion of zombie firms that were not digital and have not started to digitalise is similar to that of non-zombies.

¹⁷ See Chapter 5 for a macro analysis of the "neither firms."

Conclusion and policy implications

Corporate investment has started to rally, probably thanks to the massive policy support deployed. The strong and swift recovery in Europe suggests that, so far, policy support has reached its goal and shielded the corporate ecosystem. However, the rebound in investment relies heavily on the policy stimulus still in place and the actual damage sustained by firms will only be unveiled over time. As the current situation depends on this support, a clear indication of stronger activity is required before support can be removed. Phasing out support must not only be gradual, but also designed and explained in such a way that uncertainty is averted, because uncertainty is a major impediment to investment according to the firms polled in the EIBIS.

We did not find evidence of public support being excessively misallocated. Because it is not selective, the support provided by governments raises questions of moral hazard: firms that would have otherwise disappeared have been kept afloat. Public support might therefore lower the growth prospects of the European economy in the longer term. However, we did not find a link showing that more support went to firms that were already weak before the crisis. Instead, we found that firms with larger sales declines and low liquidity buffers received more support. In other words, the policy's main goal — preventing liquidity from drying up and the corporate ecosystem from stalling — seems to have been achieved.

Supported firms are more positive about their investment outlook and more likely to digitalise. These firms might have been in a better position to crowd in investors and to recapitalise. The combination of public support and a stronger equity base is accelerating the digital transformation of European firms — and the crisis has made the transformation more necessary than ever. Policymakers might re-prioritise public support to accompany the transition to the new normal. Equity-type instruments will be needed to rebalance firms' balance sheets as they have been affected by heavy losses and increasing leverage. Selected incentives might help and accelerate digital investments at firms.

While some firms are now stronger, pockets of vulnerability have developed and not all firms are taking the opportunity to transform. Some firms took advantage of the policy support to adjust, and to strengthen their digitalisation. Others did not, so vulnerability might emerge. Because the composition of EU economies differs, some EU members have been weakened more than others, which could cause an uneven recovery.

Policymakers must navigate the dangers of phasing out support too early and jeopardising the recovery — or doing harm by keeping support in place too long. Several countries have already withdrawn measures that supported firms. Maintaining these measures in other countries must be weighed against the risk of hampering the process of creative destruction and lowering growth in the medium term.

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Chapter 4

Regional and social cohesion: Widened gaps and how to close them

The pandemic has highlighted gaps among regions and societal groups. Where people live and what jobs they do influences their health, their career opportunities and their ability to weather a crisis. This crisis hit some groups of people and some places particularly hard.

COVID-19 amplified existing geographical and social inequalities. Disruption was more pronounced in regions with economic activity heavily exposed to the economic crisis and where working remotely was more difficult. Already vulnerable groups, such as young adults and workers with lower levels of education, felt the adverse labour market effects of the crisis more acutely.

The shock caused by the pandemic could weigh on cohesion in the European Union for some time. Lockdowns disrupted learning, in schools and in workplaces. These disruptions could have longer-term effects on earnings and career progression. They might also exacerbate inequality as students from disadvantaged backgrounds were more heavily affected. The impact of the crisis on firms was uneven, too. Firms are now emerging from the crisis at different speeds, which will have consequences for competitiveness and employment.

The crisis accelerated structural economic and societal change, creating some risks for cohesion. Restrictions on personal movement and gatherings accelerated digitalisation. In addition, certain EU members have stepped up plans for becoming carbon neutral. Some parts of Europe, and some groups of people, will have a harder time reaping the benefits of these structural changes.

Policies must ensure that the opportunities of the transition to a greener and more digital economy will be realised across the European Union and that the benefits will be shared broadly. To help lagging regions to catch up, basic infrastructure must be upgraded and made more climate-friendly. Firms need support to develop and move up the value chain. Gaps in the availability of finance and in regions' capacities — related to administration, technical expertise and planning — need to be addressed for cohesion funds to have the most impact. The political and regulatory environment must become more investment-friendly to foster entrepreneurship and to encourage transformative investments in new technologies, including green and digital, as well as in human capital. Investment in social infrastructure, and particularly in education and skills, is paramount for equality and economic growth across the European Union. Joint action to support cohesion together with the green and digital transition is key to boosting Europe's resilience in the future. Without cohesion, the green and digital transformation is unlikely to succeed.

Introduction

Support for economic, social and geographical cohesion has been an integral part of the European Union from the very start. Regional and social disparities can exacerbate social, political and economic risks. Geographical differences in prosperity are linked to divergences in working and living conditions, and ultimately affect the opportunities available to 447 million people across the European Union.

EU integration created opportunities for many people and drove economic convergence, but challenges remain. Regional convergence slowed in the aftermath of the global financial crisis. Stagnation and increasing discrepancies in economic opportunities fuelled discontent in many regions. In European labour markets, the well-educated were in a better position to benefit from changes in the demand for skills linked to globalisation and digitalisation. In contrast, many workers with lower levels of education saw their jobs disappear.

The COVID-19 crisis could exacerbate existing inequalities. The pandemic's impact was not felt evenly across Europe, and regions are rebounding at differing speeds. Increased digitalisation and the greening of the economy will bring profound structural change. Europe risks becoming more unequal once the pandemic has receded.

The COVID-19 shock demonstrated the power of policy. Recent months have shown that support can make a difference and soften the impact of economic shocks on firms and households. Furthermore, Europe's swift and joint response showed that it can act fast to address crises and challenges in a coordinated way.

This chapter describes regional and social cohesion in the European Union before the pandemic, how the pandemic affected it and how policy needs to support cohesion. The first section focuses on social cohesion, while the second one focuses on regional cohesion. The third section examines the risk that the COVID-19 crisis might cause long-term scars and slow cohesion in the European Union. The fourth section discusses how the transition towards a smart and green economy might be leveraged to more social and geographical cohesion. The fifth section summarises the policy implications and draws conclusions.

Social cohesion patterns, trends and COVID-19 effects

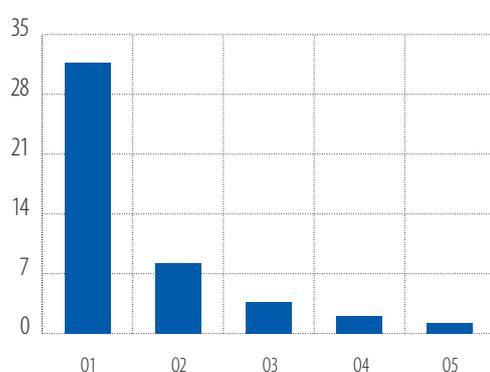
Just before the pandemic began, record levels of employment in the European Union and improved average living standards coexisted with stark differences in working and living conditions. Median incomes had increased in most EU members and fewer people were facing poverty and social exclusion compared to peak levels in 2012. The employment rate exceeded 73% in 2019 and unemployment had dropped to a 12-year low. Youth unemployment and the share of young people not in employment, education or training had similarly decreased from peaks experienced in the aftermath of the global financial crisis and the European debt crisis. The EU labour force had become older but also better educated and more diverse, with more female and foreign-born workers. More people were self-employed (without employees), sometimes benefiting from flexibility and autonomy but also facing less security. Younger workers and those with lower levels of education more often experienced less certain and sometimes precarious working conditions. Gender pay gaps persisted and some vulnerable groups such as migrants faced challenges in entering the labour market, despite conditions having improved overall.

The digital transformation had spurred profound changes in EU labour markets. Digital technologies had changed how people work and the skills they need to perform jobs. Changing labour demands raised the risk of skill shortages and mismatches as new jobs often required different and more advanced skills that were less readily available on the market. Digitalisation has raised demand for technical but also higher-level skills more broadly, and has been linked to greater polarisation on labour markets (EIB, 2019; 2020/21). People with the right skillsets or quick to acquire them were in a better position to benefit from profound structural shifts.

Having the right skills is crucial for employment opportunities, earnings and more. Workers with higher levels of education were more likely to be employed or to be successful entrepreneurs. They tended to be more satisfied with their jobs and more likely to participate in (employer-sponsored) training. Increases in employment in the years before the pandemic had been concentrated on jobs typically requiring higher levels of education, such as university degrees. Growth in lower-level occupations — typically not requiring higher levels of formal education — occurred in some parts of the services sector, where interaction was often personal and involved less routine tasks (European Centre for the Development of Vocational Training (Cedefop), 2018). Jobs requiring a lot of routine tasks but lower levels of education were increasingly at risk of being automated (Nedelkoska and Quintini, 2018; Pouliakas, 2018; EIB, 2019/20).

Education is a key determinant of socioeconomic status, living conditions and opportunities. Beyond shaping income and career development prospects, education increases the likelihood of a person having a longer, healthier and in many ways more comfortable life. The gap between the life expectancies for a 30-year-old with the highest education and one with the lowest education in the European Union was about seven years for men and three for women (Organisation for Economic Co-operation and Development (OECD), 2020a).¹ Social exclusion risks are much higher for people with lower education levels across all EU members. Households with a lower economic status are more likely to live in buildings with major deficiencies or in overcrowded conditions. They are more likely to be overburdened by housing costs and to find it difficult to keep their homes warm, and are less likely to be homeowners (Figure 1). Education — together with age — is also a key determinant of the ability to make use of digital technologies and of individuals' trust in institutions (Cruz-Jesus et al., 2016; Eurofund, 2018). At the same time, education systems often carried over inequalities of opportunity from one generation to the next (Boone/Goujard, 2019).

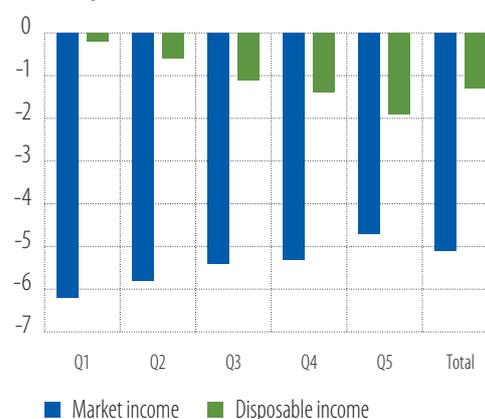
Figure 1
Households overburdened by housing costs in 2019 (in %), by income quintile



Source: EU Statistics on Income and Living Conditions (SILC), authors' calculation.

Note: The housing cost overburden rate measures the share of the population living in households that spend 40% or more of their disposable income on housing. Income quintiles from lowest to highest.

Figure 2
Simulated impact of COVID-19 on market income and disposable income (change in %), by income quintile



Source: European Commission (2021), JRC, authors' calculation.

Note: Figure 2 shows the change in EU household market incomes (labour and capital plus private transfers) and the change in EU disposable incomes (the amount of money that can be spent after personal current taxes) by income brackets. See Christl et al. (2021) for the methods used.

¹ EU average based on 14 countries for which data is available, 2017 or nearest year.

The COVID crisis hit Europeans unequally depending on their living and working conditions and resulted in some increases in inequality. Health outcomes varied by social strata (Destatis, 2021). People living in poorer areas were often less able to ensure social distancing and were at higher risk of infection. Job risks were concentrated in sectors that employ higher shares of people on lower incomes and that often required less education (Schnabel, 2020).

Policy helped to stabilise incomes and employment. Despite the sharp decline in output, simulations suggest that households' disposable incomes fell, on average, only 1.3%, less than market incomes (5.1%), as tax benefits and policy action protected households from some losses (Figure 2). Automatic stabilisers and dedicated support for poorer EU households reduced the risk of widening income divergences, at least in the short term.² Short-time work schemes kept workers on the payroll. Employment support was funded in part by the European Union via its **SURE scheme**, which is estimated to have supported over 31 million jobs (European Council, 2021).³ SURE also provided a unifying element across national labour markets, with different structures and traditions in deploying furlough or short-time work schemes. Overall, poverty rates did not increase in 2020. In some EU members, the poverty rate even dropped slightly (European Commission, 2021). However, many Southern European countries saw a moderate increase in the risk of poverty. While overall employment effects appear moderate compared to drops in economic activity and to previous crises, the pandemic shock ended a six-year run of consecutive increases in employment rates. In 2020, the employment rate dropped by some 0.7 percentage points (compared to the previous year, for the 20-64 age group) and unemployment rose by 0.3 percentage points, approaching 7%.

The pandemic hit some groups of workers harder than others. The pandemic affected workers in different ways. Many were put on furlough schemes, some lost their jobs and the self-employed often faced threats to their businesses and personal incomes. Other people were in occupations that could shift to remote work. Employment was put under pressure, particularly for jobs held by young people and those with lower levels of education. Job losses were most pronounced for the youngest people (Figure 3). The share of young people not in employment, education or training increased by 1.2 percentage points to 17.6% (for people aged 20 to 34). Youth unemployment increased by 1.8 percentage points compared to the previous year and reached 17.1% in 2020 (for the 15-24 age group). Employment rates for recent graduates dropped most for young people with lower levels of education.

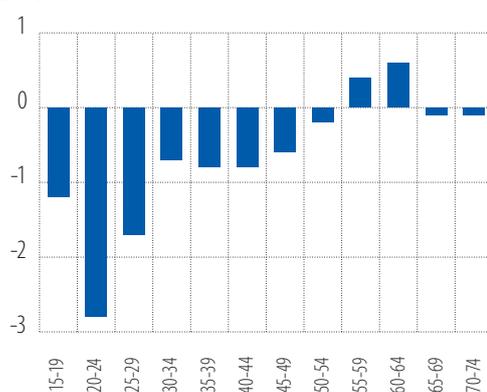
The labour market difficulties weighed more heavily on people with lower levels of education. Declines in employment rates are most pronounced for people with lower education (Figure 4). In contrast, more people with higher-level education are in employment compared to 2019. The labour market difficulties faced by young people and those with lower levels of education are linked to the sectors exposed to the crisis, differences in contract conditions compared to the rest of the labour force and the adverse effect the pandemic had on matching people with jobs, particularly for young people.

The risks posed to social cohesion go beyond the effect of the pandemic on labour markets so far. In this crisis, cohesion risks are linked to gaps in governments' crisis response and to the unwinding of policy support, while the labour market remains in flux. Past pandemics had led to a widening of income inequalities and lowered employment opportunities for people with only basic levels of education (Furceri et al., 2021). Labour market improvements following Europe's last crisis have not benefited all households at the same speed. The pandemic has accelerated the demand for certain skills (notably linked to digitalisation) and increased the demand for higher-skilled employment overall.

² Evidence on the impact of the pandemic on wealth is still scarce. However, given the distribution of asset ownership, notably stocks and real estate, effects are likely to include some shifts and potential widening of some inequalities across regions and socioeconomic groups.

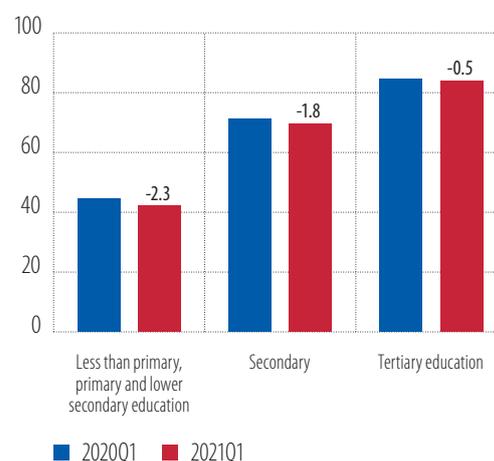
³ SURE stands for Support to mitigate Unemployment Risks in an Emergency.

Figure 3
Change in employment as share of the labour force (in percentage points), by age group 2019-2020



Source: Eurostat, authors' calculation.

Figure 4
Employment as share of the labour force (in %), by education level



Source: Eurostat, authors' calculation.

Note: The numbers on top of the bars indicate year-over-year changes in percentage points.

Regional cohesion patterns, trends and COVID-19 effects

Economic, social and geographical cohesion has been a goal of the European Union since its inception. This includes reducing regional disparities and improving the development of the least favoured regions.⁴ Regional disparities in income reflect differences in human capital and labour productivity as well as labour market performance and demographics (Monfort, 2010). Regional convergence is a long-term process and not without setbacks.

Since the start of the 20th century, Europe has seen some convergence. While two world wars interrupted this process, convergence gained pace after 1945 (Rosés and Wolf, 2019). However, it weakened in the 1970s and stalled thereafter, even reversing in some cases (Ibid., Geppert, 2005; Neven and Gouyette, 1995). Structural change drove regional convergence, with regions previously dominated by agriculture industrialising and focusing more on services (Rosés and Wolf, 2019).

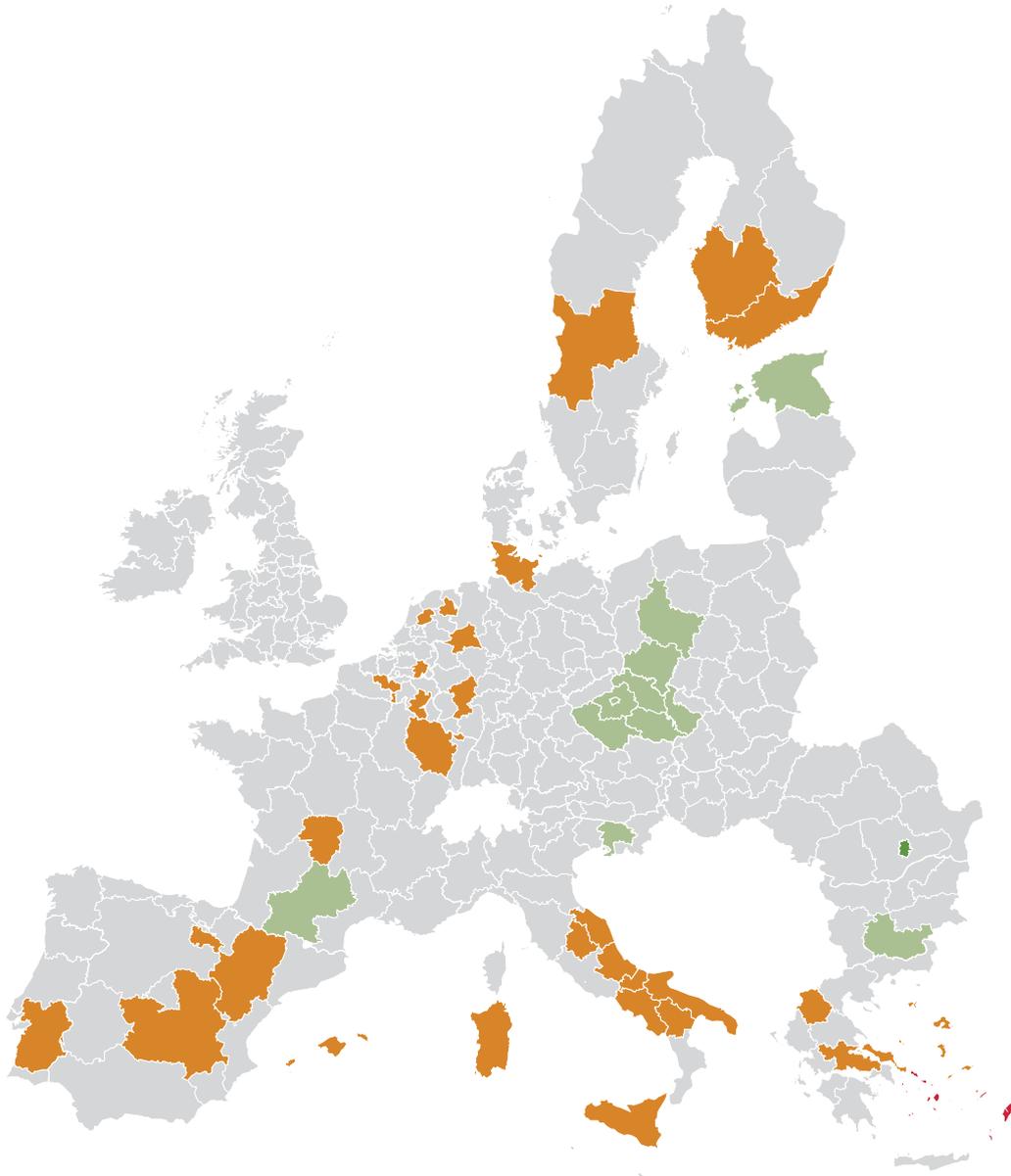
Overall, cohesion has made some progress over the past 20 years. At the country level, Central and Eastern European economies have converged significantly with the rest of Europe (Coeuré, 2018). The picture is more nuanced for regional convergence, depending on location and the type of territories considered. Below we refer to NUTS2 regions with incomes above the EU average as “more developed” or “non-cohesion” regions. We refer to regions with gross domestic product (GDP) per capita of 75% to 100% of the EU27 average as “transition” regions, and to those with incomes below 75% as “less developed,” with the last two forming the cohesion priority group.⁵ At the regional level, poorer regions have grown faster on average, and the dispersion in regional incomes per capita has decreased (Figures 5 and 6). In 2000, the median GDP per capita in the top percentile of the regional income distribution was more than five times higher than at the bottom. In 2019, this difference had shrunk to three times. Despite this

4 Article 174 of the Treaty on the Functioning of the European Union.

5 NUTS2 refers to the Nomenclature of Territorial Units for Statistics. NUTS2 regions are the main targets of EU regional policies. Cohesion policies in principle cover every region in the European Union but most of the funds are targeted where they are most needed. According to regions' income classification, the availability of co-financing from EU funds differs, with poorer regions eligible for more support.

progress, only a few less developed regions have made significant progress. Those that did are mostly located in Central and Eastern Europe. Two regions — Bucharest Ilfov (Romania) and Sostines regionas (Lithuania) — leapt from a GDP per capita of less than 75% of the EU average to more than the EU average (Map 1). Both regions include the respective capital cities.

Map 1
Regional growth dynamics and transitions

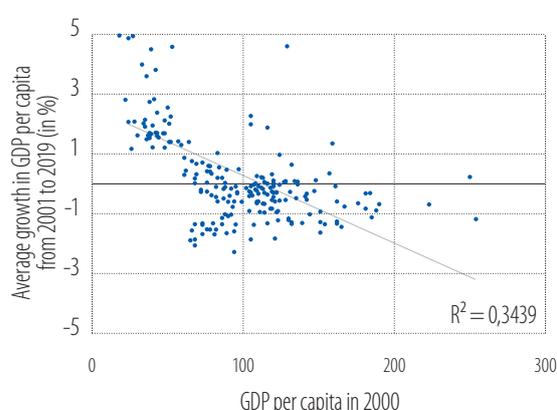


Source: Eurostat, EIB Economics Department.

Note: Grey regions remained within the same broad range of the income distribution, namely above the EU average, between 75-100% of the EU average, or below. Regions in light green positioned one income bracket higher in 2019 compared to 2000. Regions in dark green moved from below 75% to the top category. Regions in orange and dark red regressed one/two brackets respectively. The UK is not part of the sample.

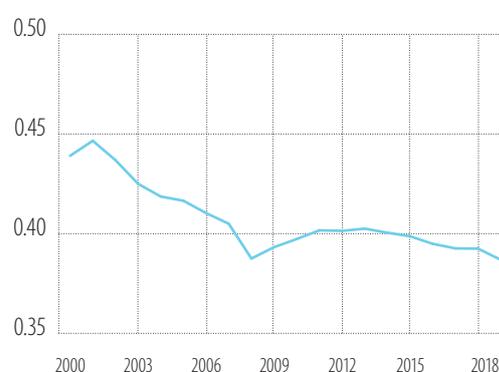
Regions in Central and Eastern Europe tend to have converged more than those in other parts of the European Union. Many Eastern European regions converged, as did some Spanish and Portuguese regions, while the opposite holds for regions in Greece and Italy (Alcidi, 2018; Hudecz et al., 2020; Goecke and Hüther, 2016). In contrast, many Southern European regions experienced a “lost decade” after the global financial crisis and the ensuing European sovereign debt crisis. Here, a number of regions experienced substantial and lasting drops in incomes in relative and some even in absolute terms. For example, per capita GDP fell in all regions in Greece from 2007 to 2019. As a result of these different experiences, the regional differences in GDP per capita increased after the financial crisis and only started to fall again several years later (Figure 6).

Figure 5
Per-capita income growth vs. GDP per capita in 2000



Source: Eurostat, authors' calculation.
Note: Dots denote regions. X-axis shows regional GDP as a percentage of the EU average.

Figure 6
Standard deviation of regional per-capita income relative to EU average, 2001-2019



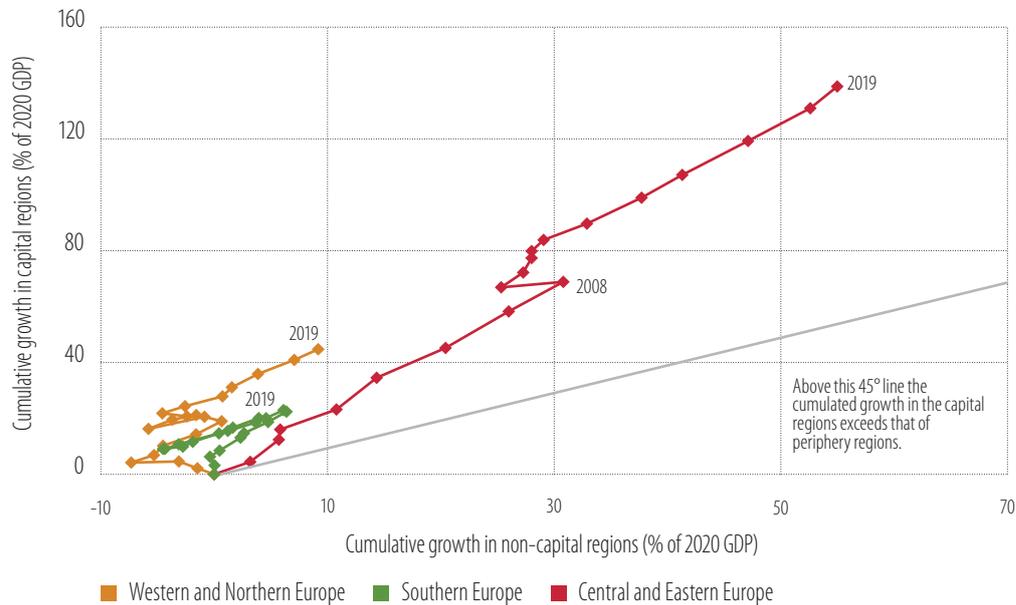
Source: Eurostat, authors' calculation.

More urban regions tended to grow faster. The growth of rural regions has lagged that of urban centres. People and businesses have increasingly clustered in a few urban locations to work and innovate (Moretti, 2012; Rodriguez-Pose, 2017), where agglomeration effects enabled them to be more productive. Income differences within countries have increased in the majority of EU members over the last few years (European Commission, 2021). Contrasts between the capitals and other regions are most pronounced in the larger Central and Eastern European Member States, reflecting, in part, a very low level of regional inequality before the transition from communism and historical differences in areas where economic activity was concentrated (Figures 7 and 8).

Capital regions often outpaced the rest (Figure 7). Differences within urban centres suggest that development is not only about size and population density.⁶ Successful urban areas have managed to replace shrinking industrial production with high-value services, tradeables, finance, technology, culture and, to some extent, high-tech manufacturing. Capital regions across the European Union are in a more advantageous position to generate this mix, given established trade and connectivity links and the presence of cultural and educational institutions (Florida, 2002; Glaeser, 2012). Entrepreneurial dynamism linked to new technologies is concentrated in a small number of cities, in particular capital regions (Figure 9). Here, labour markets are denser, allowing for better matching of job seekers and employers, and typically connecting investors to projects more easily.

⁶ See Hudecz et al. (2020), who base their analysis on a more granular spatial distinction.

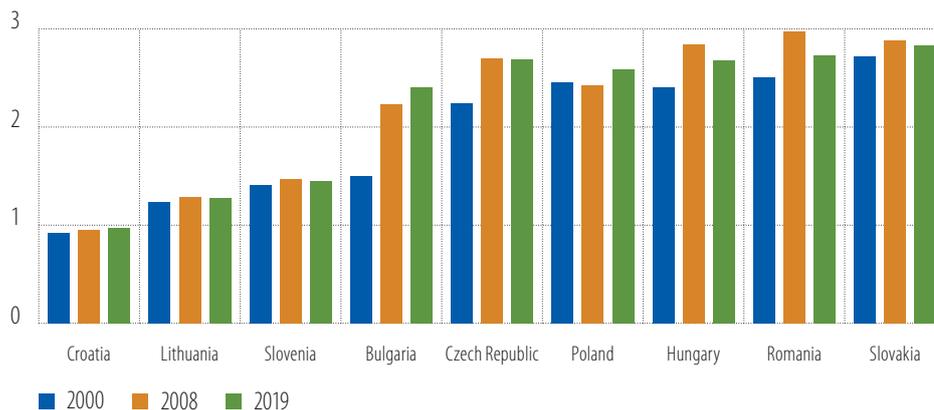
Figure 7
Cumulative growth in regions including the capital and in other regions, 2000-2019



Source: Eurostat, authors' calculation.

Note: Simple average over real GDP growth in NUTS2 regions of selected countries. Southern Europe: Italy, Spain, Portugal, Greece. Central and Eastern Europe: Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovak Republic. Western and Northern Europe: Austria, Belgium, Denmark, Finland, France, Germany, Ireland. The red line for Central and Eastern Europe extends farther because of the region's rapid growth.

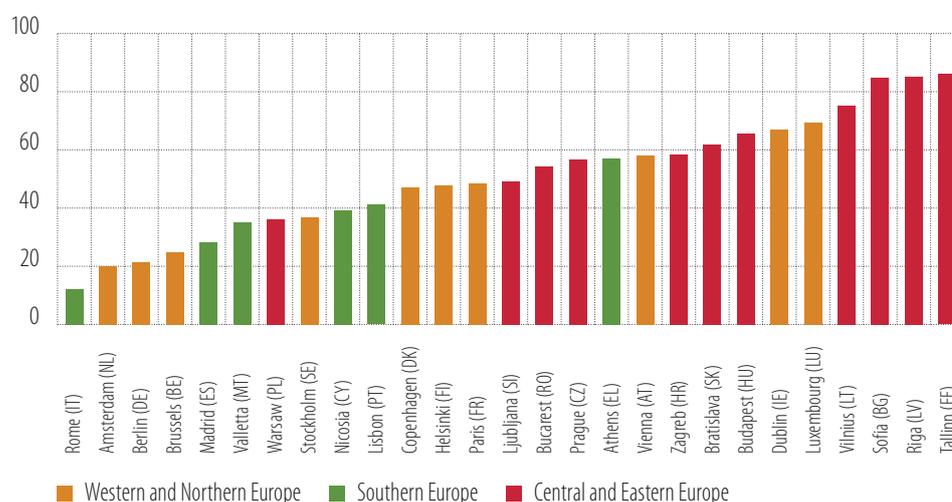
Figure 8
Per-capita GDP in the capital relative to the country's other regions, Central and Eastern Europe



Source: Eurostat, authors' calculation

Note: The chart shows GDP per capita in the capital region relative to other regions in the country and the evolution of the ratio over time. A ratio of 1 indicates no difference between incomes in the capital region compared to the rest (on average). Values greater than one indicate higher incomes in the capital.

Figure 9
Share of country's startups (in %) located in the capital

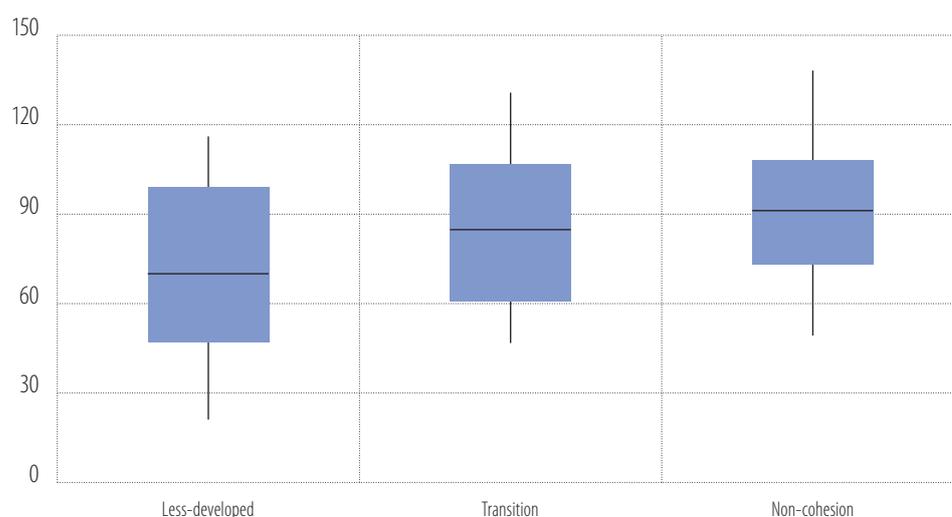


Source: Crunchbase, authors' calculation.

Baseline: Startups founded between 2008-2020 that are still active.

Despite some successful convergence, differences still exist in living conditions. Social disparities tend to be more pronounced in urban regions. Poverty and social exclusion have remained high in parts of Europe and particularly in cohesion regions located in Greece and some Central and Eastern European countries. People in poorer regions, notably in rural areas, tend to have worse access to healthcare. Similarly, the quality of transport, infrastructure (including digital infrastructure) and the variety of education on offer are typically more limited (Figure 10).

Figure 10
Distribution of download speed (in Mbps), by region

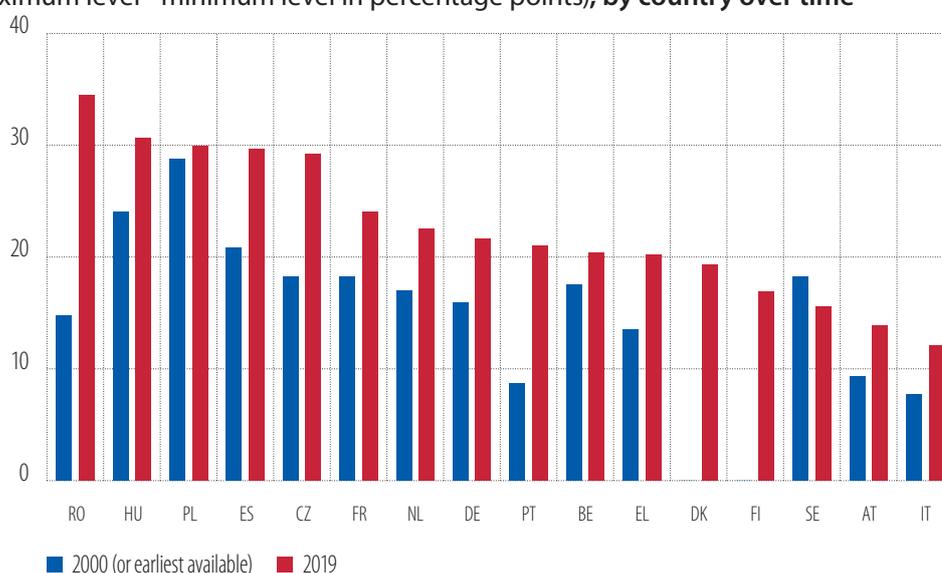


Source: European Data Journalism Network (2021), authors' calculation.

Note: The figure shows the 10th, 25th, 50th, 75th and 90th percentiles of the distribution of the average download speed.

Differences in skill levels pose persistent challenges for convergence. Human capital plays a pivotal role in driving regional developments and supporting convergence, for example through facilitating innovation and technology adoption.⁷ Educational levels in the workforce have increased over the last 20 years in all EU members (Figure 11). However, within countries regional differences have widened, reflecting factors such as migration within countries that has been driven by differences in economic growth and opportunities for jobs and learning. Similarly, participation in lifelong learning, or training, is lower in cohesion regions and rural locations. These trends reflect the clustering of skilled jobs, the proximity of educational options and the higher share of skilled individuals in urban areas, as individuals with higher skills are more likely to participate in lifelong learning (EIB, 2020/2021).

Figure 11
Difference across regions in the share of people with tertiary education
(maximum level - minimum level in percentage points), by country over time



Source: Eurostat, authors' calculation.

Note: Bars show the percentage point differences between the region with the highest and the region with the lowest share of people with tertiary education in the labour force by country. Member States with a small number of regions are not displayed. Excludes outermost regions for France. For Portugal, the chart uses 2004 values for Acores and Madeira. For Hungary and Poland, the comparison is based on 2013 to 2019, as earlier values for the capital region are missing.

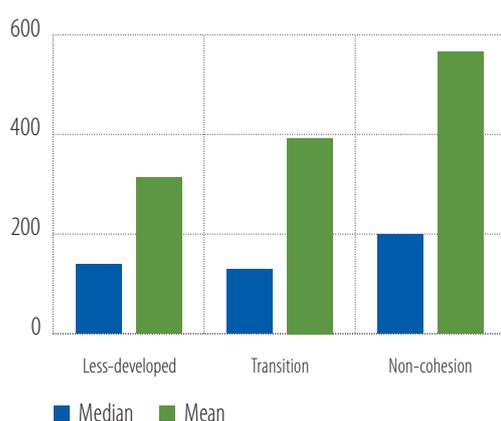
Many poorer regions face structural labour market challenges. Non-cohesion regions typically have higher employment rates. Within the cohesion group, heterogeneity is high. Peripheral and sparsely populated regions — where agriculture often plays an important role in the economy and skilled employment opportunities are scarce — have some of the lowest employment rates. Even in countries with high nationwide income per capita, some former industrial heartland regions are struggling to adapt their economies to structural shifts in labour markets and record low employment rates. Long-term unemployment (people without a job for 12 months or more) is comparatively high in many cohesion regions, particularly in Southern Europe. Similarly, youth unemployment has remained high in many cohesion regions, like Southern Europe. The high unemployment rate for youths indicates issues in labour markets and education systems, such as two-tiered labour market structures characterised by differences in types of contracts, wages, skills and access to benefits for groups of workers. Many cohesion regions in Central and Eastern Europe recorded lower levels of unemployment in the years before the pandemic, and many firms are having difficulty finding employees with the right skills. At the same time, higher inactivity rates and the marginal attachment of some vulnerable groups to the labour market remained a challenge (EIB, 2019).

⁷ See, for example, Coady and Dizoli, 2017; Worldbank, 2018/2019; OECD, 2018; EIB, 2019/2020.

Investment gaps are larger in cohesion regions. The EIB Investment Survey (EIBIS) shows how businesses differ structurally across EU regions. Data from the EIBIS show that firms in cohesion regions tend to be smaller on average (Figure 12). The smaller average size reflects the limited presence of very large firms and corporate headquarters. The share of firms undertaking investment is lower in cohesion regions, even though firms in these regions report that they have invested too little in recent years.

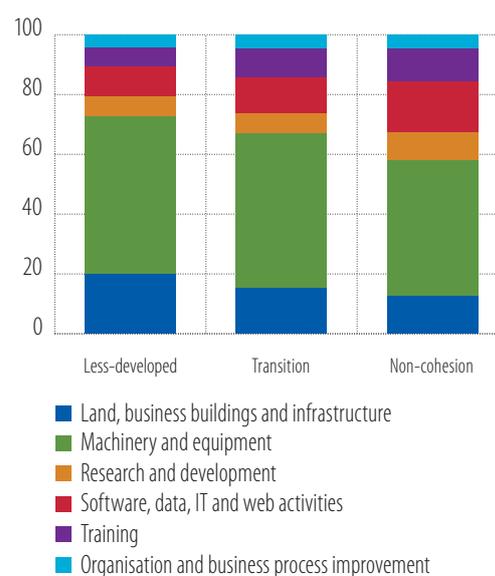
Firms' investment in cohesion regions is tilted towards tangible assets, meaning it is focused on machinery and equipment, land, buildings and infrastructure (Figure 13). Conversely, intangibles (research and development, training, organisation and business process improvements, and software and IT) account for some 42% of investment in non-cohesion regions compared with 33% in transition and 27% in less developed regions. The lower share of investment in intangible assets partly reflects the industrial structure but also a more limited presence of some corporate activities, such as large research centres, in some cohesion regions. Large firms in non-cohesion regions dedicate a higher share of their investment to research and development (11% vs. 7% in transition and less developed). Large firms in less developed regions report the lowest shares of investment dedicated to the training of employees compared to those firms in other regions.

Figure 12
Average firm size (number of employees)



Source: EIBIS 2021.
Question: How many people does your company employ either full or part time at all its locations, including yourself?

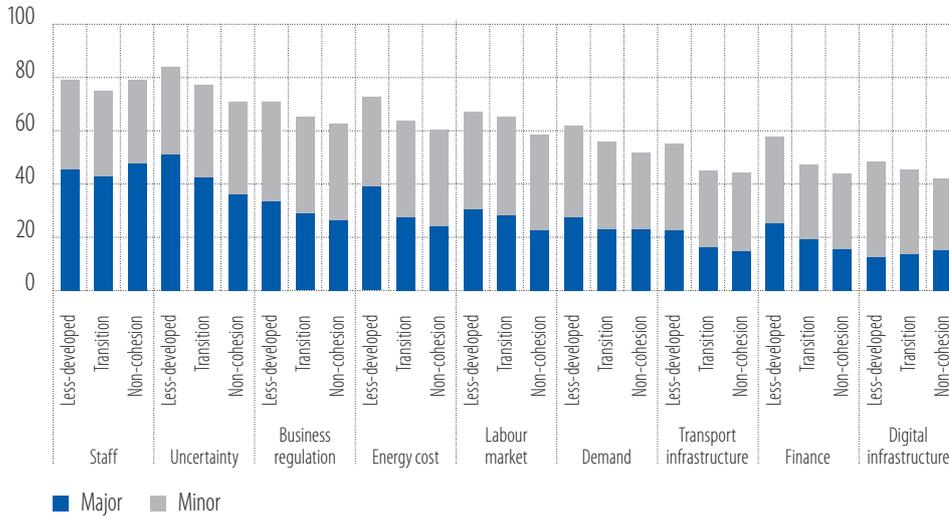
Figure 13
Composition of firms' investment (in %)



Source: EIBIS 2021.
Base: All firms who have invested in the last financial year (excluding don't know/refused responses).
Question: In the last financial year, how much did your business invest in each of the following with the intention of maintaining or increasing your company's future earnings?

Firms in cohesion regions operate in a more challenging environment and report obstacles to investment more often (Figure 14). Firms in the poorest regions report considerably more often that their investment is hindered by uncertainty, energy costs, and access to transport infrastructure and finance. In particular, many small and medium sized companies (SMEs) in less developed regions report finance-related issues. However, a lack of access to finance is also an obstacle for many large firms in the poorest regions (52% in less developed regions, 43% in transition regions, and 42% in non-cohesion regions). The limited availability of staff with the right skills is a persistent problem shared by most firms in cohesion and non-cohesion regions and is the most frequently named obstacle across the European Union (see Chapter 2).

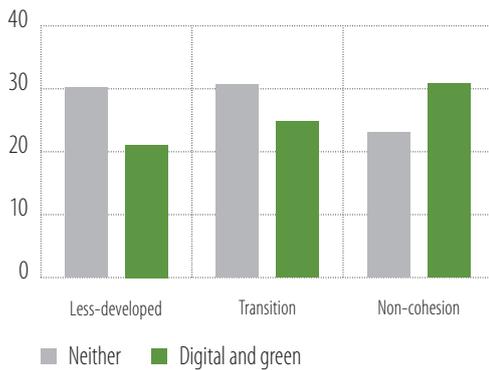
Figure 14
Firms reporting obstacles (in %), by region



Source: EIBIS 2021.
Question: Thinking about your investment activities, to what extent is each of the following an obstacle? Is it a major obstacle, a minor obstacle or not an obstacle at all?

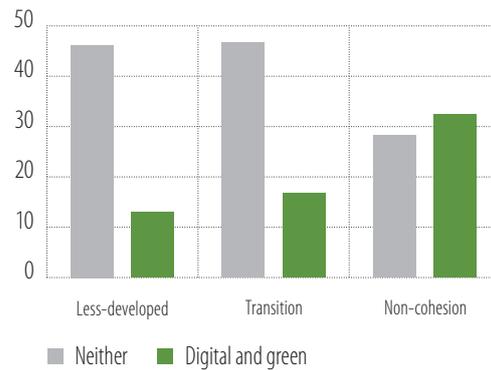
Fewer firms in cohesion regions are taking steps to transform digitally or to tackle climate change risks. In non-cohesion regions, more firms have already invested in measures to tackle climate change and in digital technologies. In cohesion regions, many firms have done neither (firms classified as “neither green nor digital” in Figure 15). At the same time, many firms in cohesion regions express even greater concerns about climate-related risks (EIB, 2021c).

Figure 15
Firms investing in climate-related measures and digitalisation (in %), by region



Source: EIBIS 2021.
Question: Green: Thinking about investments to tackle the impacts of weather events and reduction in carbon emissions, has your company already invested?
Digital: Can you tell me for each of the following digital technologies if you have heard about them, not heard about them, implemented them in parts of your business, or whether your entire business is organised around them?

Figure 16
Digital and green municipalities (in %), by region

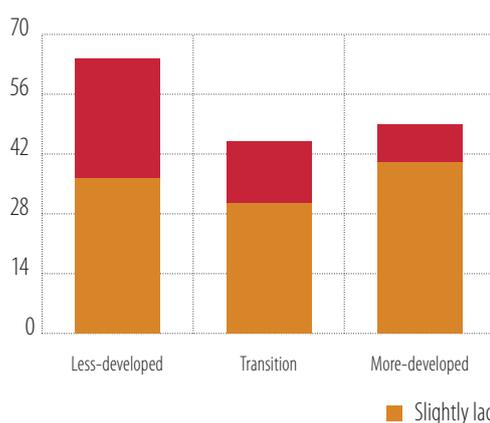


Source: EIB Municipalities Survey 2020.
Note: For the conceptual introduction of green and digital municipalities see EIB (2020, Chapter 9).

Many municipalities need to invest more in climate change adaptation and mitigation as well as in digitalisation. In many regions across the European Union, municipal public investment was slow to recover from the global financial crisis and the European sovereign debt crisis. Results from the EIB municipalities survey show that municipalities in cohesion regions lag on the green and digital transition (Figure 16) (EIB, 2020, 2021b). Many municipalities in cohesion regions report infrastructure investment gaps, including on digital infrastructure and for climate change mitigation and adaptation. Existing investment gaps for public and private projects make public-private investment synergies more difficult to realise, including for digitalisation and climate action.

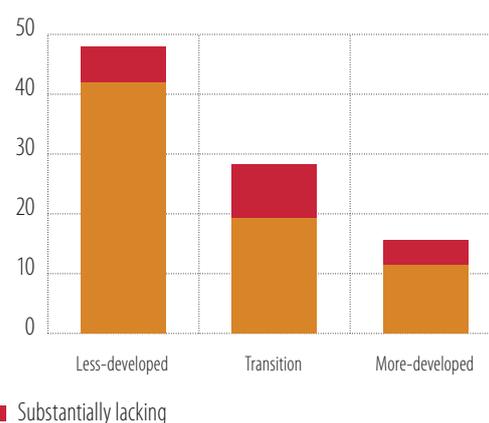
Investment gaps in cohesion regions limit opportunities for firms and people. In less developed regions, gaps in basic infrastructure — namely for urban transport, healthcare and social infrastructure (including health, care infrastructure for children and the elderly, education and housing) — are more common and more severe (Figure 17 and 18). For example, 58% of municipalities in less developed regions report gaps for urban public transport compared to some 40% in transition and non-cohesion regions. Almost half report gaps in social infrastructure compared to slightly less than 30% in the two other groups.

Figure 17
Municipalities with investment gaps in social housing (% of respondents)



Source: EIB Municipalities Survey 2020.
Question: For each of the following would you say that the quality of infrastructure is satisfactory, slightly lacking or substantially lacking?

Figure 18
Municipalities with investment gaps in health (% of respondents)



Source: EIB Municipalities Survey 2020.
Question: For each of the following would you say that the quality of infrastructure is satisfactory, slightly lacking or substantially lacking?

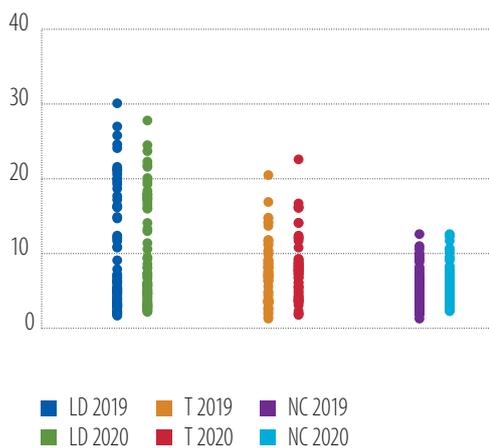
Infrastructure gaps, notably for health, were felt when the pandemic hit. Regional characteristics — such as the age distribution of the population, access to healthcare services and local factors (such as air pollution or access to recreational space) — affected health-related risks. Yet, the extent to which these characteristics resulted in adverse health outcomes depended on policy responses, including pandemic-related restrictions on mobility, the speed with which the provision of healthcare was improved, and the evolution of the disease. Overall, however, mortality rates tended to be higher in metropolitan regions because the population density favoured the spread of the virus faster than existing health infrastructure could react, regardless of the sometimes higher quality services (OECD, 2021).

The economic impact of the pandemic on regions reflects the exposure of certain sectors to the pandemic and the effectiveness of policy responses. Specifically, the impact depended on economic structures, including specialisation in sectors that required human contact, the degree of integration into global value chains, the possibility of remote work, and firms' characteristics such as size and financial resources (European Commission, 2021). In addition, the duration and design of their COVID-19 restrictions played a role.

Policy softened the pandemic's immediate impact on labour markets, but some regions were still hit hard. The highest increases in unemployment were recorded in regions in Greece and Spain that specialise in tourism.⁸ These regions similarly show the largest drops in hours worked and increases in temporary layoffs. The majority of regions saw increases in unemployment, albeit from very different levels (Figure 19). The most recent data from the EIB Investment Survey show that for more than half of the firms across the European Union, employment has remained constant since the start of the pandemic. While policy measures helped to preserve jobs across the European Union in the short term, the removal of support, corporate restructuring and accelerated structural change suggest there is a risk employment will take time to fully recover. These factors often coincide with structural challenges in labour markets across EU regions.

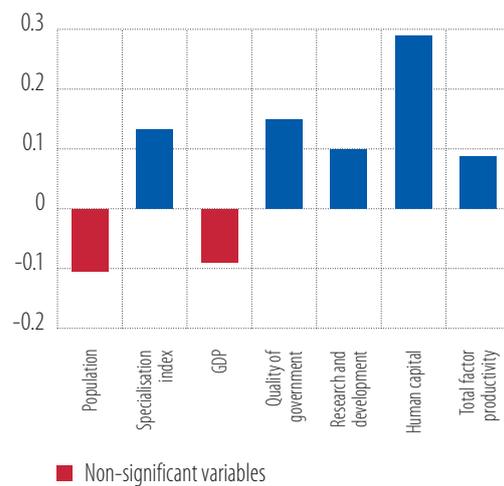
Human capital and the quality of local institutions were key to how regions weathered the pandemic. Based on the European Commission's RHOMOLO macroeconomic model, the quality of human capital and the quality of government are the two most important factors supporting regions' ability to resist the COVID-19 shock (Figure 20).⁹

Figure 19
Dispersion of regional unemployment rates (in %)



Source: Eurostat, authors' calculation.
Note: LD denotes less developed regions. T refers to transition and NC to the non-cohesion/more developed category. Dots denote NUTS2 regions.

Figure 20
Factors supporting regions' resilience against the pandemic



Source: DG EMPL, European Commission (2021).
Note: Reported are the coefficients of a regression of the pandemic-induced change in regional GDP on the factors shown. See European Commission (2021), section 3.4, for details.

8 Based on increases from 2019 to 2020. Kriti, Illes Balears, Ionia Nisia and Noto Aigaiio record increases in regional unemployment rates by 3 percentage points or more compared to 2019 levels (for people in the labour force aged 15-74). The regions with the highest shares of absences due to temporary layoffs are Canarias, Notio Aigaiio, Illes Balears and Ionia Nisia.

9 The RHOMOLO model makes it possible to simulate the effects of the COVID shock taking into account regional economic characteristics. For further information on the model and its calibration to assess the impact of the pandemic, see European Commission (2021).

The risk of longer-term scars from COVID-19

The pandemic could reinforce regional and social divergences, making them more permanent. In particular, differences in companies' adaptive capacities, in challenges to entrepreneurship and to education and training could slow cohesion.

Companies' adaptive capacities

Medium to longer-term risks for employment depend on how firms react to the pandemic and adjust to the "new normal." Corporate restructuring and accelerated structural change can cause some risks for employment. About 14% of EU firms expect the pandemic to lead to permanent losses in employment, according to the EIBIS. Firms' views differ geographically, with more firms in poorer regions expecting to cut jobs (Figure 21).

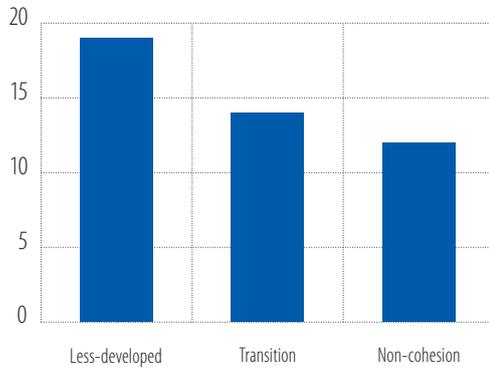
Structural changes in employment risk adding to existing labour market challenges and exacerbating territorial and social divergences. Firms that saw the COVID-19 crisis as an existential threat were more likely to cut jobs and see a negative impact on staffing levels looking ahead. Firms in poorer regions tend to see a stronger structural impact on employment. For less developed regions in particular, the expected shifts in employment may reflect concerns about strategic positioning and competitiveness after the crisis, as well as the acceleration of existing economic trends, notably digitalisation and automation. More firms in poorer regions also expect robotics to reduce job numbers more drastically than elsewhere in Europe. These regions often have less developed mechanisms to help people adjust to the changing labour market. Spending on active labour market policies tends to be lower, fewer people participate in lifelong learning and fewer firms invest in the training of their workforce (EIB, 2019, 2020).

The pandemic provided a further boost to digitalisation, with firms in the richest regions often reacting faster to the crisis. Cohesion regions continue to have higher shares of firms with no investment planned, and more firms that had to increase their debt in recent months, which limits their ability to borrow in the future. EIBIS data show that fewer firms in cohesion regions have reacted to the pandemic by becoming more digital (Figure 22). Non-cohesion firms — which are already more advanced on digitalisation, more productive, and in a better position to invest — also seem to be more aware of the longer-term shift towards digital technologies that the pandemic accelerated.

Less capacity to innovate hinders adjustment in cohesion regions. Fewer firms in cohesion regions reacted to the COVID-19 shock by introducing new products or services (Figure 22). In fact, firms in countries with many cohesion regions often report having innovated less as a result of the pandemic (Figure 23). At the same time, more firms find that the lack of innovation is affecting their competitiveness (Figure 24). A limited ability to innovate also reflects differences that existed before the pandemic, which makes it more difficult for firms to adjust to shocks and also to reposition themselves post-crisis.

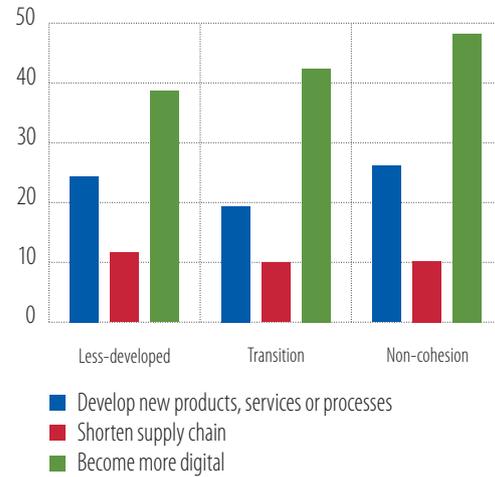
Tackling challenges in the post-pandemic world — particularly climate-related challenges — will require innovation and transformation at the corporate level. Firms at the forefront of green innovation have mostly been located in Western and Northern Europe or in non-cohesion regions (Figure 25). At the same time, firms in cohesion regions have showed less inclination to tackle climate-related challenges as part of their business (fewer have a designated person in charge of climate strategies). They also express greater scepticism as to whether they will be able to take advantage of the opportunities linked to emissions reduction. On balance, fewer firms in cohesion regions expect the green transition to positively impact market demand for their products or improve their reputation (EIB, 2021c). At the same time, more firms are worried about transition risks.

Figure 21
Firms expecting a structural reduction in employment linked to COVID-19 (in %)



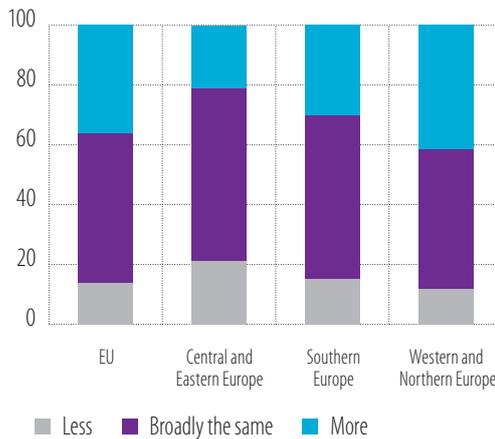
Source: EIBIS 2021.
Question: Do you expect the coronavirus outbreak to lead to a decrease in employment in the longer term?

Figure 22
Firms' immediate responses to COVID-19 (in %)



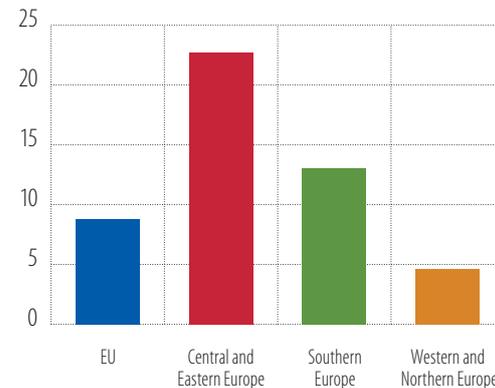
Source: EIBIS 2021.
Question: As a response to the COVID-19 pandemic, have you taken any action or made investments to...?

Figure 23
COVID-19's impact on firms' innovation (in %, by region)



Source: EIBIS 2021 add-on module – sample of EU SMEs in Manufacturing and Services (2021).
Question: Did you, innovate less, about the same amount, or more in 2020 as you would have done under normal circumstances (prior to COVID-19)?

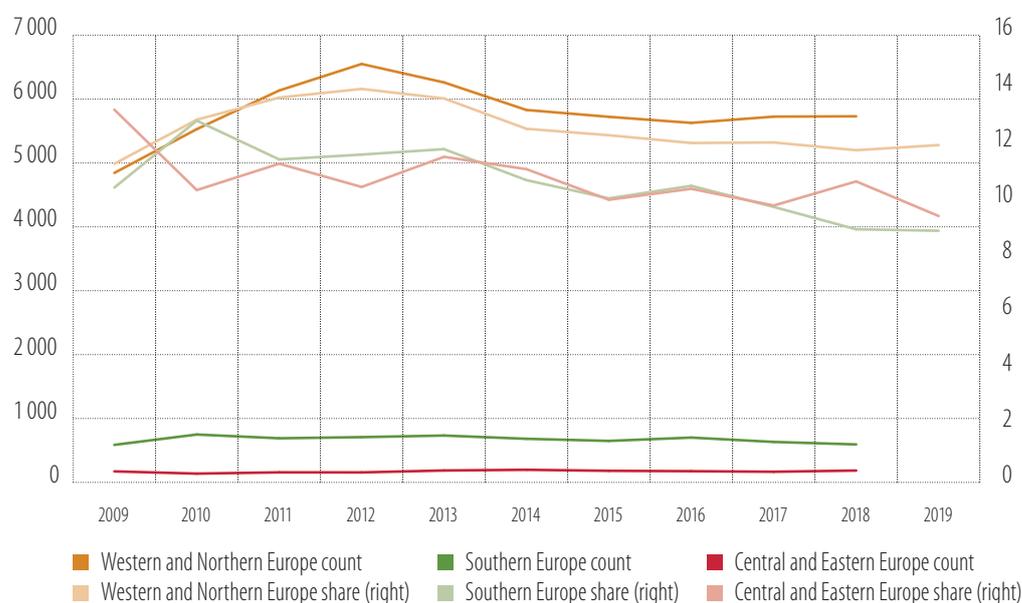
Figure 24
SMEs saying a lack of innovation is affecting their competitiveness (in %, by region)



Source: EIBIS 2021 add-on module – sample of EU SMEs in Manufacturing and Services (2021).
Base: Firms that innovated less/no innovation.
Question: Do you expect the fact that your innovated less in 2020 to disadvantage your company's competitive position relative to others in your market?

Figure 25

Green patents, by region (left: green patent count; right: % of green patents in total domestic patent portfolio)



Source: PATSTAT (PCT) data prepared in collaboration with the Centre for Research & Development Monitoring (ECOOM).

Note: The light lines show the count of green patents (left axis) and the dark lines show the share of green patents in the total portfolio of domestic patents (right axis).

Firms that adapt slowly to the changing economic environment risk stagnation and eventually falling behind competitively, which bodes ill for the regions in which they are based and for future employment. Creating and growing new firms can help to mitigate these risks. Moreover, new businesses are often drivers of change themselves, doing things differently and bringing new ideas, products and services to the market.

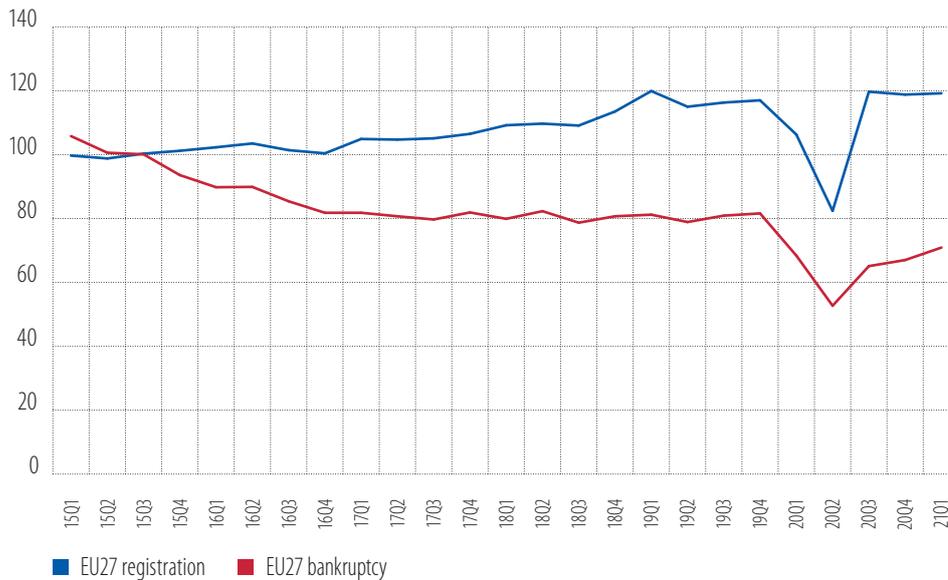
Challenges to entrepreneurship

Business registrations dropped significantly when the pandemic hit but bounced back quickly (Figure 26). In most European countries, policy responses have been aimed at keeping existing businesses alive and have targeted firms' financial fragilities, leading to a reduction in the number of bankruptcies. However, less has been done to support the creation of new businesses since the beginning of the COVID-19 pandemic.

The remaining uncertainty on the potential impact of new waves of the pandemic adds to the numerous structural issues holding back business creation in the European Union. The pandemic might have aggravated some of the issues. First, the number of self-employed persons with employees dropped more than total employment over the first year of the pandemic, suggesting that entrepreneurs ended up benefiting less from furlough schemes and other support measures in many European countries. Second, female entrepreneurship seemed to be particularly hard hit. One reason relates to women entrepreneurs often undertaking unpaid care work during the pandemic, and there is some tentative evidence that businesses led by women have benefited less from support (De Paz et. al., 2021). The crisis's impact on female entrepreneurship could exacerbate gender gaps, with potential knock-on effects for (female) employment (see also Stevenson (2020) who reports similar patterns for the United States). Furthermore, not only new firm creation, but also the exit of firms matters for an efficient allocation of economic resources, which can benefit new and dynamic firms. The temporary decline in the founding of new

businesses and the limited number of bankruptcies at the beginning of the pandemic could negatively affect business dynamism and productivity, as some resources could be trapped in less productive firms.

Figure 26
New business formation and bankruptcies (2015=100)



Source: Eurostat, authors' calculation.

Not only did business formation decline, but the creation of startups also fell when the pandemic hit.

This is worrisome, as seemingly small changes in startup creation can have persistent and strong ripple effects on the overall economy as some of these new firms will mature and grow into larger businesses. These young firms are drivers of investment activities, carriers of innovation and an important source of labour demand. More structurally, a lack of startups also matters for cohesion. Central and Eastern Europe is home to many of the countries where employment is expected to be affected by a lack of startup formation (Sedláček and Sterk, 2020). Many cohesion regions can also be found in Central and Eastern Europe. With a view to social cohesion, startups typically employ younger people, and the lack of startups could exacerbate youth unemployment (Davis and Haltiwanger, 2019; Quimet et al., 2011).

A lack of entrepreneurial dynamism limits opportunities. During the crisis, policy support was often geared towards maintaining the status quo and not all EU members introduced measures to support the formation of startups as the crisis has progressed (OECD, 2021).

Strengthening structural support to encourage entrepreneurial dynamism is key to longer-term growth. Policy support measures helped to keep people employed during periods of economic shock, limiting hardship. However, moving into the recovery, additional emphasis should be placed on boosting entrepreneurship, reigniting dynamism and creating new employment opportunities. Labour market and training policies can play an important role in supporting these dynamics, for example by facilitating the acquisition of new skills and putting them to best use. However, training and education have both been negatively affected by the pandemic.

Challenges to education and training

School closures could pose considerable risks for regional and social cohesion. During the pandemic, schools tended to be closed for longer in poorer EU members. In addition, less engaged schoolchildren and those who could have expected to earn substantially less over their lifetime even before schools closed seem to have benefited least from distance learning.

Without remedial measures, school closures could reduce students' lifetime income by about 3.5%, on average. The length of time spent in education is a key predictor of lifetime earnings. We evaluated a survey of adults' skills run by the OECD to quantify the effect of closures, drawing on work by Hanushek and Woessman (2008, 2020). According to the survey, the Programme for the International Assessment of Adult Competencies (PIAAC), for the average individual who has spent 12 to 13 years in formal education, each additional year of education increases lifetime earnings by about 7%¹⁰. With schools in the European Union fully closed for an average of 100 days (about half a school year) during the pandemic, students' lifetime income could have fallen by up to 3.5% without measures to address the education gap.¹¹

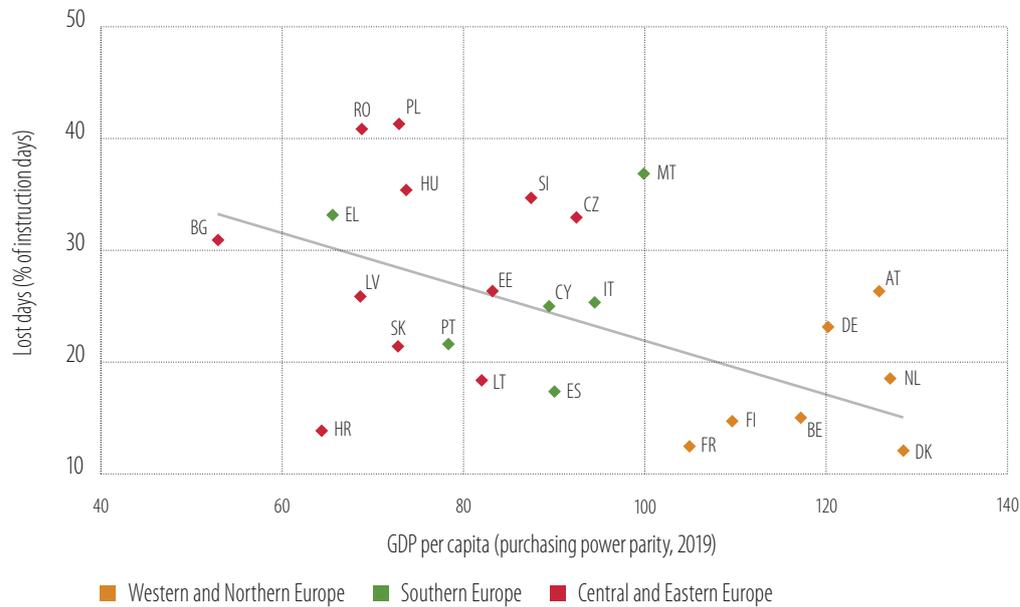
School closures are likely to have accentuated regional disparities because less wealthy EU members closed schools for longer. By the end of August 2021, schools had been fully closed during the pandemic for 15% to 40% of instruction days across the European Union. Closures tended to be longer in countries with lower GDP per capita, in particular in Eastern and Southern Europe (Figure 27). Moreover, parental income and the quality of schools' digital infrastructure — two factors helping to mitigate the impact of closures on learning losses — tend to be higher in wealthier Member States (Figure 28). However, notable exceptions exist. Before the pandemic, schools had better digital infrastructure in the Baltics than in Germany and France. For example, in Estonia, all learning materials were already online before the pandemic (OECD, 2020). Unsurprisingly, the initial level of digitalisation also facilitated the shift to remote learning (OECD, 2020). Low levels of digitalisation may also partially explain parents' disappointment with remote schooling in some countries. For example, 64% of parents in Germany thought that their children at primary and secondary school learned much less than usual during lockdowns. Analyses show that even during the second lockdown early 2021, children still spent three hours less on school tasks per day.¹²

10 Based on a regression of hourly wages of 30–55 year-old full-time employees on education, its square, and controls for age, gender, immigration status, willingness to trust others, and parents' highest educational qualification, and country of residence. Sample: EU members in PIAAC (BE, CZ, DK, EE, EL, ES, FI, FR, IE, IT, LT, NL, PL, SI, SK, UK; 23 049 observations in total). For the coefficient estimates, see Box A, Table A.1, column 2.

11 The academic literature debates whether the link between years of schooling and earnings is causal or reflects the common effect of a student's unmeasured ability on both schooling and wages. Estimates yielded from attempts to identify the causal effect of schooling are sometimes higher and sometimes lower than what we obtain here.

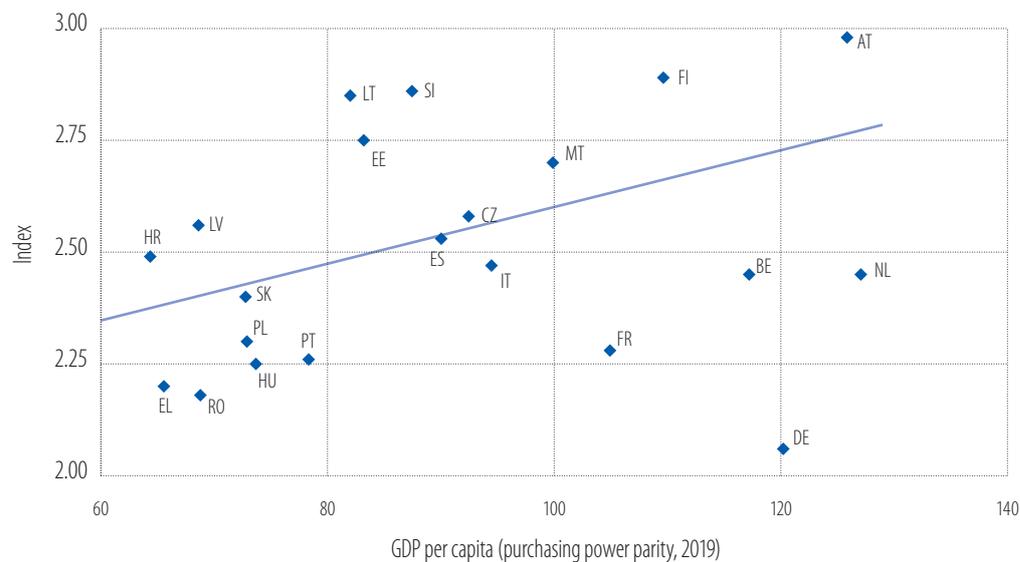
12 Parent satisfaction quoted from Thorn and Vincent-Lancrin (2021) and Woessman et al. (2021).

Figure 27
School days lost during the pandemic vs. GDP per capita



Source: Eurostat, UNICEF, authors' calculation. Days of full school closure during 26 February 2020 - 31 August 2021.

Figure 28
Schools' digital capacity and parental wealth vs. GDP per capita



Sources: Eurostat, OECD, authors' calculation. Digital capacity is proxied by school principals' assessments of whether an online learning platform is available.

The impact of school closures on already disadvantaged children is likely to have accentuated social disparities. To contain the pandemic, distance learning replaced in-person classes in many places. The success of distance learning arguably depended not only on material factors, such as schools' digital infrastructure and parental income, but also on the support offered by teachers and parents and students' personalities (see, for example, OECD, 2021d). Students who received little material support and those who were less resilient were already likely to spend less time in formal education and to earn considerably less over their lifetime before the pandemic hit. Box A provides evidence for this potentially regressive effect of school closures.

Box A

The potentially regressive effect of school closures

Before the pandemic, disadvantaged students were already expected to spend less time in formal education and to earn considerably less over their lifetime. Unfortunately, those students were also less likely to benefit from remote learning. The success of distance learning depends on many factors including schools' digital capacity and parental income, but also on teachers' digital skills and their ability to engage with students remotely, students' determination, resilience and appreciation of education, and their parents' emotional support. Two OECD surveys measure proxies of these variables and enable us to link them to educational outcomes and wages. PIAAC collected information about the skills, personality traits, education and employment status of adults from 2011 to 2015, while the Programme for International Student Assessment (PISA) combined information about the skills, schools and life of 15 year-olds in 2018.

We show this potentially regressive effect of school closures by combining these two OECD surveys. We combine PIAAC and PISA through information that is present in both surveys and assume that schoolchildren interviewed for PISA have the same education and employment prospects as adults interviewed for PIAAC with comparable characteristics. Relevant characteristics that are available in both surveys include gender, immigration background and parents' educational background. These characteristics help predict family wealth, support from families, and, to some degree, the digital equipment of the interviewee's school (Table A-2). Students' determination, resilience and appreciation of school education are more highly associated with whether a student is bullied at school. This information is available in PISA but not in PIAAC. However, PIAAC includes information about whether the interviewee tends to trust others. We assume that being bullied at school reduces an individual's willingness to trust others later in life (Jantzer et al., 2006).

Students who appear to benefit less from distance learning were already likely to earn about a third less over their life. Students whose parents do not have at least upper secondary education tend to spend over two years less in education (Table A-1, column 1). Similarly, students from immigrant families spend about half a year less in education. Partly as a result, their lifetime earnings are 20% lower if both parents are without upper secondary education, and by 14% if their family has immigrated. These students also have lower family wealth, receive less support from their parents, and tend to go to schools with worse digital equipment (Table A-2, columns 1-4). They are therefore less likely to have benefited from remote learning. Being bullied at school is associated with weaker work discipline, lower resilience and lower appreciation of school education (Table A-2, columns 6-8). In turn, those less willing to trust others tend to spend over a year less in education, and expect to earn about 18% less over their life (Table A-1, column 2). Gender has a clear impact on earnings (20% less for the women in our sample), but not on the ability to take advantage of distance learning opportunities: girls score more highly on discipline and on appreciating education but lower on resilience (Table A-2, columns 6-8). Finally, students whose parents did not have at least an upper secondary education, and those less willing to trust, are also less likely to enjoy learning new things as adults (Table A-1, column 4). This matters because lifelong learning is a prerequisite for adapting to structural economic changes, such as digitalisation.

Initial evidence about the extent of learning losses during the pandemic is mixed. There are not yet any systematic international studies about the impact of the pandemic on learning losses. Initial results from a patchwork of studies do not show a clear trend (see Thorn and Vincent-Lancrin (2021) for an overview).

Table A.1

Impact of schoolchildren's characteristics on expected time spent in formal education, lifetime income and enjoyment of learning

	(1)	(2)	(3)	(4)
	Time spent in formal education (years)	Hourly wages (log)	Hourly wages (log)	Likes to learn (degree of agreement)
Parents' educational background: at least one parent has upper secondary education	2.3***	0.2***	0.08***	1.7***
Immigration status: interviewee is first or second generation immigrant	-0.4***	-0.14***	-0.13***	1.1***
Trust: interviewee disagrees with at least one of the following statements: "Others take advantage of you," "I trust only few people"	1.3***	0.18***	0.09***	1.2***
Gender: interviewee is female	0.3***	-0.15***	-0.195***	1
Education: years of formal education			-0.03***	
Education: years of formal education, squared			0.004***	
Number of observations	40 736	23 153	23 049	86 720
R-squared	0.24	0.4	0.5	

Sample: EU-resident students surveyed in PIAAC (2011-15). (1) – (3) report slope coefficients of ordinary least squares (OLS) regressions; (4) reports odds ratios of an ordered logit. All regressions include country fixed effects. Robust standard errors (*** = 0.1%, ** = 1% significance).

Table A.2a

Impact of schoolchildren's characteristics on their ability to benefit from remote schooling

	(1)	(2)	(3)	(4)
	Family wealth	Parents' support for learning at home	Parents' emotional support	Schools' digital equipment
Parents' educational background: at least one parent has upper secondary education	0.4***	0.2***	0.17***	0.04*
Immigration status: interviewee is first or second generation immigrant	-0.4***	-0.16***	-0.3***	-0.03*
Bullying: top quartile of summary indicator of being left out, made fun of, subject to rumours, threats, theft or violence	-0.06***	0.05*	-0.08**	-0.01
Gender: interviewee is female	-0.07***	0.08***	0.09***	-0.01
Number of observations	145 253	29 361	29 196	139 591
R-squared	0.15	0.04	0.07	0.09

Sample: EU-resident students surveyed in PISA (2018). Dependent variables in (1) – (8) are all derived by the OECD from responses of questions included in PISA. All regressions include country fixed effects. Robust standard errors (*** = 0.1%, ** = 1%, * = 5% significance).

Table A.2b**Impact of schoolchildren's characteristics on their ability to benefit from remote schooling**

	(5) Teachers' digital abilities	(6) Student's determination	(7) Student's resilience	(8) Student's valuation of school
Parents' educational background: at least one parent has upper secondary education	0.01	0.05**	0.07***	0.04*
Immigration status: interviewee is first or second generation immigrant	-0.04***	0.05*	0.08***	0.04*
Bullying: top quartile of summary indicator of being left out, made fun of, subject to rumours, threats, theft or violence	-0.02**	-0.13***	-0.24***	-0.14***
Gender: interviewee is female	-0.01*	0.17***	-0.12***	0.19***
Number of observations	139 946	136 038	141 480	143 964
R-squared	0.06	0.08	0.03	0.05

Sample: EU-resident students surveyed in PISA (2018). Dependent variables in (1) – (8) are all derived by the OECD from responses of questions included in PISA. All regressions include country fixed effects. Robust standard errors (*** = 0.1%, ** = 1%, * = 5% significance).

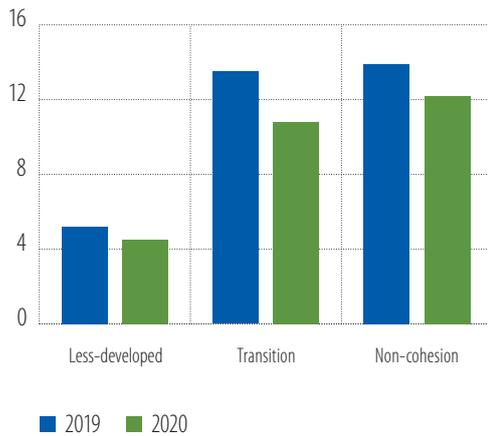
The pandemic is likely to have also slowed learning by groups other than school-age children. Early childhood education, which can help bridge the learning gaps of pre-school children from disadvantaged backgrounds, closed as well. As closures were more prevalent in Southern and Eastern Europe, regional cohesion might suffer in the long term (OECD, 2021). Policy support measures were mostly geared towards preserving existing employment, but many young people faced the daunting challenge of having to find new jobs during the pandemic, when many firms were more reluctant to hire, particularly for entry-level positions. Young people with lower levels of education tend to have more difficulty entering the labour market. They are also more often unemployed and are unlikely to participate in further education or training. Evidence from previous crises suggests less advantaged students experience the negative effects of entering the labour market in a downturn for longer (Oreopolous, 2012). Workers with lower levels of education may find it more difficult to change careers in a shifting labour market.

Adults participated less in education and training (Figure 29). Not only did on-the-job training suffer as workplaces closed, but it also seems that fewer firms invested in the formal training of their workforce. The share of firms investing in the training of their workforce dropped by some 10 percentage points on average (Figure 30). The consequences of less training will be felt throughout the European Union. A shortage of skilled staff is the most frequently cited investment barrier across the European Union (see Chapter 2). Like school closures, the shortage of skilled staff also has regional and a social dimensions. Training declined from an already low level in less developed regions, suggesting that only a very small share of adults were able to enhance their skills through dedicated education and training. In addition, disruptions to training appear to have had a particularly strong impact on vulnerable groups in the labour market, such as migrant workers (Institute for Employment Research (IAB), 2020).

Firms undertaking transformative investment continued to invest in their workforce. In recent months, employment in most firms remained constant. However, those better-positioned to see the crisis and the related changes as an opportunity to undertake transformative investments were more likely to invest in their workforce. Firms that see opportunities linked to the climate transition and that invested in advanced digital technologies also appear more inclined to invest in their workforce (61% vs. 40%). The firms leading the green and digital transformation invest in training more often across all regions,

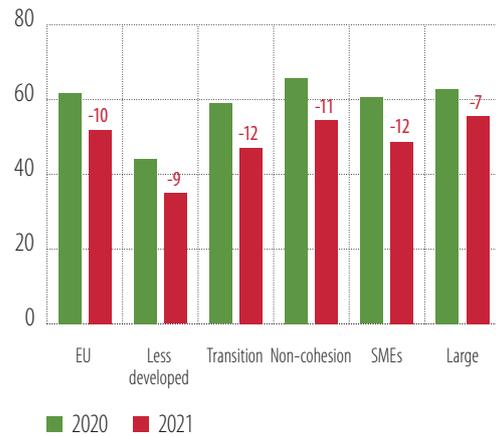
which contrasts sharply with firms not investing in green and digital (Figure 31). Training investment and activities for small firms¹³ also appear to have been more heavily disrupted as many small firms were facing existential threats and levels of digitalisation tend to be lower, posing challenges for maintaining training efforts.

Figure 29
Participation in education and training
(in %, share of adults, 24-64, in the last four weeks)



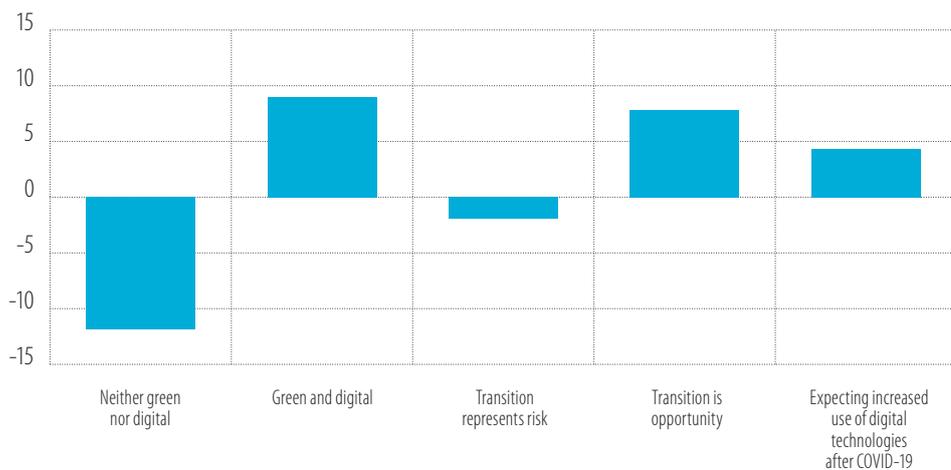
Source: Eurostat, authors' calculation.
Note: Adults participating in education and training in the four weeks preceding their interview.

Figure 30
Firms investing in training (in %)



Source: EIBIS 2020, 2021.
Note: The percentage of firms that invest more than EUR 50 per employee in training. Numbers above bars indicate year-on-year differences in percentage points.

Figure 31
Differences in the share of firms' investing in training (in percentage points), by firm type compared to the EU average



Source: EIBIS 2021.
Note: The percentage of firms that invest more than EUR 50 per employee in training.

13 We distinguish between firms with fewer than 50 employees and those with over 50 employees.

Creating opportunities for people and places

The recovery presents opportunities for regional and social cohesion. The joint EU policy response to the crisis — such as **NextGenerationEU** and the European Union's long-term budget, the Multiannual Financial Framework — provides plenty of support for rebooting economies and facilitating profound structural transformation (See "Fiscal policy in the recovery phase" in Chapter 1). These funds must be used diligently to address structural divergences, reduce the risk of long-term scars from the pandemic and ensure that the benefits of the green and smart transition are broadly shared.

For the financial support to be used most effectively, governments need to address capacity gaps and barriers to investment. The urgency in addressing these gaps is most acute for cohesion regions, where a lack of funds is a bigger problem. However, investment barriers do not stem solely from a lack of access to finance. Barriers also include complicated regulatory processes and general uncertainty. According to municipalities in cohesion regions, these barriers are the key obstacles to infrastructure investment, green or otherwise (Figure 32 and EIB, 2021b).

Tackling investment and capacity barriers might also help municipalities in cohesion regions to halt or even reverse population declines. Strengthening capacity is key to implementing investment plans, helping to address infrastructure gaps, making lagging regions more attractive and benefiting people and firms in their respective locations. The population in some urban centres appears to have stopped growing during the pandemic (Destatis, 2021). However, if urban areas recover faster, migration away from rural areas might soon pick up again, just as migration followed job opportunities in the aftermath of the global financial crisis. To halt or reverse population declines, regions must create attractive living and investment conditions. Investment in digital connectivity and social infrastructure appears crucial in this respect and, in combination with shifts in work practices, could provide positive stimulus for some lagging regions. In this way, digital investments have the potential to help regions converse and improve overall social inclusion, particularly if they are combined with coherent policies to strengthen competitiveness, broaden access to digital infrastructure and foster digital skills.

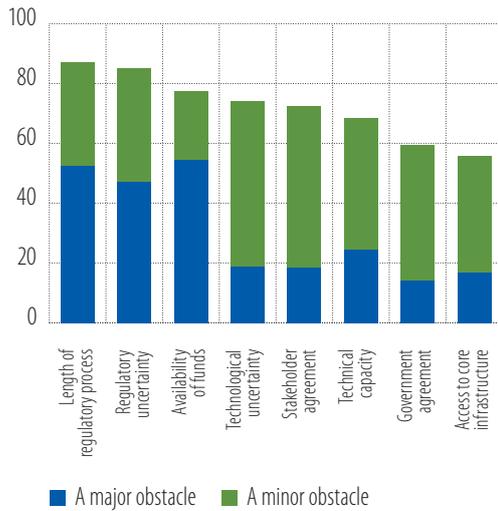
Firms — particularly those driving the green and digital transformation — stand to benefit from lower barriers to investment. While firms in cohesion regions generally report more barriers, firms investing in climate change-related measures and digitalisation feel an even greater effect. The limited availability of skills stands out as an obstacle to firms driving the green and digital transition, and most often in less developed regions (Figure 33). At the same time, the firms leading the green and digital transition are, on average, more productive, pay higher wages and invest more often in the training of their workforce (EIB, 2021). Reducing key barriers to their operations can thereby help them to grow, generate wider benefits for their regions and advance the digital and green transformation across the European Union. Moreover, addressing barriers could also help attract new investors.

Firms' climate change and digitalisation activities influenced employment and training during the pandemic and will continue to do so afterwards. Firms forging ahead with digital and green investments are more likely to have increased employment during the crisis than firms that did not invest in digital technologies and climate change-related measures (Figure 34). Similarly, significant differences exist in investment in employee training across firms. While the pandemic took a toll on training, firms that have invested in digital technologies and climate change measures were more likely to continue investing in their workforce, which indicates resilience and the capacity to drive changes in the future.

Firms driving the digital and green transformation are helping to update skills and offer employment even in the current environment. Green and digital firms were more than twice as likely to continue investing in 2021. However, fewer firms have invested in climate measures and digital technologies in cohesion regions. The variation across regions may also be related to the prevalence of teleworking and the ability to deliver training online, which often proved difficult, particularly for smaller firms (OECD, forthcoming). Before the pandemic, smaller firms were already less likely to offer online training than

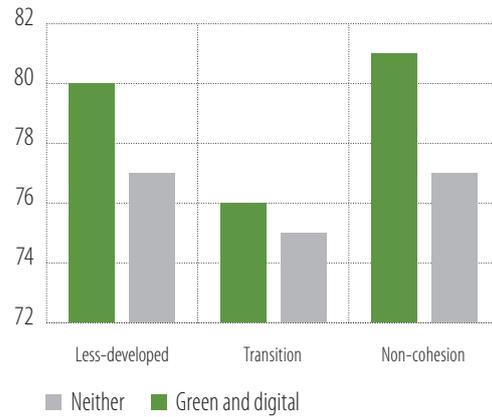
large companies, or those that were part of a multinational corporation. This implies that smaller firms were less prepared to transition to online training when COVID-19 struck. The disparities underscore the need to improve the business environment to support the growth of successful firms.

Figure 32
Lack of funds remains an important barrier for municipalities in cohesion regions (in %)



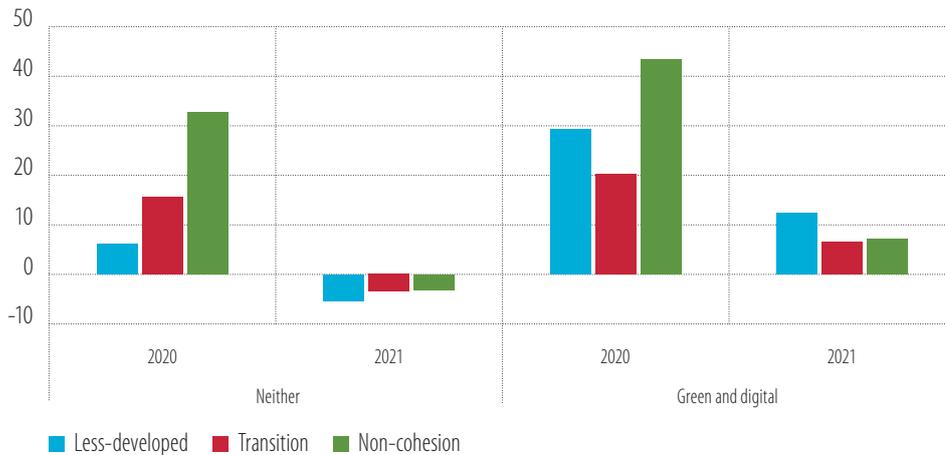
Source: EIB Municipalities Survey 2020.
Question: To what extent is each of the following an obstacle to the implementation of your infrastructure investment activities? Is it a major obstacle, a minor obstacle or not an obstacle at all?

Figure 33
Skills as an obstacle to investment for “green and digital” firms vs. “neither” firms (% of firms reporting skills as an obstacle), by region



Source: EIBIS 2021.
Question: Thinking about your investment activities, to what extent is the availability of skills an obstacle? Is it a major obstacle, a minor obstacle or not an obstacle at all?

Figure 34
Share of firms increasing vs. those decreasing employment (net balance in percentage points), for firms that are “green and digital” and for firms that are “neither”



Source: EIBIS 2021.
Question: How many people did your company employ either full or part time at all its locations at the beginning of 2020, before the COVID-19 pandemic?
Note: The graph shows the share of firms increasing employment minus the share of firms decreasing employment for the respective EIBIS waves. Differences in percentage points.

A high quality business environment is conducive to the creation and growth of new firms. Such an environment is vital for economic dynamism, generating employment opportunities and driving structural change in Europe. Entrepreneurial activity in recent years showed some sectoral shifts towards ICT in Europe, and these businesses are generating jobs.¹⁴ While these are positive developments, maintaining and accelerating momentum is important. Similar shifts in the kind of startups being created are seen in the United States, where entrepreneurs face a better-developed ecosystem for starting up and scaling up a business. This means that the drop in startups at the beginning of the pandemic might negatively affect competitiveness. While overall business creation followed a similar trend (a sharp drop in the second quarter of 2020 but with a quick rebound), the pace of applications for new businesses in the United States has surged to a record high since the middle of 2020 and that surge has continued into 2021 (Haltiwanger, 2021). Similarly, the number of unicorns (young firms with a market valuation of USD 1 billion or more) based in the United States more than doubled, exceeding those based in the European Union by a factor of five.

The resilience of parts of the EU funding landscape during this crisis is a remarkable achievement (EIF, 2021). Policy measures help keep credit markets functioning, and this presents an opportunity for the founding of new businesses as the economy moves into recovery. To seize the opportunity of the recovery, however, Europe must improve the environment for startups and address structural barriers (other than access to funds) that prevent them from thriving. Making sure that people have the right skills will also be important for the growth of new firms. Analysis based on the EIBIS special survey on digitalisation and skills illustrates that skills are real barrier for firms trying to scale up (EIB, 2018).

Investment in human capital is key to an inclusive recovery and economic transition. Dedicated measures would help people particularly affected by school closures and would ideally improve investment in the modernisation of educational systems. Investment in education is an opportunity to reap multiple dividends for growth, inclusiveness and resilience of the EU workforce.

The pandemic has boosted the digitalisation of schools, creating new opportunities for future education. In addition to investing in digital infrastructure, almost all EU members provided some support to teachers with IT training and professional development activities on teaching and the effective use of technologies. Continuing in this direction could create new educational opportunities. Digital resources can provide teachers with feedback on their teaching and their students' progress, and make it easier to adjust the speed of learning to individual students' skills. Digital platforms can also facilitate collaboration between teachers and the curation of learning materials.

Taking advantage of these opportunities requires continued investment in IT infrastructure and in teaching skills. Grants from the **Recovery and Resilience Facility** play an important role in funding these investments. Many EU members (such as Austria and France) intend to use some of the €723.8 billion in grants and loans to purchase IT equipment for schools, support the acquisition of digital devices for low-income families (such as Greece and Slovakia) and to fund teacher training (such as the Czech Republic and Portugal).

Many EU members have taken action to address the impact of school closures.¹⁵ Almost all attempted to reduce learning gaps. Disadvantaged students, in particular those at risk of dropping out, were the focus of these measures in two-thirds of EU members. Just under half of EU members implemented programmes with a special focus on immigrant or minority students. This included additional financial support in the form of cash transfers or subsidies for acquiring digital devices, provided in particular to low-income families in more than half of EU members, and to help with accessing learning platforms and/or setting up self-paced learning platforms, in particular for children with disabilities in half of EU members.

¹⁴ Based on Eurostat sectoral LFS data and Crunchbase analysis.

¹⁵ The following figures report summary statistics for EU Member States computed from the OECD survey *The state of education during the Covid pandemic* (2021) as far as they pertain to primary and secondary education.

Nevertheless, a broader range of policies must be adjusted to ensure that education systems promote social mobility. Parental background — both wealth and educational achievements — appears to be a deeply engrained determinant of students' educational achievements. This hinders social mobility. A wide range of policies have been identified to improve social mobility, such as offering early childhood education independently of parental income, insuring parents against income losses (for example by facilitating the re-integration of parents into the labour market) and addressing geographical segregation of poor families (see, for example, OECD, 2018).

High quality education systems are the basis for building the skills people need to thrive in a changing labour market. People's ability to adjust to unforeseen circumstances has been necessary across the European Union and in occupations requiring different levels of skills (Box B). Firms are also increasingly seeking digital skills. The changing labour market underscores the need to invest in quality education from early ages on to foster the skills that will help people adapt and thrive.

Box B

What skills are firms seeking in a fast-changing labour market?

We analyse data based on Skills-OVATE, an online vacancy analysis tool for Europe, powered by the European Centre for the Development of Vocational Training (Cedefop) and Eurostat. Skills-OVATE provides detailed information on the jobs and skills employers seek based on online job advertisements.

When looking at occupations searched in 2020/2021, we can see that most online job advertisements targeted professionals (25%), associate professionals (20%) and trade workers (12%).

Figure B1

Structure of online job advertisements, by occupation, (in %)



Source: Skills Online Vacancy Analysis Tool for Europe (Skills-OVATE).

Note: This figure provides information on the occupations (on ISCO 1 level) sought in online job advertisements from the second quarter of 2020 to the first quarter of 2021, for the European Union. Size of rectangles indicate shares.

The COVID-19 pandemic had a strong effect on job openings. Only the number of job advertisements for managers and professionals increased from the first quarter of 2020 to the first quarter of 2021 — all other occupations were less sought-after.

The database shows us not only what jobs employers were looking for, but also the skills in demand. In 2020, 44% of job ads sought employees that adapt well to change. This share is even higher when focusing on managers (65% of job ads for managers mention that “adapt to change” is a required skill for the job). Focusing on digitalisation, “accessing and analysing digital data” and “using digital tools for collaboration and productivity” were the most sought-after digital skills in the EU27. Job ads for managers mentioned digital skills more often than those for the average worker.

Figure B.2

Change in online job advertisements (in %), by occupation

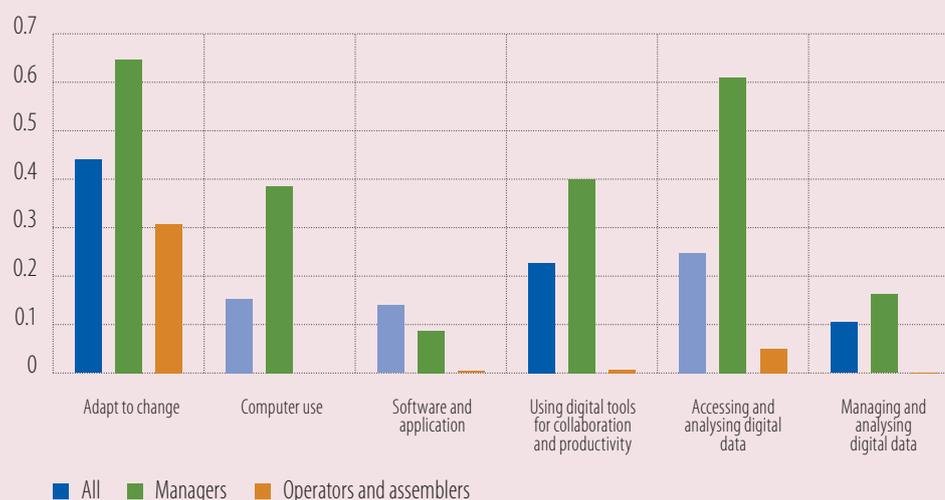


Source: Skills Online Vacancy Analysis Tool for Europe (Skills-OVATE).

Note: This figure provides information on how the demand for occupations changes over time (on ISCO 1 level). It displays the percentage change in the number of online job advertisement by occupation from the first quarter of 2021 compared to the first quarter of 2020, for the European Union.

Figure B.3

Skills most sought-after by employers (in %)



Source: Skills Online Vacancy Analysis Tool for Europe (Skills-OVATE).

Note: This figure provides information on the importance of a skill group in different occupations from the second quarter of 2020 to the first quarter of 2021, for the European Union

A huge variation among EU countries can be observed when comparing the digital skills sought. Irish and Luxembourg companies were more than twice as likely to search for “using digital tools for collaboration and productivity” and “accessing and analysing digital data.”

Figure B.4
Digital skills employers are seeking (1 = EU average)

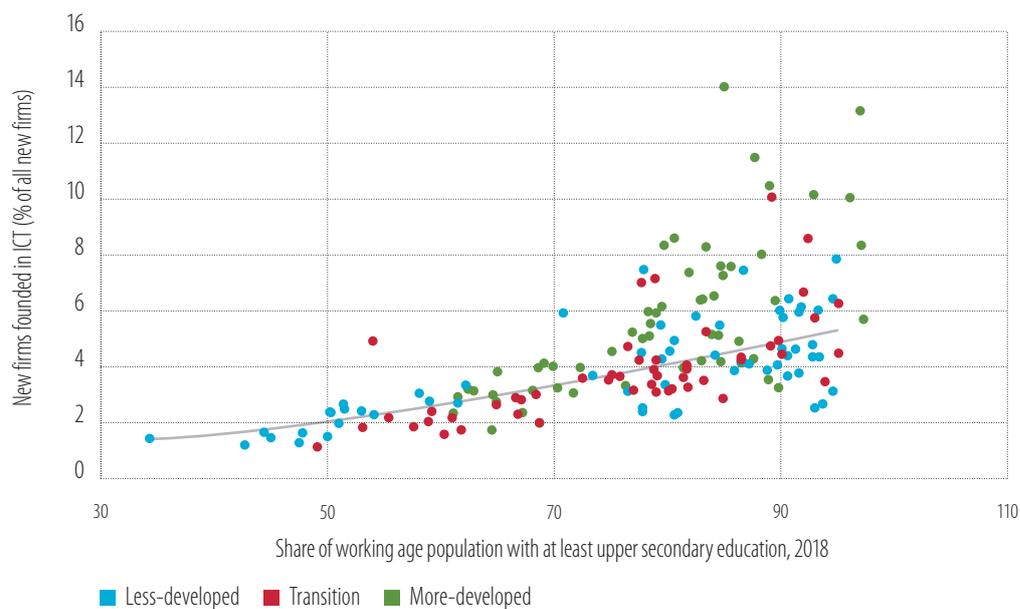


Source: Skills Online Vacancy Analysis Tool for Europe (Skills-OVATE).

Note: This chart provides information on the importance of skills in different occupations in the second quarter of 2020 compared to the first quarter of 2021.

A highly skilled workforce can help economies to adjust to shocks and facilitate structural change. An important way to adjust to structural shocks is to create new firms. The numbers of newly created firms are not generally higher in richer economies, nor are they generally higher in regions with a more highly skilled workforce. For example, some regions in Southern Europe have seen many new firms created for personal services. Firm creation in sectors that drive growth (such as ICT) occur more frequently when the workforce is highly qualified (Figure 35). Another way to adjust to structural shocks is to support the adoption of new digital technologies, which also tends to be higher in countries with a relatively well-developed skill base (see Chapter 5 for further discussion).

Figure 35
Higher education is associated with larger rates of newly created ICT firms



Source: Eurostat, authors' calculation.

Conclusion and policy implications

The pandemic provoked a severe health and economic crisis that affected all Europeans, but the shock was felt differently by various socioeconomic groups and geographical regions. The impact of the pandemic exacerbated existing gaps. Regional and social disparities posed considerable challenges even before the COVID-19 pandemic. The global financial crisis slowed regional convergence and exacerbated divergences among different social groups. Divergences that widened during the pandemic risk persisting during and after the recovery.

The pandemic shock may have a negative effect on cohesion well into the future through its impact on business dynamism, human capital and firms' capacity to adapt to a changing environment. Businesses' ability to spot and to take advantage of the opportunities of structural changes in the economy is crucial for regional prosperity and local employment. Structural gaps and challenges in the business environment weaken firms' resilience and their capacity to adapt. Focusing on the quality of the business environment and productivity-enhancing reforms across Europe, particularly in lagging regions, is therefore necessary for growth and cohesion.

Investment is key to mitigating the negative effects of the pandemic on human capital formation and long-term prosperity. Policymakers must prioritise improving skills for people hardest hit by the crisis. Skills can be improved through dedicated training and employment incentives that target young people, displaced workers and the most vulnerable groups in the labour market. To limit the negative effects of school closures, support programmes and additional resources are needed for schools to address the learning gaps. Dedicating more resources to education, such as ensuring that schools are well equipped and staffed, is crucial. It will ensure that schools provide opportunities for young people and equip them with the skills they need to thrive in a changing labour market. Education is essential for personal and economic resilience.

Leaving social and regional disparities unaddressed would likely exacerbate Europe's cyclical and structural challenges, particularly those linked to the green and digital transition. Failing to address the risk of rising inequality and social exclusion would deepen social divisions. These risks could slow the economic recovery, productivity growth and the transition towards a greener and smarter economy in Europe. Europe urgently needs to renew its support for social and geographical cohesion.

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PART III

Recovery as a springboard for structural change

46% of EU firms **became more digital** as a response to the crisis, vs. **58%** in the United States

The European Union has **50%** **fewer patents in digital technologies** than the United States and China

26%

of EU firms have **neither** implemented advanced digital technologies nor made investments to become more digital

Those firms account for **1/3** of jobs in EU firms, compared to **1/5** in the United States

The share of EU firms adopting advanced digital technologies **stalled at 61%**

16% of EU firms consider poor digital infrastructure as a **major obstacle to investment**

Europe has **2x** as many patents in **sustainable transport and mobility** as the United States and China

3x as many in **wind power**

43% of EU firms **are investing in climate measures**

47% plan to invest in climate measures

58% of EU firms feel vulnerable to climate change vs. **63%** of US firms

25% of EU firms adopted wait-and-see climate strategies vs. **45%** of US firms

40% of EU firms in brown sectors **see the climate transition as a risk**

40% in low-carbon sectors **see it as an opportunity**

71% of EU SMEs say **uncertainty about regulation and taxation** is a key impediment for climate-related investment

Europe has **7** companies

in the world's top 20 green innovators, vs. **2** in the United States and **1** in China

10 basis points

is the estimated green premium for corporate bonds in the European Union

Chapter 5

Investing in Europe's digital transformation

The COVID-19 crisis has accelerated the digital transformation of Europe's economy. Close to half of firms in the European Union report investing in digitalisation as a response to the pandemic — for example, by providing services online — according to the EIB Investment Survey (EIBIS). Until recently, the implementation of digital technologies was considered important for market success and was usually associated with the most innovative and modern companies. However, the pandemic has made the digital transformation an integral part of society — and integral to firms' survival. Digitalisation can transform business dynamics, work organisation, education, health and government services.

Digital firms were better able than non-digital firms to cope with the disruption unleashed by the pandemic. They were less likely to experience a strong decrease in sales since the beginning of 2020. In addition, while policy support for the private sector was widespread and did not target digital firms in particular, digital firms report more often than other firms that they used the crisis as an opportunity to accelerate digitalisation. This suggests that the crisis forced them to find more efficient ways of working with digital technologies. Overall, digital firms tend to perform better than non-digital firms. They are more productive, export more, invest more, are more innovative, grow faster and pay higher wages on average.

With digitalisation advancing fast, the European Union is facing a digital dilemma. Some EU firms are at risk of being left behind, in particular in regions where digital infrastructure is lacking. One in six EU firms consider access to digital infrastructure to be a major obstacle to investment. However, this assessment varies significantly across EU countries and regions within countries. Significant investment in digital infrastructure is needed across the European Union to support a broad-based economic recovery. Firm size also partly determines digital investment. The failure of many small EU firms to adopt digital technologies could have negative implications for Europe's long-term competitiveness. These firms need to reassess their operating environment and to invest to innovate and adapt. Digital investment will help ensure firms' survival and ability to thrive in a new, more digital environment.

Accelerating the European Union's digital transformation will also require a policy framework that fosters cutting-edge digital innovation. Digitalisation has completely transformed research, innovation and technology, intensifying the pace at which ideas spread. Digital innovation is no longer the exclusive domain of software companies, and it is crucial for an increasing variety of innovative businesses across many sectors. For example, all areas of technology are becoming data-intensive, increasingly relying upon and generating big data. A few notable examples are new battery technologies, precision agriculture, 3-D bioprinting used for medical applications and autonomous vehicles.

The European Union is lagging behind the United States and China for digital innovation and patent applications relevant to industry 4.0, but Europe's excellence in certain areas of innovation can be used to its advantage. Some of the continent's traditional sectors, such as the automotive industry, could potentially embark upon a new era of innovation thanks to digital innovation. In fact, the European Union is a global leader for patenting activities at the crossroads of digital and automotive technologies and digital and green technologies. Another sector where digitalisation could play a major role is healthcare, especially in light of the COVID-19 pandemic. Nevertheless, unlike overall healthcare innovation, patenting activity that combined digital innovation and healthcare did not pick up as an immediate response to the health crisis. The **European Green Deal** and the European Union's **Digital Strategy** constitute the cornerstone of the **recovery plan for Europe**. These initiatives, combined with the national recovery and resilience plans, represent a unique opportunity to transform the EU economy and make it greener, more digital and more innovative.

Introduction

The coronavirus crisis has accelerated the digital transformation of Europe's economy. Close to half of firms in the European Union report investing in digitalisation as a response to COVID-19 — for example, by providing services online — according to the EIB Investment Survey (EIBIS). Until recently, the implementation of digital technologies was considered important to market success and was usually associated with the most innovative and modern companies. However, the pandemic has made the digital transformation an integral part of society — and integral to firms' survival.

This chapter discusses the rapid digitalisation efforts of firms in the European Union during the pandemic. Digital firms were better able than non-digital firms to cope with the disruption unleashed by the COVID-19 pandemic. They were less likely to experience a decrease in sales since the beginning of 2020. Digital firms more often report that they used the crisis as an opportunity to accelerate digitalisation. This suggests that the crisis forced them to find more efficient ways of working with digital technologies. Overall, digital firms tend to perform better than non-digital firms. They are more productive, export more, invest more, are more innovative, grow faster and pay higher wages on average.

The chapter also analyses patent data to map recent patterns in cutting-edge digital innovation. Digital innovation is no longer the exclusive domain of software companies, and it is crucial for an increasing variety of innovative businesses across many sectors. The European Union is lagging behind the United States and China in digital patents. However, it is at the forefront of developments where digital innovation meets green and automotive technologies. Some of the continent's traditional sectors, such as the automotive industry, could potentially embark upon a new era of innovation thanks to major changes triggered by digital innovation. In addition, new green technologies will be key enablers of the green transition envisioned under the European Green Deal. The chapter also discusses how digital technologies have supported innovation in the healthcare domain. It concludes by highlighting the importance of developing effective public policies that incentivise investment in the digital transformation and innovation to address the COVID-19 crisis and foster the green transition.

Digitalisation during the COVID-19 crisis

Responding to the pandemic

The pandemic led to wider recognition of the importance of the digital transformation. Until recently, the implementation of digital technologies was considered important for market success and was usually associated with the most innovative and modern companies. However, the pandemic has made the digital transformation integral to firms' survival. Many of the changes associated with digitalisation are likely to stay. Investment in digitalisation is vital to preventing business disruption, organising work remotely, improving communication with customers, suppliers and employees and selling products and services online.

As a response to the COVID-19 crisis, many firms invested in digitalisation. In the European Union, 46% of firms report that they took action to become more digital — for example, by providing services online — according to the results of the EIBIS conducted from April to July 2021. However, significant differences exist across firm size classes, sectors and countries.¹ Micro and small firms are lagging behind medium-sized and large firms: only 30% of micro firms stated that they took steps to improve digitalisation, compared with 54% of large firms (Figure 1).² Furthermore, 49% of firms in the services sector report they

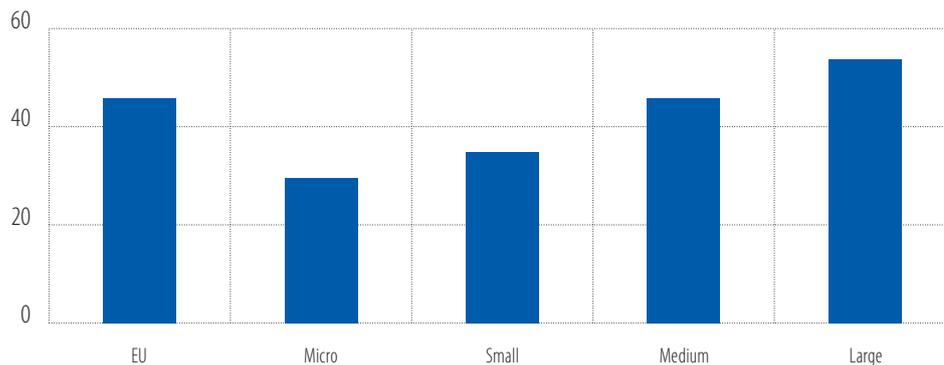
¹ All the associations discussed in the analysis using EIBIS data — such as the link between digitalisation and firm size or firm performance — also hold in multivariate regression analysis controlling for potential factors that might confound the analysis, such as size, sector and country of the firms.

² All figures relying on EIBIS data are weighted using value added to make the sample of firms covered by EIBIS representative of the economy.

invested in digitalisation, compared with 32% of firms in the construction sector, which reflects different dynamics across sectors during the pandemic (see Chapter 3). Comparing the different EU regions, 48% of firms in Western and Northern Europe reported taking steps or investing to become more digital, compared with 43% in Southern Europe and 37% in Central and Eastern Europe.

Figure 1

Firms that invested to become more digital as a response to COVID-19 (in %)



Source: EIB Investment Survey 2021, firms in the EU27.

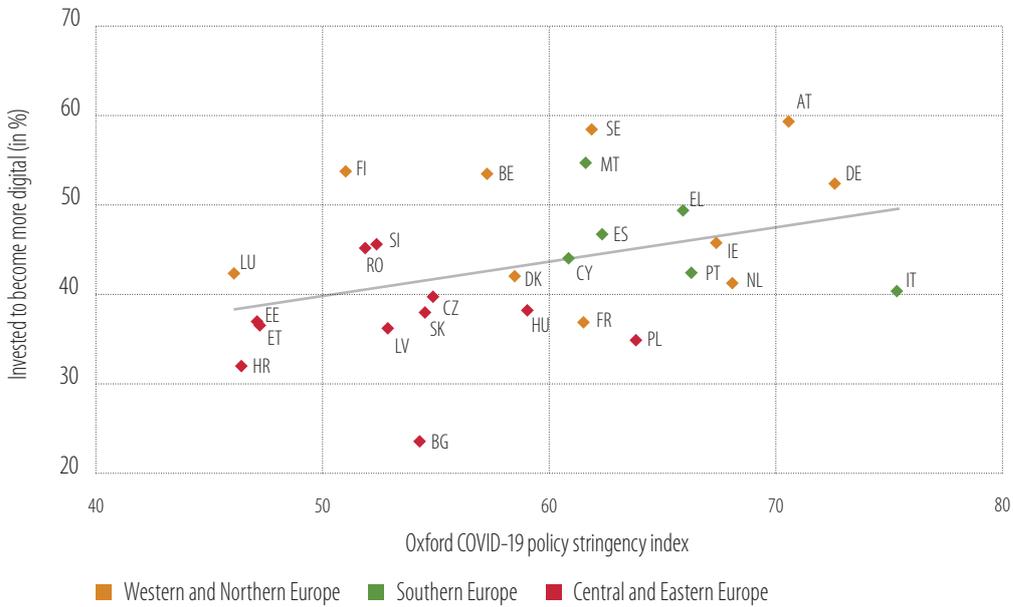
Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)?

Digitalisation efforts appear to be linked to health-related measures put in place by governments during the COVID-19 pandemic, such as restrictions on movement. Throughout the pandemic, firms across the European Union were faced with different workplace closure and stay-at-home requirements. Firms were more likely to state that they invested in becoming more digital in countries with stricter measures (Figure 2).

Public policy support provided over the past three years to encourage firms to become more digital helped accelerate the digital transformation during the COVID-19 crisis. Some 15% of small and medium-sized enterprises (SMEs)³ report having received public support — such as government grants, subsidies or subsidised finance from the public sector — to accelerate digitalisation investments over the past three years. Among the firms that benefited from this financial support, 67% report that they also took action to become more digital during the COVID-19 crisis, compared to only 38% of SMEs that did not receive previous support (Figure 3). This evidence shows that targeted incentives, when they are well designed, can make a difference in accelerating the digital transformation of the European Union.

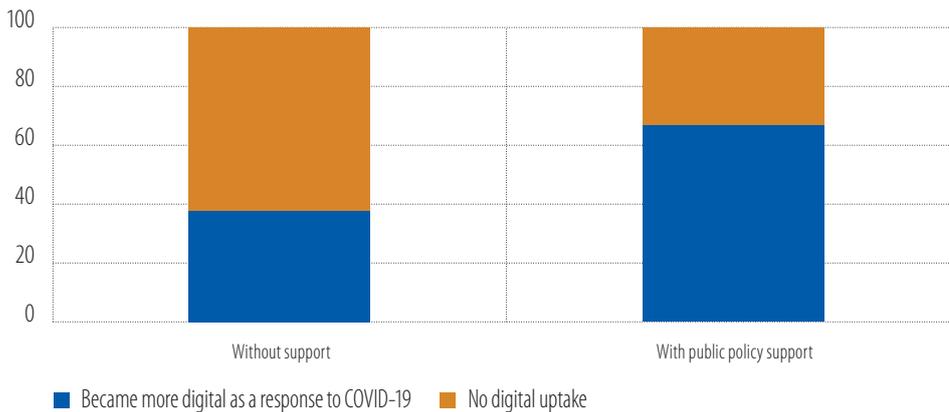
³ See the Data Annex for more information on the EIBIS 2021 AOM survey, which covers a sample of EU SMEs in manufacturing and services.

Figure 2
Firms that invested in becoming more digital as a response to COVID-19 and the pandemic-related policy stringency index



Source: EIBIS 2021, firms in the EU27 and Oxford COVID-19 Government Response Tracker (second quarter of 2021).
Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)?

Figure 3
SMEs that invested in becoming more digital as a response to COVID-19 and received public support for digitalisation over the past three years (in %)



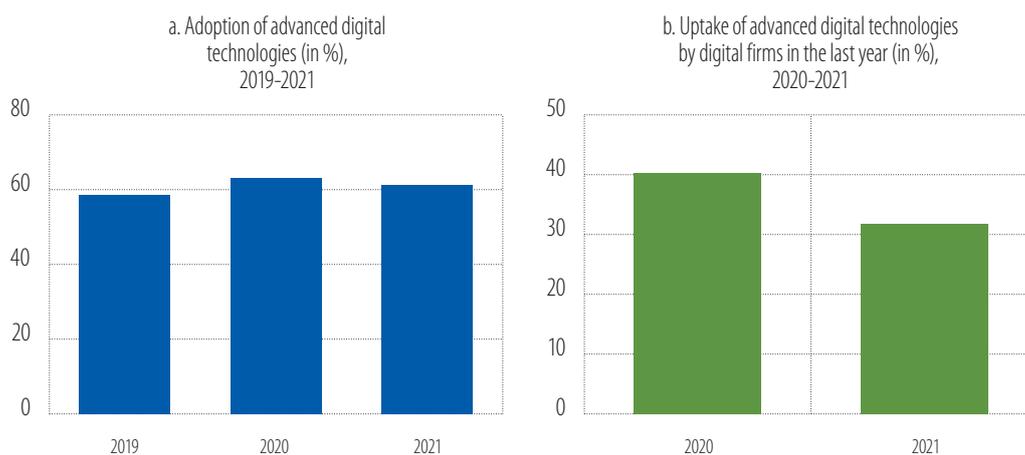
Source: EIBIS 2021 add-on module (AOM) — sample of EU SMEs in manufacturing and services (2021).
Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)? In the past three years, have you received public support (e.g. government grants, subsidies, subsidised finance from the public sector) to accelerate investments in order to become more digital?

Implementation of advanced digital technologies

During the COVID-19 crisis, firms put more complex digitalisation processes on hold. In contrast to the more general digital transformation, the adoption of new advanced digital technologies is stalling. Beyond the short-term response to COVID-19, another structural element for the digital transformation of the EU economy is the implementation of advanced digital technologies such as 3-D printing, advanced robotics, the internet of things, big data analytics and artificial intelligence, drones, augmented or virtual reality, or platforms. The share of EU firms implementing advanced digital technologies in their business increased significantly from 2019 to 2020 (Figure 4a). However, this share stayed more or less constant from 2020 to 2021, reaching 61% in 2021, compared to 63% 2020 and 58% in 2019.

The share of firms that report having implemented new advanced digital technologies in their business in the past year was lower in 2020 than in 2019. Adopting advanced digital technologies is often a complex process, requiring a reorganisation of the company's business and re-training of staff. It is likely that, against the backdrop of the pandemic, firms have been delaying the most complex investment projects, focusing on their immediate needs. New, advanced and complex digital technologies appear to have been less of a priority for many firms during the COVID-19 crisis.

Figure 4
Adoption of advanced digital technologies



Source: EIBIS 2019, 2020, 2021, firms in the EU27.

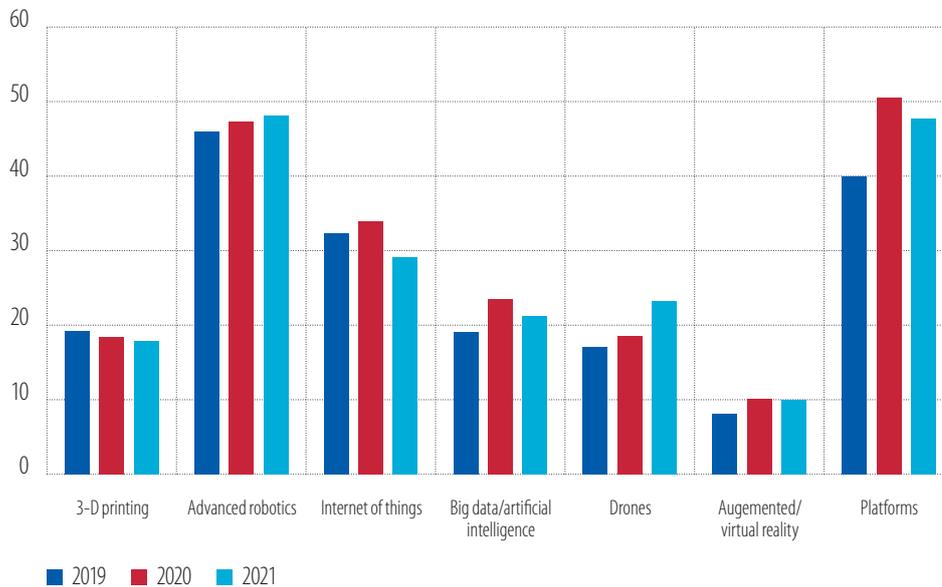
Note: A firm is identified as having adopted an "advanced digital technology" if at least one digital technology specific to its sector was implemented in parts of the business and/or if the entire business is organised around at least one digital technology. The question on whether any new digital technology was introduced in the last year was not asked in EIBIS 2019.

Question: Can you tell me for each of the following digital technologies if you have heard about them, not heard about them, implemented them in parts of your business, or whether your entire business is organised around them? Firms were asked to answer the question for four different digital technologies specific to their sector (see the note to Figure 5 for the definition of digital technologies).

Question: You just said that you implemented digital technologies in your business or organised your entire business around them. Did you introduce any of these technologies in the past year?

Platforms and advanced robotics remain the most widespread digital technologies. The implementation of most advanced digital technologies has not changed significantly since the beginning of the pandemic. An exception is the implementation of the internet of things, which decreased slightly across all sectors, while the adoption of drones (used by firms in the construction sector) increased (Figure 5).

Figure 5
Adoption of specific digital technologies (in %)



Source: EIBIS 2019, 2020, 2021, firms in the EU27.

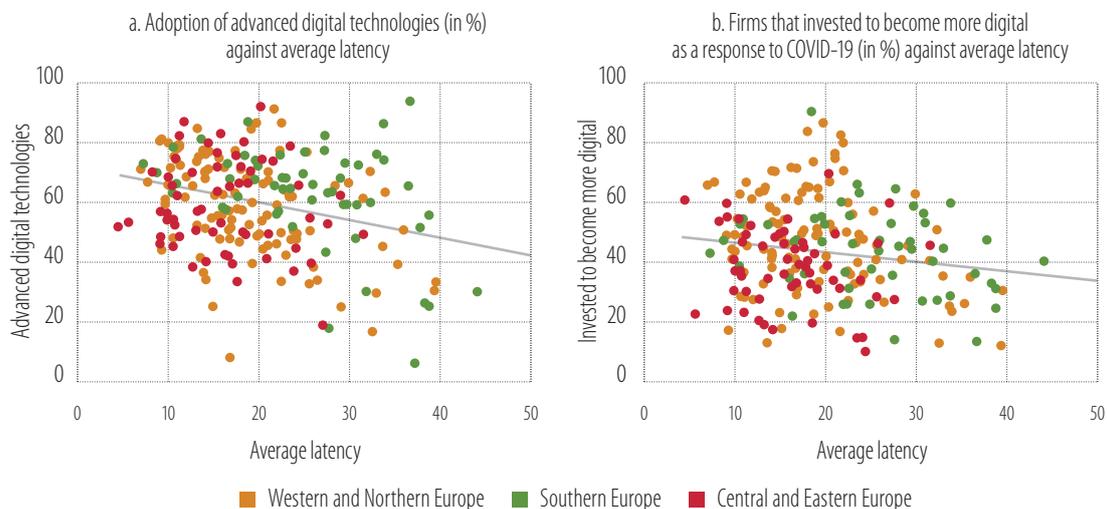
Note: "3-D printing" is also known as additive manufacturing (manufacturing, construction, infrastructure). "Robotics" is automation via advanced robotics (manufacturing). "Internet of things" refers to electronic devices that communicate with each other without human assistance (all sectors). "Big data/artificial intelligence" refers to cognitive technologies, such as big data analytics and artificial intelligence (manufacturing, services, infrastructure). "Drones" are unmanned aerial vehicles (construction). "Virtual reality" refers to augmented or virtual reality, such as presenting information integrated with real-world objects using a head-mounted display (construction, services). "Platforms" refers to a platform that connects customers with businesses or customers with other customers (services and infrastructure).

Question: Can you tell me for each of the following digital technologies if you have heard about them, not heard about them, implemented them in parts of your business, or whether your entire business is organised around them?

The role of the operating environment

Digital infrastructure played a critical role during the coronavirus pandemic. Among EU firms, 16% consider access to digital infrastructure to be a major obstacle to investment, according to the latest EIBIS results. However, the assessment varies significantly across EU regions. For example, firms operating in regions with low average latency (a proxy for a good internet connection) tend to have higher rates of digital adoption (Figure 6a), and they are more likely to have invested in digitalisation as a response to COVID-19 (Figure 6b). The responses indicate that many EU regions have the potential to unlock investment in the digital transformation of businesses by making access to faster broadband more widespread. The operating environment has an impact on firms' decisions to become more digital.

Figure 6
Quality of digital infrastructure and digital adoption, by NUTS2 regions



Source: EIBIS 2021, firms in the EU27 and European Data Journalism Network (2021).

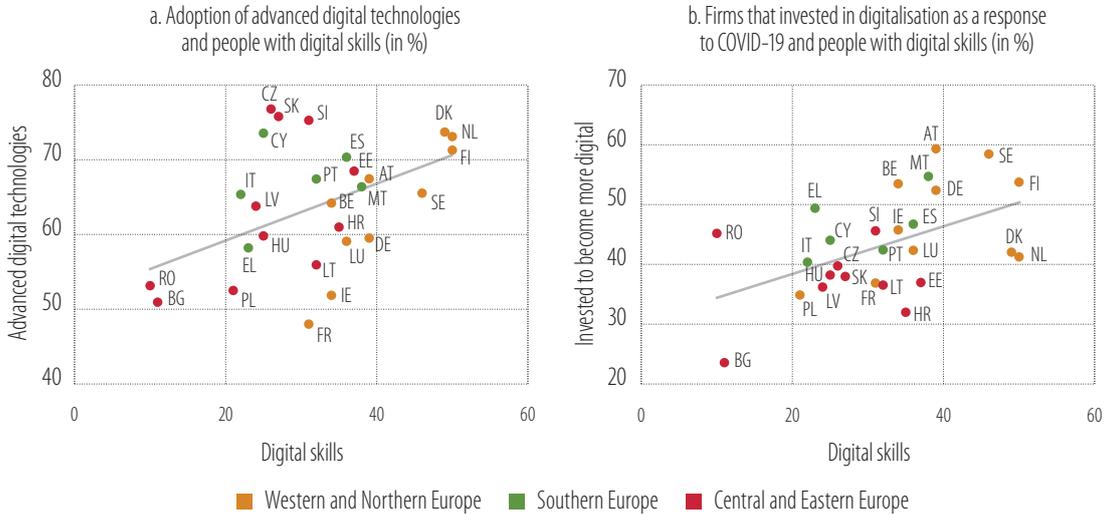
Note: Latency is the time it takes for data to be transferred between its original source and its destination, measured in milliseconds. Red dots: NUTS2 regions in Central and Eastern Europe, green dots: NUTS2 regions in Southern Europe, orange dots: NUTS2 regions in Western and Northern Europe. See note to Figure 4 for the definition of the adoption of advanced digital technologies. NUTS refers to the Nomenclature of Territorial Units for Statistics.

Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)?

The availability of people with digital skills supports the digital transformation. Firms operating in countries where a higher share of the population has above-average digital skills tend to have implemented advanced digital technologies more often (Figure 7a). They are also more likely to report having taken action on increasing their digitalisation or made investments (Figure 7b). Reaping the benefits of digitalisation will require improvements in education and training systems as well as online learning for groups that are currently excluded from the digital economy (see Chapter 4).

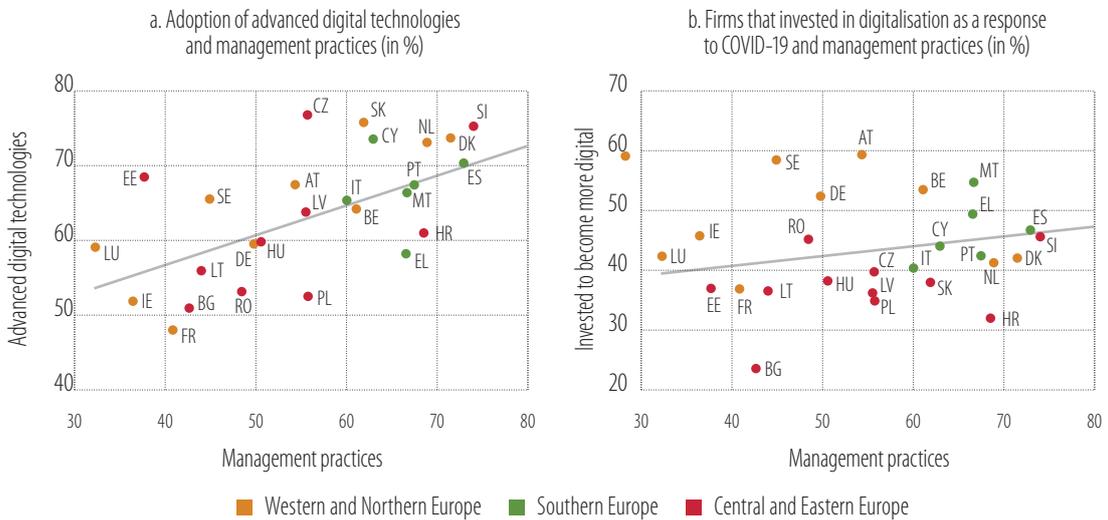
Firms that have invested in the digital transformation also tend to implement better management practices. Firms based in countries with a high share of firms saying that they use strategic business monitoring systems and key performance indicators (a proxy for management quality) are more likely to have implemented advanced digital technologies (Figure 8a). Management practices are also linked to the uptake of digitalisation during the pandemic, even though the positive correlation is less pronounced (Figure 8b). Furthermore, firms that have adopted advanced digital technologies tend to reward individual performance with higher pay, and they are more likely to have appointed a designated person responsible for defining and monitoring climate change strategies. These firms more frequently report that they have set and are monitoring targets on carbon emissions and energy consumption. These findings are in line with results from previous studies highlighting the importance of management practices for technology adoption and firm performance (Bloom et al., 2019; EIB, 2020).

Figure 7
Digital adoption and share of population with high digital skills



Source: EIBIS 2021, firms in the EU27 and Eurostat.
 Note: See note to Figure 4 for the definition of the adoption of advanced digital technologies.
 Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)?

Figure 8
Digital adoption and management practices

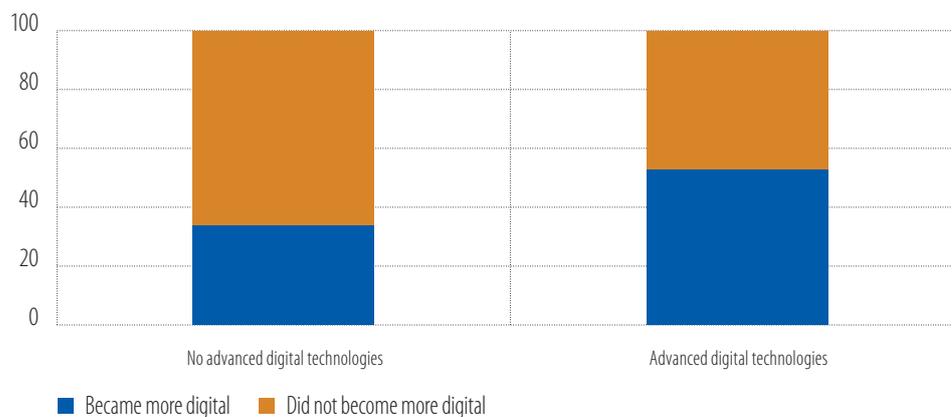


Source: EIBIS 2021, firms in the EU27.
 Note: See note to Figure 4 for the definition of the adoption of advanced digital technologies.
 Questions: In 2020, did you company use a strategical business monitoring system? As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)?

The digital divide revisited

Firms that already implemented advanced digital technologies are more likely to report that they invested in increasing digitalisation activities in response to COVID-19. The finding suggests that the coronavirus pandemic has not been the driving factor pushing firms to catch up, but instead has further deepened the digital divide. Leading firms pushed ahead while lagging firms fell even further behind (Rückert et al., 2021). Nevertheless, 34% of firms have used the crisis as an opportunity to begin to invest in their digital transformation, compared with 53% of firms that had already adopted advanced digital technologies and invested in becoming more digital (Figure 9). At country level, the share of firms that made digital investments during the COVID-19 crisis is positively associated with the implementation of advanced digital technologies in the same country.

Figure 9
Firms that invested in digitalisation as a response to COVID-19 (in %)



Source: EIBIS 2021, firms in the EU27.

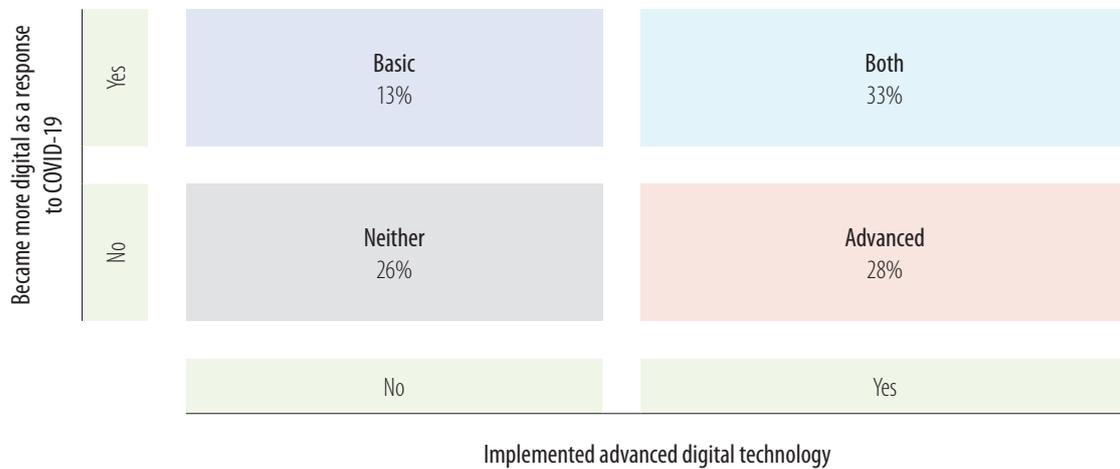
Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)? See note to Figure 4 for the definition of the adoption of advanced digital technologies.

Firms are grouped into four different profiles to identify where they fall in the digital divide. The four categories are based on the combination of firms' current implementation of advanced digital technologies, and the action they took to become more digital as a response to COVID-19: neither, basic, advanced and both. Figure 10 positions firms on the digital divide grid according to these categories and displays the share of EU firms in each category.

A substantial share of EU firms did not invest in digitalisation, despite the impact the pandemic had on the economy. Of EU firms, 26% have not invested in digital transformation: they are in the "neither" category, at the bottom of the corporate digital divide. The large share of firms not investing in digitalisation is worrying and could have serious repercussions on firms' competitiveness during the economic recovery. Firms that fall in the "neither" category may need stronger or specific policy support to prevent them from falling behind.

On the upside, a non-negligible share of firms has used the COVID-19 pandemic to embark on their digitalisation journey. These companies have not implemented any advanced digital technology in their business yet but have taken action to become more digital as a response to COVID-19 — for example, by providing services online — and are categorised as "basic" digital.

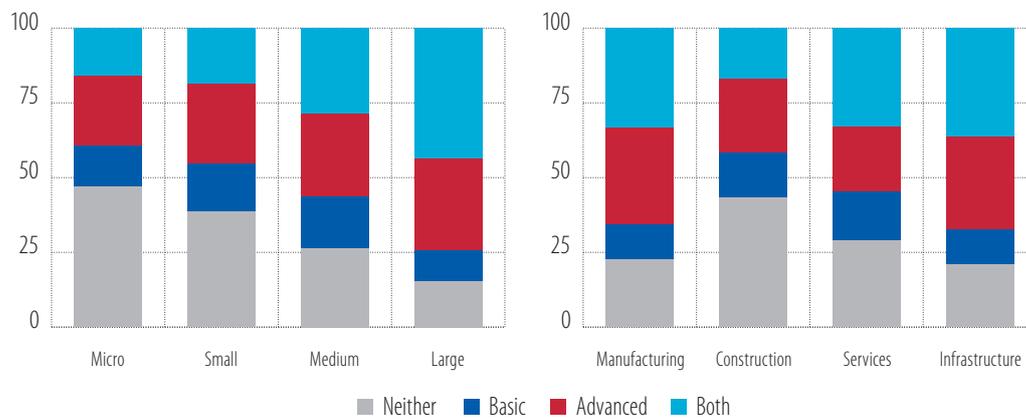
Figure 10
Corporate digital divide profiles



At the other end of the spectrum, 61% of firms have already adopted advanced digital technologies. Among firms that have implemented advanced digital technologies in their business, some firms have not invested in increasing digitalisation activities during the pandemic. These firms are categorised as “advanced.” Finally, firms that use digital technologies and that have also invested further in digitalisation as a response to the pandemic are categorised as “both” because they have fully embraced the digital transformation. To understand which companies are falling behind and which are leading, the remainder of this section will examine firms on each side of the divide, and explore the impact of the COVID-19 crisis on their business.

Firm size plays a key role in the corporate digital divide. Larger firms are much more likely to be on the right (or digital) side of the corporate digital divide. They are more likely to be in the “both” category and less likely to be “neither” (Figure 11a). By contrast, smaller firms tend to be stuck on the wrong (or non-digital) side of the digital divide grid. This lack of investment in digital technologies by small EU firms is an area of concern because small firms are more prevalent in the European Union than in the United States. Furthermore, small firms are on average more digital in the United States (EIB, 2021a). This disparity is likely to be a major disadvantage for accelerating the digital transformation in Europe (Revoltella, Rückert and Weiss, 2020). Some differences exist in the corporate digital divide profiles across sectors. For example, the construction sector has a lower share of firms that invest in digital transformation (Figure 11b). Nevertheless, the effect of size on digitalisation activities is particularly strong. Box A highlights the differences between the European Union and the United States in firm digitalisation profiles.

Figure 11
Corporate digital divide profiles (in %), by size and sector



Source: EIBIS 2021, firms in the EU27.

Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)? See Figure 10 for the definition of corporate digital divide profiles.

Box A

Digitalisation in the European Union and the United States⁴

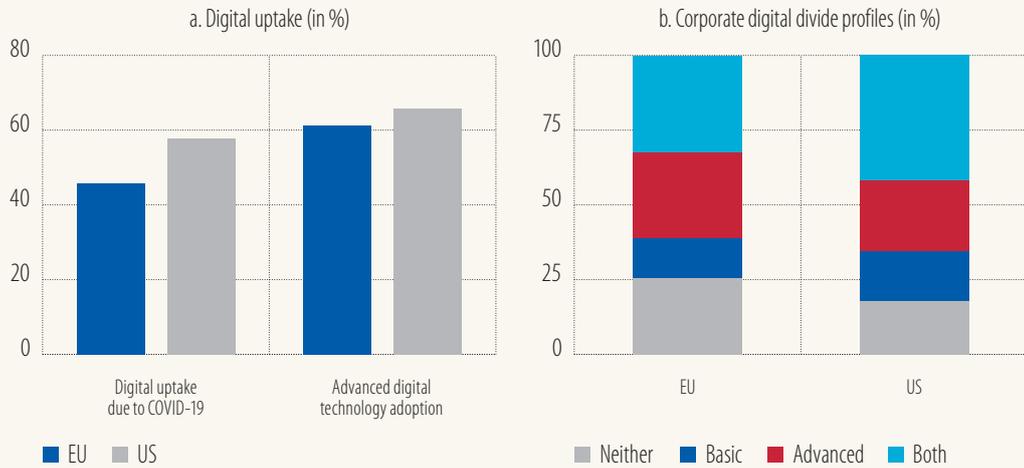
The European Union lags behind the United States in digitalisation. 46% of EU firms report having taken action to become more digital during the COVID-19 crisis, compared with 58% of US firms (Figure A1.a). Furthermore, the share of firms adopting advanced digital technologies is higher in the United States (66%) than in the European Union (61%). 42% of US firms fall into the “both” group, compared with 33% in the European Union. Only 18% of US firms have neither implemented advanced digital technologies nor invested in digitalisation as a response to the pandemic, compared with 26% of firms in the European Union (Figure A1.b). This higher share of EU firms that have not invested in the digital transformation compared to the United States is worrisome as it could have long-term negative consequences for the economy.

If policymakers want to close the gap in adoption rates between EU and US firms, they need to help European firms grow to a sufficient size. It is clear that large firms tend to be more digital in the European Union and in the United States. The larger EU share of “neither” compared to the United States is observed in particular for micro and small firms, suggesting that the overall difference in the digital divide between the European Union and the United States is driven by the greater preponderance of small businesses in the European economy (Figure A2).

A lack of available finance and digital infrastructure are more often reported as major obstacles to investment by small non-digital firms. 24% of small EU non-digital firms (the “neither” category in the corporate digital divide profiles) mention a lack of available finance as major obstacle, compared with 10% in the United States (Figure A3). Similarly, 15% of EU small firms report that securing access to infrastructure is an obstacle compared with 3% for US small firms. In addition, being unable to find workers with the right skills is also more often mentioned as an obstacle for small EU companies than for large EU firms, unlike in the United States.

⁴ Data for US firms in EIBIS wave 6 were not available when this chapter was prepared. The comparison with EU firms was added in this box.

Figure A.1
Digitalisation activities in the European Union and the United States



Source: EIBIS 2021.

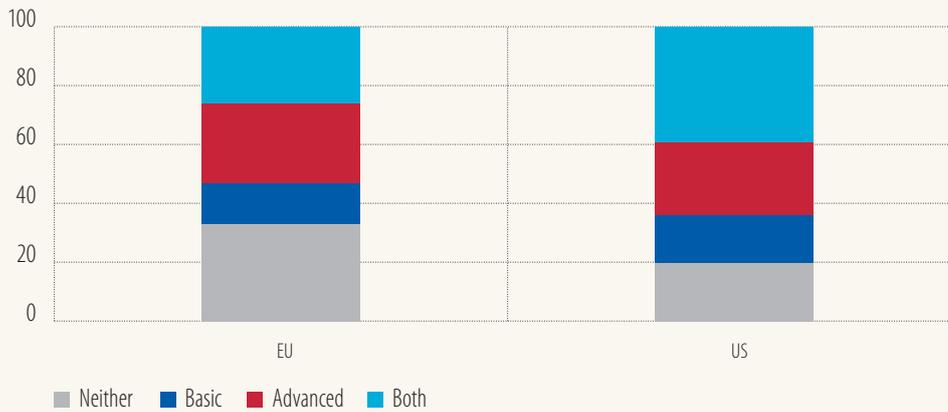
Note: See Figure 4 for the definition of digital adoption.

Question: As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)?

Source: EIBIS 2021.

Note: See Figure 10 for the definition of corporate digital divide profiles.

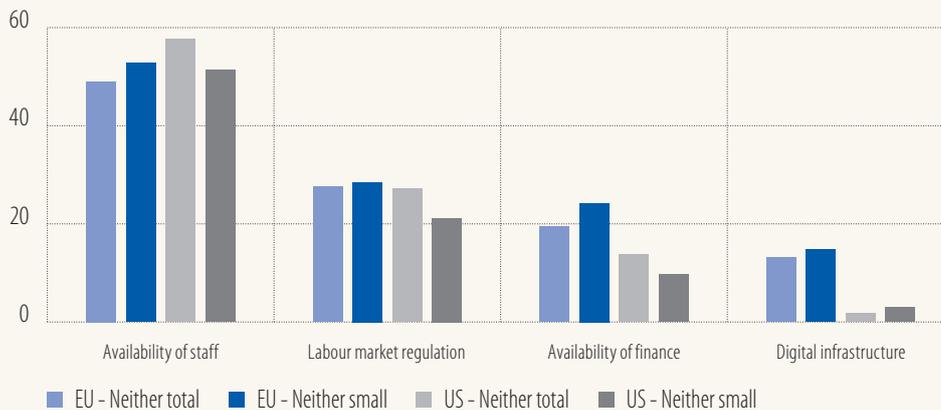
Figure A.2
Employment (in %), by corporate digital divide profile



Source: EIBIS 2021, Eurostat and OECD Structural Business Statistics, and US Census Bureau.

Note: See Figure 10 for the definition of corporate digital divide profiles.

Figure A.3
Major obstacles to investment (in %) for firms in the bottom category (“neither”) of the corporate digital divide profiles, by firm size



Source: EIBIS 2021.

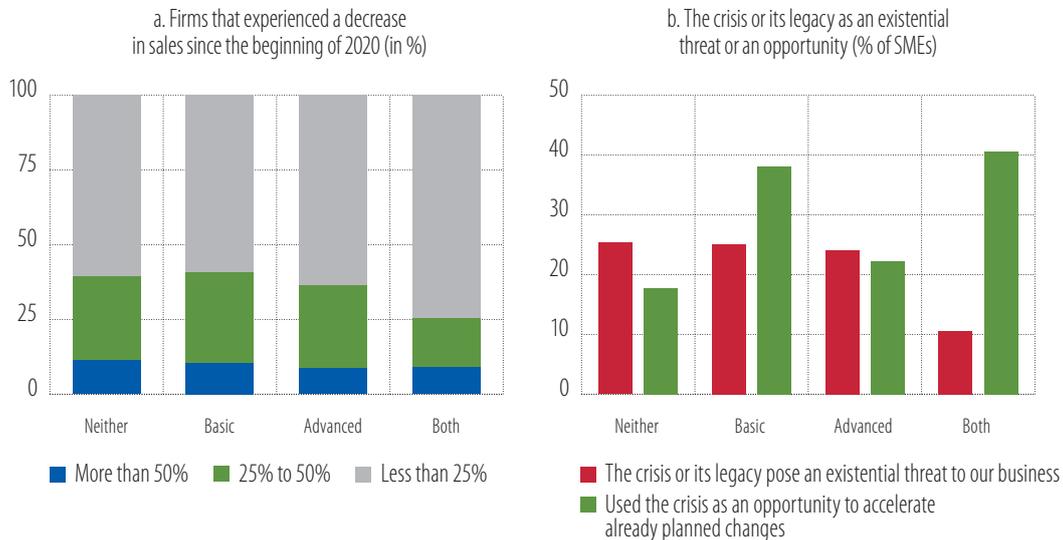
Note: See Figure 10 for the definition of corporate digital divide profiles. Small: 5-50 employees.

Question: Thinking about your investment activities, to what extent is each of the following a major obstacle?

Firms that have embraced digital technologies were better able to cope with the disruptions created by the pandemic. Firms adapted by enabling remote working arrangements, implementing smart factories, using 3-D printing to produce in house product components or parts affected by supply chain disruptions, and taking advantage of big data analytics and artificial intelligence to reschedule and plan activities to adapt to the COVID-19 crisis. The more digitally advanced firms were less likely than non-digital firms to have experienced a strong decrease in sales since the beginning of 2020 (Figure 12a). They were also the least likely to consider that the crisis or its legacy posed an existential threat to their business (Figure 12b). Furthermore, the crisis forced firms to find more efficient ways of working with digital technologies. Smaller businesses that improved their digitalisation as a response to the pandemic report more often that they used the crisis to accelerate changes they had already planned to make (38% of “basic” and 41% of “both”, compared with 18% of “neither” and 22% of “advanced”).

Larger firms are more likely to have invested in becoming more digital during the COVID-19 crisis. Comparing the probability of firms falling into the “neither” vs. “basic” categories can provide insight into which firms decided to start investing in digitalisation as a response to COVID-19. The estimates in Table 1 confirm once again that firm size matters. In particular, firms with more than 50 employees are much more likely to start investing in the digital transformation. Similarly, the probability of falling into the “both” category vs. remaining “advanced” highlights the firms that are likely to forge ahead during the pandemic among those that have already implemented digital technologies. Again, small firms belong to the problematic category. Even when they are already digitally active, they are significantly less likely to have increased their digital investments.

Figure 12
Impact of the COVID-19 crisis on the business



Source: EIBIS 2021, firms in the EU27.

Note: See Figure 10 for the definition of corporate digital divide profiles.

Base: All firms that responded that sales decreased since the beginning of 2020.

Question: By how much has your sales or turnover decreased since the beginning of 2020?

Source: EIBIS 2021 AOM — sample of EU SMEs in manufacturing and services (2021).

Note: See Figure 10 for the definition of corporate digital divide profiles.

Question: The current coronavirus pandemic has led to a large number of changes. Which of the following statements best reflect the position of your own company?

Fluctuations in sales during the crisis are also linked to whether a firm decided to start investing in digitalisation. Among firms that had not adopted advanced digital technologies (“neither” and “basic”), those that experienced an increase or decrease in sales from 2019 to 2020 were more likely to have subsequently invested in increased digitalisation than firms that reported no change in sales. Firms that were negatively affected by the COVID-19 crisis and experienced a drop in sales were more likely to have then invested than those not reporting a change, but to a lesser extent than firms that saw a positive impact. However, the impact of COVID-19 on sales was not associated with the continued digitalisation efforts of firms that had already implemented advanced digital technologies.

The digital divide between firms in the European Union may continue to grow over time. Looking ahead to the next three years, the top investment priorities for more digital advanced firms are expanding capacity and developing new products, processes or services. For non-digital firms, on the other hand, replacing capacity (including existing buildings, machinery, equipment and IT) is more often mentioned as the investment priority (Figure 13a). About 20% of non-digital firms report that they do not have any investment plans. Furthermore, firms that have adopted advanced digital technologies are more optimistic about business prospects specific to their industry and the overall economic climate over the next 12 months (Figure 13b). At the same time, they are less likely to expect the political and regulatory climate to deteriorate. This suggests that less digital firms consider that they are in a more difficult investment situation in the short term, which leaves them with a less positive long-term outlook. Ultimately, there is a risk that the digital divide will be exacerbated by the pandemic (Rückert et al., 2021).

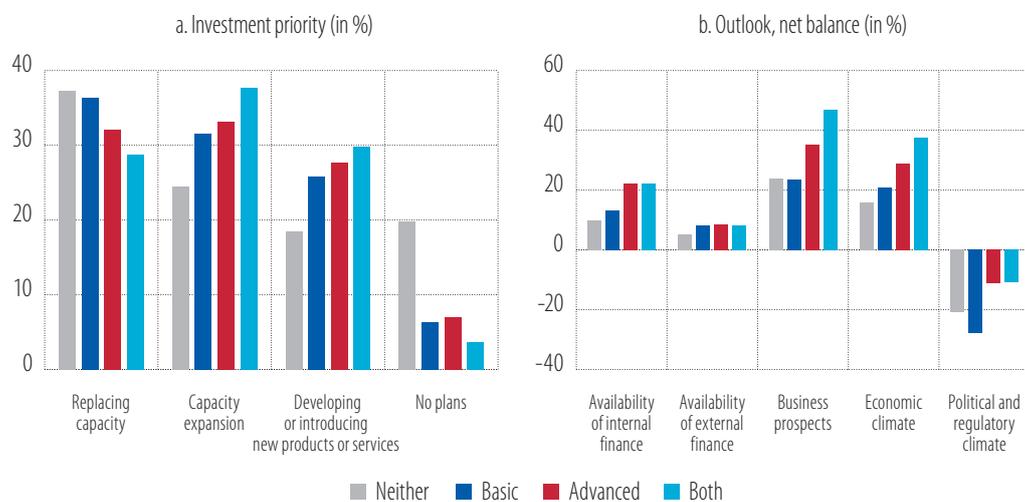
Table 1
Probability of investing in digitalisation as a response to COVID-19

	Basic vs. neither	Both vs. advanced
Omitted category: micro		
Small	0.069*** (0.025)	0.020 (0.032)
Medium	0.173*** (0.031)	0.128*** (0.032)
Large	0.179*** (0.044)	0.219*** (0.034)
Omitted category: COVID-19 had no impact on sales		
Increased sales or turnover	0.108** (0.044)	0.003 (0.041)
Decreased sales or turnover	0.080** (0.034)	0.044 (0.034)
Observations	5 560	6 135

Source: EIBIS 2021, firms in the EU27.

Note: Marginal effects in a probit model. The coefficients can be interpreted as marginal effects on the probability of being "basic" or "both". *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The regression also controls for country groups and sector.

Figure 13
Investment priority over the next three years and short-term outlook



Source: EIBIS 2021, firms in the EU27.

Note: See Figure 10 for the definition of corporate digital divide profiles.

Question: Looking ahead to the next three years, which of the following is your investment priority?

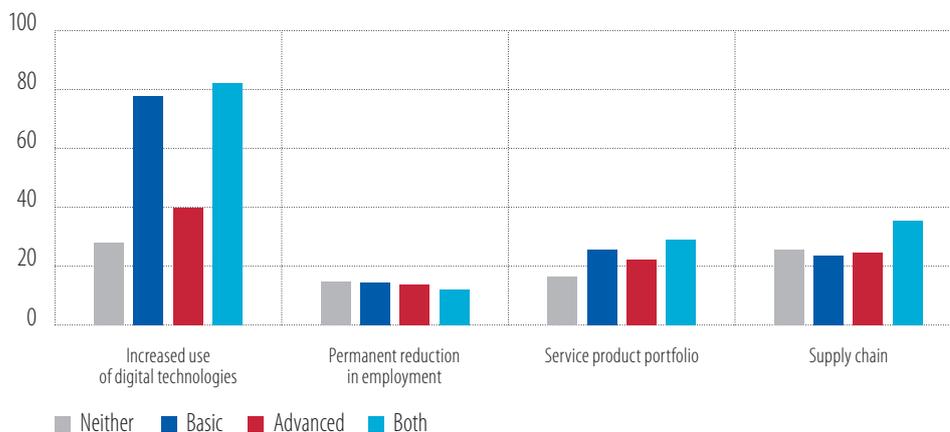
Source: EIBIS 2021, firms in the EU27.

Note: See Figure 10 for the definition of corporate digital divide profiles.

Question: Do you think that each of the following will improve, stay the same or get worse over the next 12 months?

Firms that invested in becoming more digital during the pandemic believe that the business environment created by the pandemic will require enhanced digitalisation. In particular, the firms with “basic” and “both” digital divide profiles are much more likely to expect COVID-19 to increase the use of digital technologies in the long term (Figure 14). In addition, firms with the most advanced level of digitalisation are more likely to expect COVID-19 to affect their service and product portfolio as well as the supply chain. By contrast, the long-term expected impact of COVID-19 on employment is not associated with firms’ digitalisation status.⁵

Figure 14
Expected long-term impact of COVID-19 (in %)



Source: EIBIS 2021, firms in the EU27.

Note: See Figure 10 for the definition of corporate digital divide profiles.

Question: Do you expect the coronavirus outbreak to have a long-term impact on any of the following?

Digital transformation and firm performance

Digitalisation, productivity and competitiveness

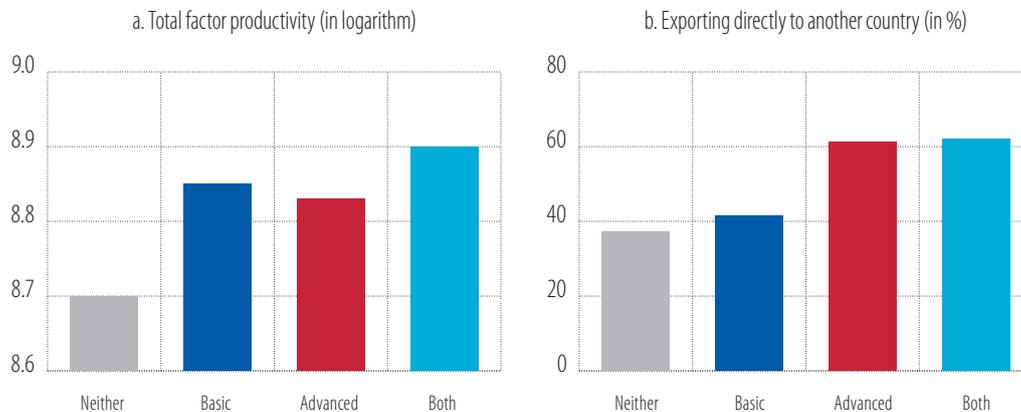
Digital firms tend to be more productive. Non-digital firms that started investing in their digital transformation during the pandemic and do not use advanced digital technologies have lower total factor productivity (Figure 15a).⁶ These results support previous empirical evidence on the positive effect of digital adoption — including the use of platform technologies in the services sector — on productivity (Falk and Hagsten, 2015; Bailin Rivares et al., 2019; Gal et al., 2019). The pandemic has led to major changes in the nature and organisation of work, with implications for productivity, employment, wages and investment (Revoltella, Maurin and Pál, 2020).

Firms that have adopted advanced digital technologies are more likely to export goods and services to another country (Figure 15b). This is in line with studies stressing that exporters tend to be more productive (Melitz and Redding, 2021). Investing in digital technologies therefore appears to be especially relevant to firms wanting to compete in international markets (DeStefano and Timmis, 2021). Exporting products or services also improved firms’ resilience during the COVID-19 crisis and recovery, as export-led sectors tend to bounce back faster than non-export-led ones (McKinsey, 2020).

⁵ See Chapter 4 of this report for an in-depth discussion of the impact of the COVID-19 crisis on labour markets in Europe.

⁶ Total factor productivity (TFP) is the portion of output not explained by the amount of inputs used in production. It reflects the overall efficiency with which labour and capital inputs are used together in the production process.

Figure 15
Total factor productivity and export performance



Source: EIBIS 2021, firms in the EU27.
Note: The figure shows the median total factor productivity. See Figure 10 for the definition of corporate digital divide profiles.

Source: EIBIS 2021, firms in the EU27.
Note: See Figure 10 for the definition of corporate digital divide profiles.
Question: In the previous financial year, has your company directly exported goods and services to another country?

Firms that have implemented advanced digital technologies tend to charge higher mark-ups. While digital technologies can lead to more competition (Crémer et al., 2019), firms that adopt advanced digital technologies are often in a relatively privileged market situation, with above-average mark-ups (Figure 16 and Table 2). This supports previous empirical evidence showing that digital technologies often come with (i) network effects; (ii) economies of scope in data collection and analysis; and thanks to this information, (iii) a high and increasing level of price and product differentiation leading to a concentration of market power (Brynjolfsson and McAfee, 2011; Calligaris, Criscuolo and Marcolin, 2018).

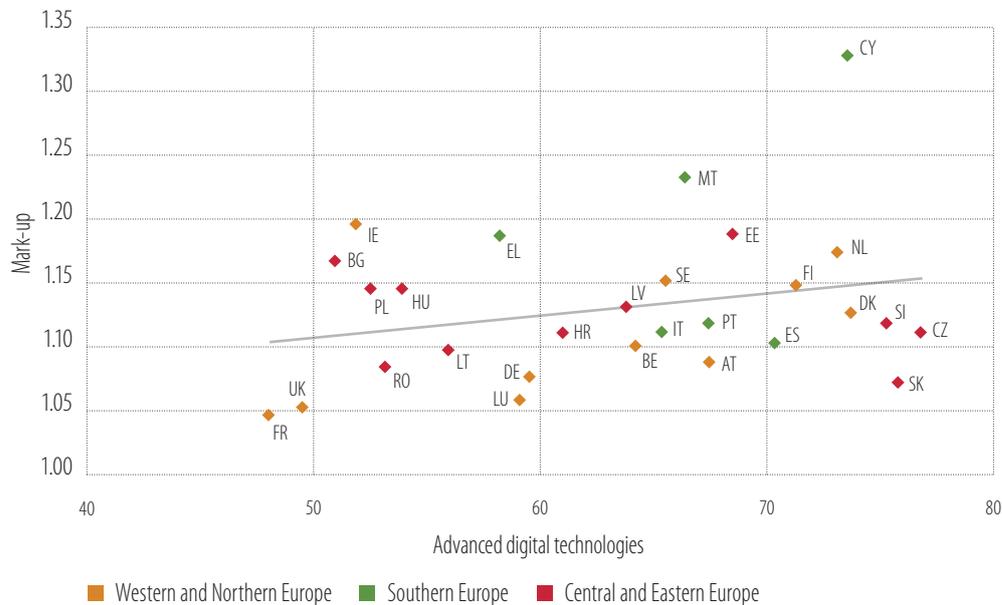
Table 2
Mark-ups and corporate digital profiles

Dependent variable	Mark-up (in log)
Digital profiles (omitted category: neither)	
Basic	0.013 (0.030)
Advanced	0.049* (0.027)
Both	0.047* (0.027)
Controlling for firm size, sector, country	
Sample size	9 220

*Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Source: EIBIS 2021, firms in the EU27.
Note: See Figure 10 for the definition of corporate digital divide profiles. Mark-up calculations are based on the approach of De Loecker et al. (2020).

Figure 16
Average mark-ups and adoption of advanced digital technologies



Source: EIBIS 2021, firms in the EU27.

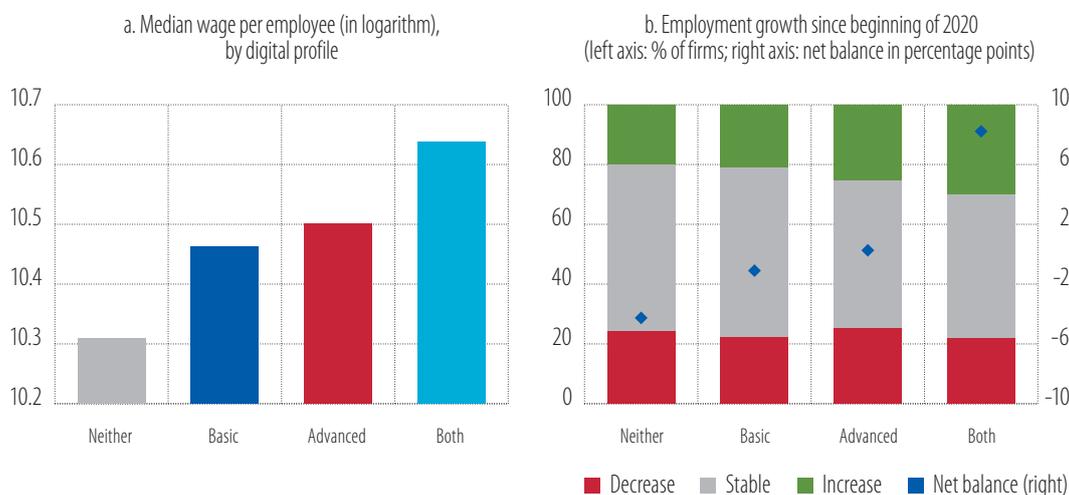
Note: See Figure 10 for the definition of corporate digital divide profiles. Mark-up calculations are based on the approach of De Loecker et al. (2020).

Digitalisation and the demand for skills

Digital firms pay higher wages on average. Many economists argue that digital technologies — such as artificial intelligence, machine learning and industrial robots — have an impact on employment, wages, the demand for skills and job polarisation because of automation and skill biased technological change (Acemoglu and Autor, 2011; Autor, 2015; EIB, 2018; Frank et al., 2019; Acemoglu and Restrepo, 2020). The higher demand for skilled workers is reflected in the higher average wages paid by digital firms (Figure 17a). The digital transformation often goes hand in hand with the automation of routine jobs. 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 digital firms often appear to be relatively well paid.

The most advanced digital firms were able to increase staff numbers compared to before the pandemic. On average, firms that adopted advanced digital technologies and invested in becoming more digital during the coronavirus pandemic have increased the number of workers they employ since the beginning of 2020 (Figure 17b). The share of non-digital firms that downsized after the COVID-19 outbreak was also higher than the share of non-digital firms with positive employment growth. The net balance of employment was negative for non-digital firms.

Figure 17
Wages and employment change



Source: EIBIS 2021, firms in the EU27.

Note: The figure shows the median wage per employee (in log). Wage per employee is defined as the wage bill divided by the number of employees. See Figure 10 for the definition of corporate digital divide profiles.

Question: How much did the company spend on wages in the previous financial year?

Source: EIBIS 2021, firms in the EU27.

Note: See Figure 10 for the definition of corporate digital divide profiles.

Question: How many people does your company employ either full or part-time at all its locations, including yourself? How many people did your company employ either full or part-time at all its locations, at the beginning of 2020?

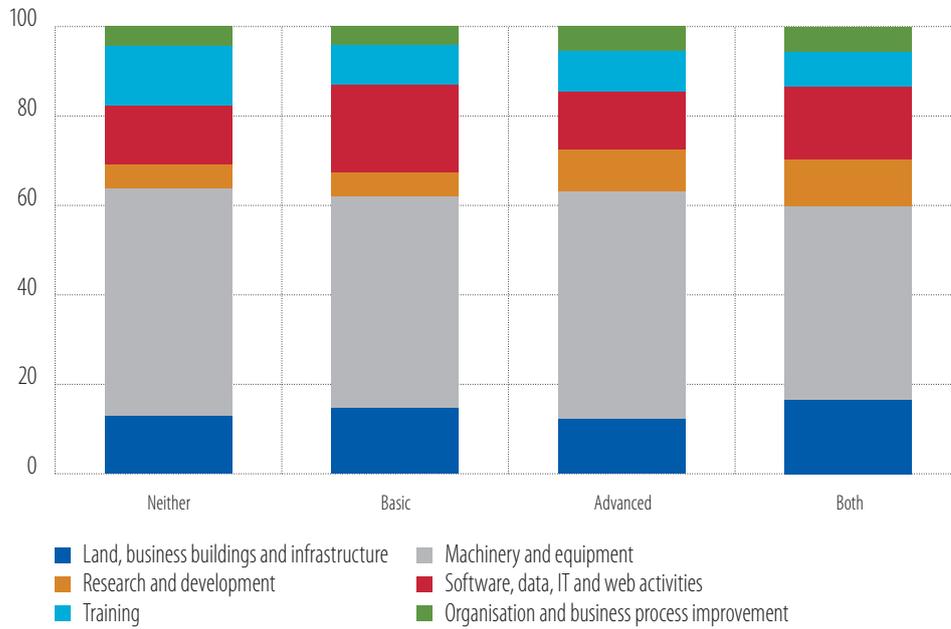
Digitalisation and innovation

Digital firms tend to invest more, especially in R&D. More advanced digital firms have higher investment intensity (defined as investment spending over turnover). This higher investment intensity can be explained by the higher productivity of digital firms and the stronger demand for their goods and services. Firms that have adopted advanced digital technologies tend to allocate a larger share of their investment activities to R&D (Figure 18). Firms that invested in digitalisation during the pandemic report having spent a large share of their investment on software, data, IT infrastructure and website activities in 2020.

Digital firms tend to invest more in innovation. The share of active innovators — either incremental or leading (such as firms that invest in R&D and introduce products, processes and services new to the company or to their market) — is higher among digital firms (Figure 19). At the same time, non-digital firms are less likely to invest in innovation, meaning they do not conduct any R&D and do not develop new products, processes or services. However, the correlation between investment in digitalisation and the wide range of firm performance metrics considered in this chapter – such as productivity, employment growth, average wage per employee or innovation activities – does not necessarily imply causation.

Higher innovativeness is associated with the use of big data analytics, artificial intelligence and 3-D printing. To make the most of these technologies, firms have to collect and analyse large amounts of information. Big data analytics or artificial intelligence can enable the innovation process (Haskel and Westlake, 2017; Cockburn et al., 2018). 3-D printers also improve the innovation process.

Figure 18
Composition of investment (in %)

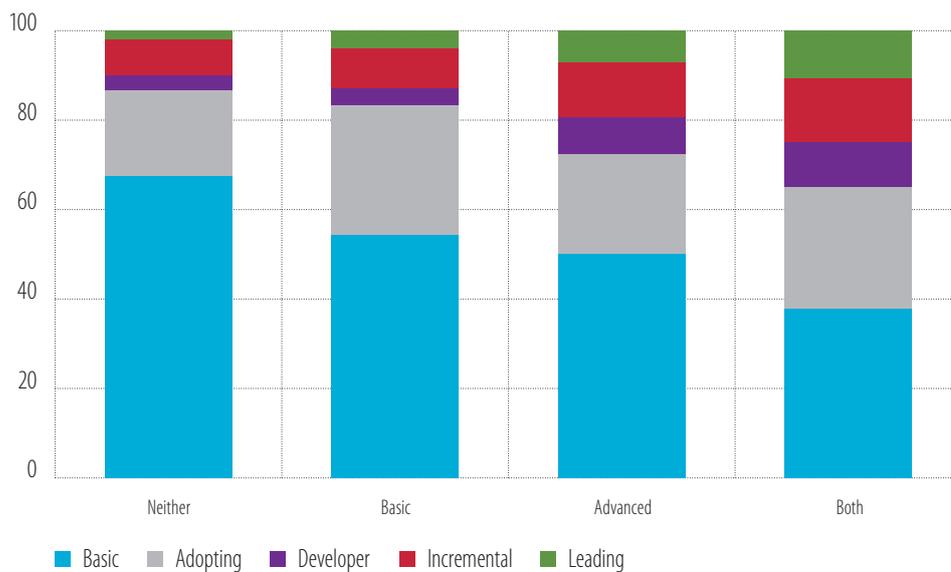


Source: EIBIS 2021, firms in the EU27.

Note: See explanation above Figure 10 for the definition of corporate digital divide profiles.

Question: In the previous financial year, how much did your business invest in each of the following with the intention of maintaining or increasing your company's future earnings?

Figure 19
Innovation profiles (in %)



Source: EIBIS 2021, firms in the EU27.

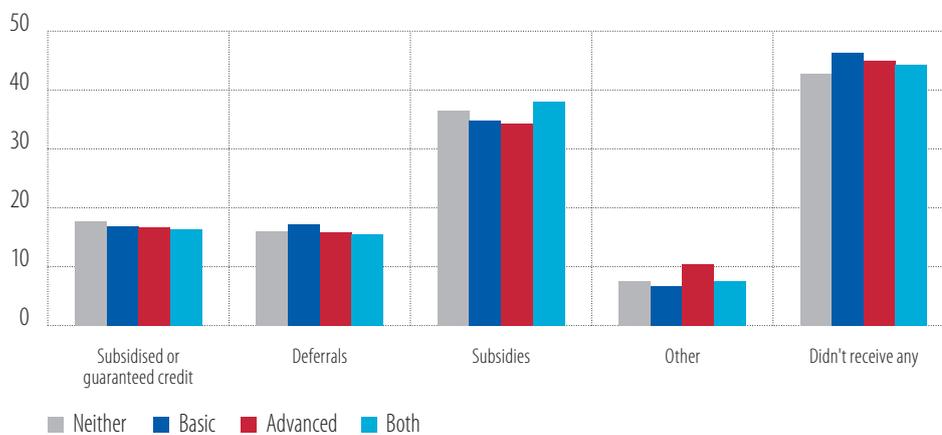
Note: See Veugelers et al. (2019) for the definition of innovation profiles and Figure 10 for the definition of corporate digital divide profiles.

Policy support and barriers

Policy support during the COVID-19 crisis

Government support for firms was widespread during the crisis. As the support was general and not targeted at specific sectors, there is no significant difference in the share of firms receiving support in each digital divide profile. The support also took many forms, such as access to subsidised or guaranteed credit, deferral of payments (tax, rent or mortgage, or interest payments) or subsidies to help with wage costs or government grants (Figure 20). Nevertheless, the COVID-19-related support enabled firms to preserve their investment plans, including in digital, regardless of fluctuations in sales (see Chapter 3).

Figure 20
Firms that received financial support (in %)



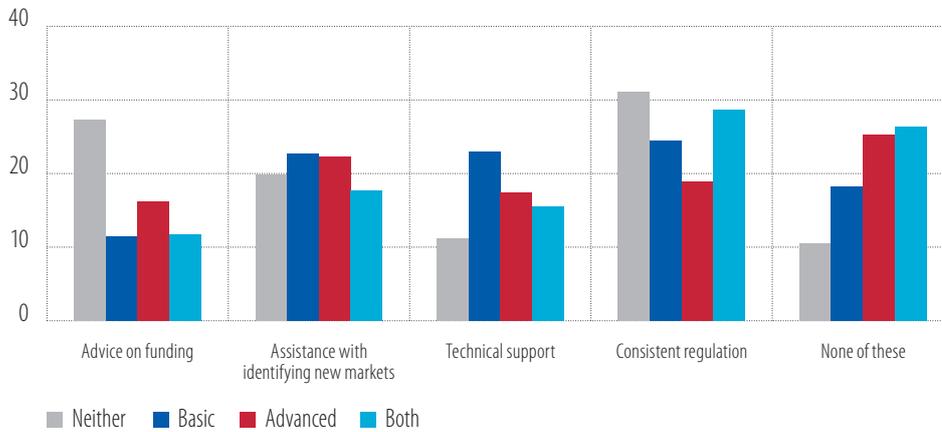
Source: EIBIS 2021, firms in the EU27.

Note: See Figure 10 for the definition of corporate digital divide profiles.

Question: Since the start of the pandemic, have you received any financial support in response to COVID-19? This can include finance from a bank or other finance provider, or government-backed finance.

Non-digital firms say that advice on funding and consistent regulation would be the best way to support their digital investments (Figure 21). The types of support that firms would like to receive differ among the corporate digital profiles. The add-on module (AOM) to EIBIS 2021 asked SMEs in the services and manufacturing sectors which type of support would incentivise them to invest in digital technologies. Firms clearly signalled that consistent regulation would be welcome, and firms that started digitalisation activities in response to the COVID-19 crisis said they would like technical support and help in identifying new markets. This suggests that policy support focusing on facilitating access to finance for SMEs will not necessarily accelerate the digital transformation in the European Union. Technical support, market expertise and predictable regulation are also required.

Figure 21
Policy support SMEs considered most useful (in %)



Source: EIBIS 2021 AOM — sample of EU SMEs in manufacturing and services (2021).

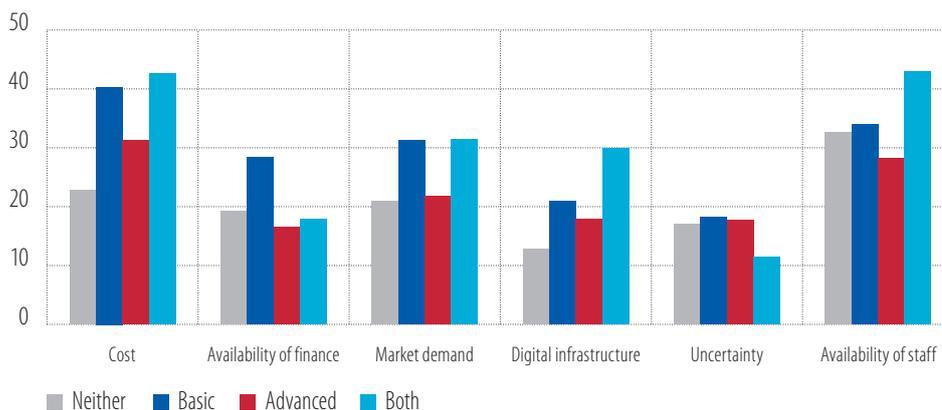
Note: See Figure 10 for the definition of corporate digital divide profiles.

Question: When thinking about investments in digital technologies, which of the following would you find most helpful?

Barriers to the digital transformation

Finding staff with the right skills and the cost of investments are the most significant obstacles to the digital transformation. More than one in three EU firms consider an absence of workers with the right skills to be a major barrier. Access to digital infrastructure is less frequently cited, on average, but there are significant differences across digital divide profiles. Firms that took steps to become more digital as a response to the pandemic are more likely to report that a lack of access to digital infrastructure constrains their investment in digital technologies (Figure 22).

Figure 22
Major obstacles SMEs face when investing in digital technologies (in %)



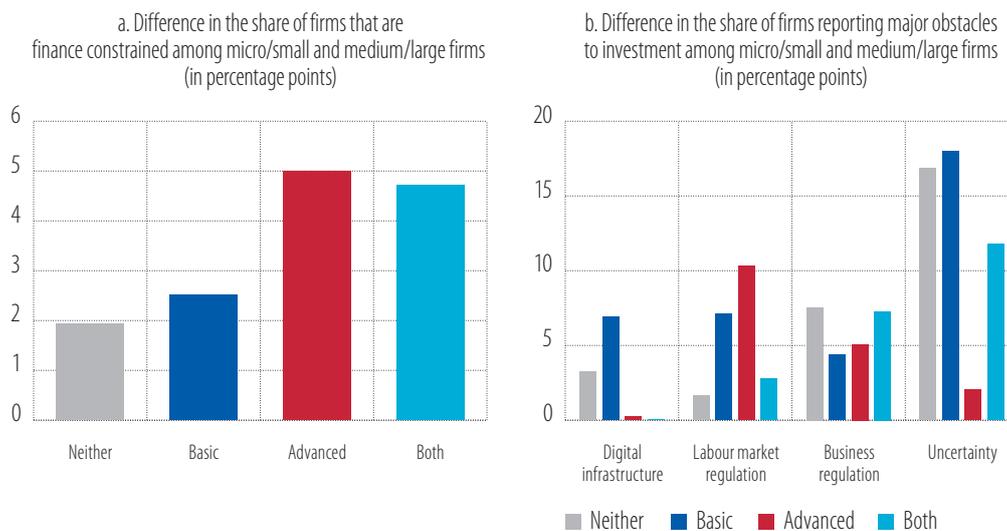
Source: EIBIS 2021 AOM — sample of EU SMEs in manufacturing and services (2021).

Note: See Figure 10 for the definition of corporate digital divide profiles.

Question: Thinking about your investment activities in digital technologies, to what extent is each of the following a major obstacle?

Difficulty attracting finance and regulatory obstacles can also create barriers to digital investment, especially for small firms. While financial conditions throughout Europe are relatively relaxed and difficulties in accessing finance are not the top obstacle to investment, small firms that implemented advanced digital technologies are more likely to say they are financially constrained (Figure 23a). Furthermore, among firms that have started investing in digitalisation, small firms perceive access to digital infrastructure to be a more severe obstacle than large firms (Figure 23b).

Figure 23
Differences between small and large firms for financial constraints and major barriers to investment



Source: EIBIS 2021, firms in the EU27.

Note: See Figure 10 for the definition of corporate digital divide profiles. Micro and small: 5 to 50 employees, medium-sized and large: 50+ employees.

Digital innovation

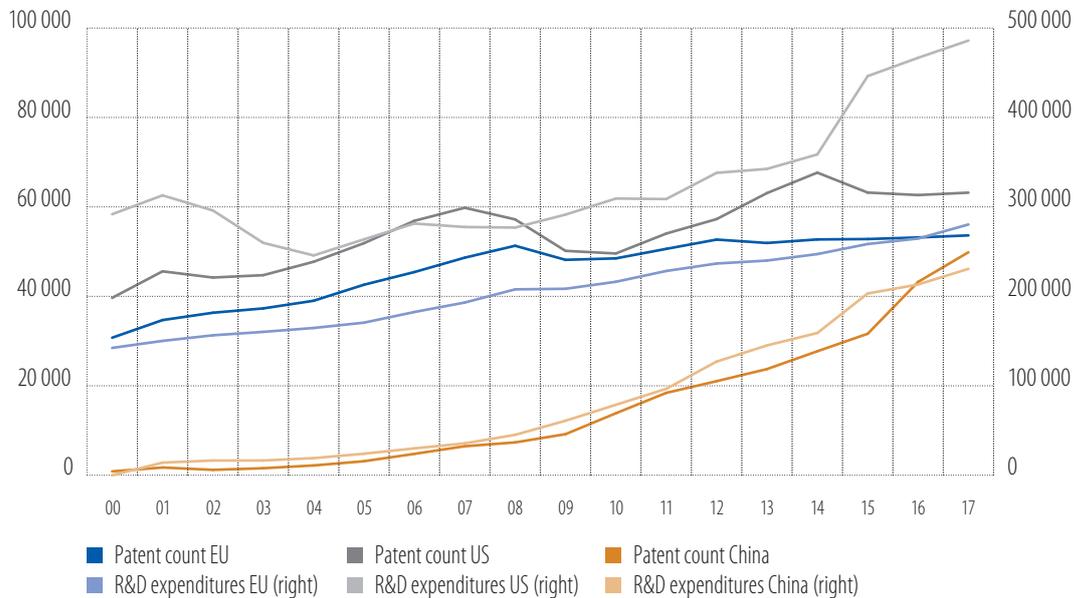
Digitalisation should also go hand in hand with digital innovation. As highlighted in the previous sections, the importance of adopting digital technologies has been analysed extensively by researchers and policymakers. However, much less is known about the different research and innovation streams that lead to the development of new digital technologies. This section presents evidence on recent developments at the cutting edge of technology and discusses possible opportunities to develop new knowledge.

Where the European Union stands on digital innovation

The European Union, the United States and China are the global leaders in innovation, as reflected in patent data and R&D expenditure. The United States and the European Union continue to lead in overall patent counts while China is rapidly catching up (Figure 24). Patent applications run parallel to R&D expenditure over time. This suggests that patents, a proxy of the output of innovation activities, are closely associated with R&D spending, a proxy for innovation input.

Figure 24

Patents and R&D expenditure, 2000-2017 (left axis: patent count; right axis: R&D expenditure in EUR million)



Source: PATSTAT (PCT) data prepared in collaboration with the Centre for Research and Development Monitoring (ECOOM), and Eurostat data on R&D expenditure (GERD) within the European Union.

Note: The dark lines show total patents (left axis); the light lines show R&D expenditure in EUR million of purchasing power standards (PPS) at 2005 prices (right axis).

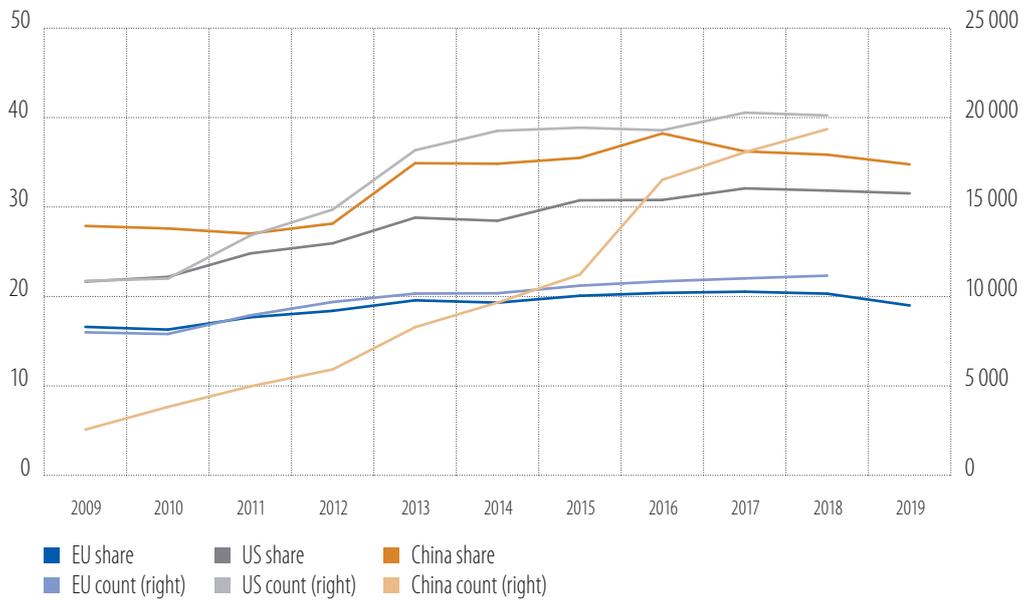
The European Union needs to play a more prominent role in developing new digital technologies.

Figure 25 shows that the European Union is lagging behind the United States and China in patent applications in the digital and industry 4.0⁷ domains, defined in Box B. While the share of digital patents in the total patent portfolio has remained relatively stable in the European Union since 2012, the US share has increased over time, widening the EU-US gap in digital innovation. 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 European Union, the United States and China have accelerated investments in digital innovation over the past decade. Within the European Union, digital innovation continues to be mainly driven by countries in Western and Northern Europe, which hold more than 90% of all EU digital patents.

US digital patents tend to be cited more often for new digital innovations than EU patents. Until recently, EU digital patents had a relatively high impact, as indicated by the forward citations they received — forward citations reflect the breadth of the patent's impact because they measure the number of times the knowledge is followed up on. However, the European Union's impact has changed in recent years. In 2010, the United States overtook the European Union in the number of digital patents receiving citations and has continued to outperform since then (Figure 26). Relative to the European Union, China continues to lag behind in the impact of its digital innovation but it is closing the gap. A similar pattern emerges when looking at each patent's average share of the total number of forward citations over a three-year timeframe, which indicates the depth of the patent's impact (Figure 26). The European Union appears to be slowly losing its influence in the development of new digital technologies, especially compared to the United States.

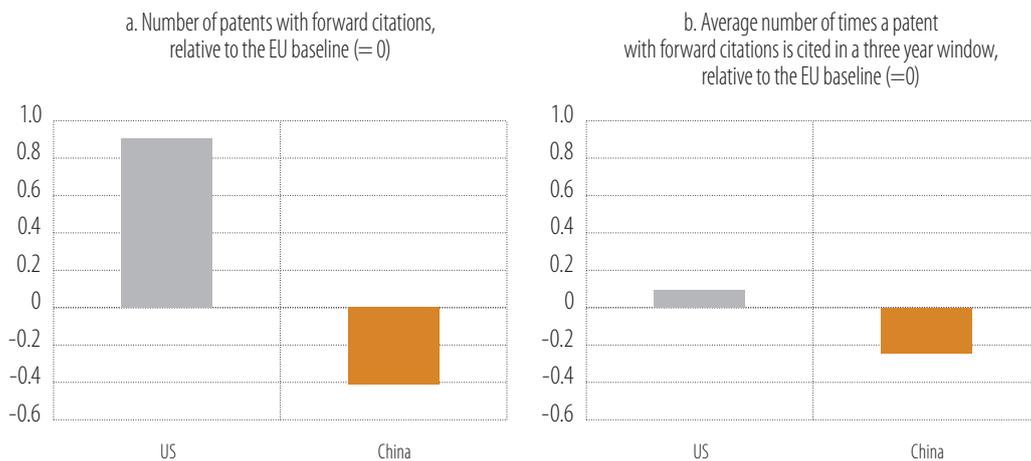
7 Industry 4.0, or the Fourth Industrial Revolution, refers to the disruption technology is causing in many major industries. In this chapter, industry 4.0 is defined in line with the classification provided by the European Patent Office (see Box B) and consists of a variety of technologies, such as big data, artificial intelligence, the internet of things and many more technologies.

Figure 25
Digital patents, 2009-2019 (left axis: patent share in %; right axis: patent count)



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
Note: The light lines show the number of digital patents (right axis); the dark lines show the percentage share of digital patents in the total portfolio of domestic patents (left axis).

Figure 26
Forward citations of digital patents



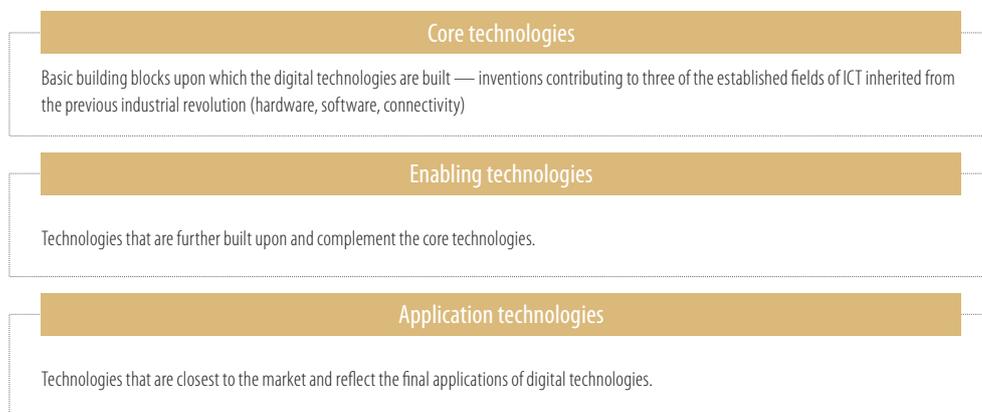
Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
Note: The count measures the number of patents with forward citations (providing an indicator of the breadth of the impact or the number of times knowledge is used) relative to the EU count. Only data until 2017 are shown because forward citations of patents take time to materialise.

Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
Note: The shares are measured as the average number of times a patent with forward citations is cited in a three-year window relative to the EU baseline. This share is computed as the ratio of its forward citations to the overall number of patents with forward citations (providing an indicator of the depth of the impact an individual patent has).

Different domains of digital innovation

The digital transformation is affecting virtually every sector of the economy. Digital innovation is no longer the exclusive domain of software companies. An increasing number of companies are pushing the digital frontier as they try to seize new opportunities in the fast-changing digital and economic environment. Digital innovation is therefore a very broad concept. Digital technology can be the basis for and the result of digital innovations, with different types of digital innovation processes underpinning these different stages (Yoo et al., 2012). According to the European Patent Office (EPO, 2017), digital innovation can be classified into three main domains — core technologies, enabling technologies and application technologies (Figure 27). Box B discusses the classification of digital patents in more depth and gives examples of recent digital technologies.

Figure 27
Different domains of digital innovation



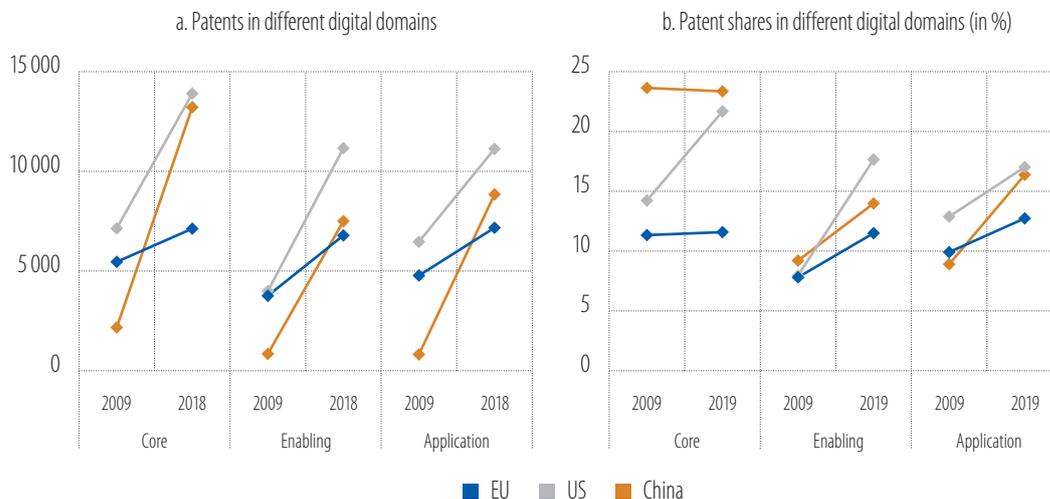
Source: Based on EPO (2017).

Note: See Box B for a more detailed description of the different digital subdomains.

The United States leads in all three domains of digital innovation. The United States is at the top of the different fields of digital innovation, while China's patenting activity has overtaken the European Union in all three domains (Figure 28a). Over the past decade, the United States has mainly increased its focus on core and enabling technologies, while China has been focusing more on enabling and application technologies (Figure 28b). While the European Union lags behind the United States in all three domains, the difference with China is less marked in enabling and application technologies. Compared to the United States and China, the European Union is less active in the innovation of core technologies that contribute to established fields of information and communications technology (ICT), such as hardware, software and connectivity.

Despite its weakness in several areas of digital innovation, the European Union is a global leader in certain subdomains. For example, it has more patents in vehicle applications, which includes autonomous driving and vehicle fleet navigation devices (Figure 29). The United States and China still lag behind the European Union in this area, but they are rapidly catching up. Europe's position in the development of new digital technologies is fragile, even in the limited number of fields where it is performing relatively well.

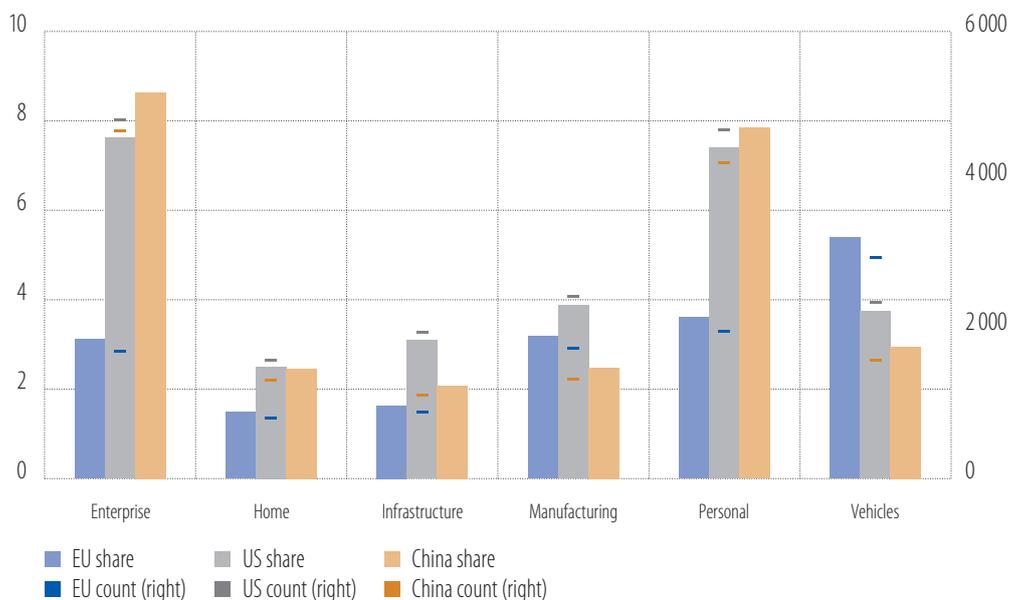
Figure 28
Digital innovation in different domains



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
 Note: The figure shows the count of digital patents for the three different digital domains.

Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
 Note: The figure shows the shares of digital patents for the three different digital domains over the total portfolio domestic patents.

Figure 29
Patents for digital application technologies in 2018 (left axis: patent share in %; right axis: patent count)



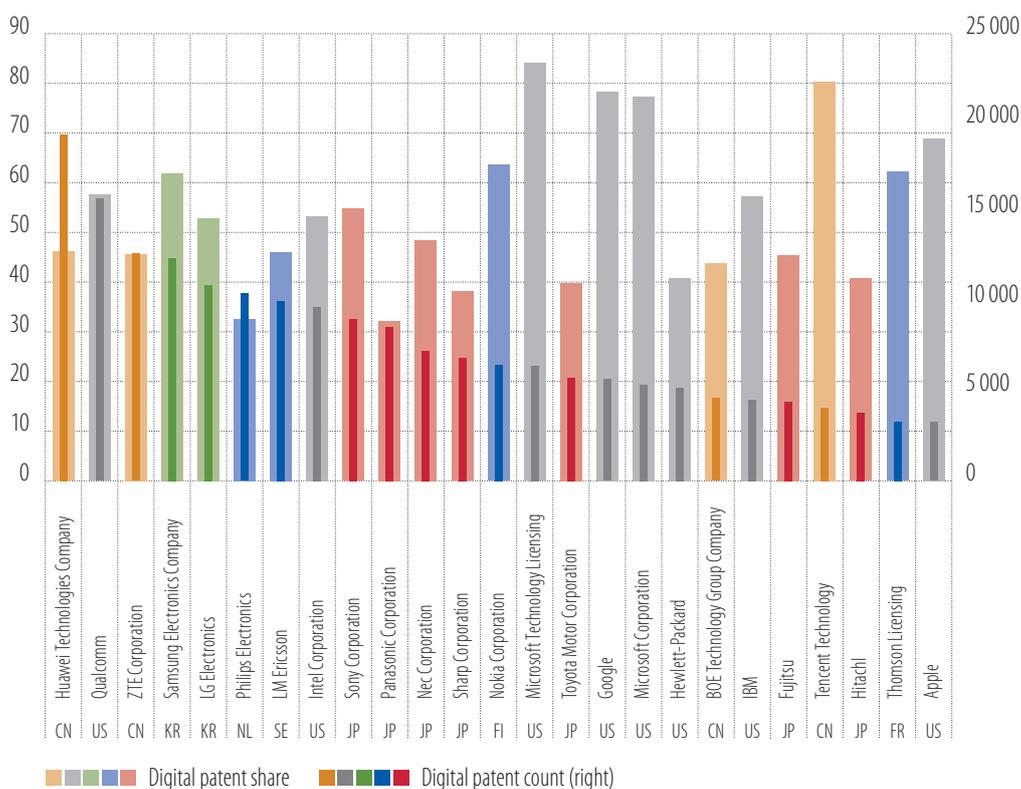
Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
 Note: The lines show the count of digital patents in the digital application subdomains in 2018 (right axis); the bars show the share of patents in the respective total domestic patent portfolio for the digital application subdomains in 2018 in percent (left axis).

Competition and concentration as key forces of digital innovation

The European Union only has four companies among the top 25 digital players, while the United States has eight. China also has four companies on this list, while the remaining strong digital innovators come from South Korea and Japan (Figure 30). The extent to which companies are leading in digital innovation can be measured by the number of patents they hold and the share of digital patents in their total patent portfolio. Some EU companies such as Philips Electronics, Ericsson, Nokia and Thomson Licensing are in the top 25 because they hold many digital patents. However, they do not have the same focus on digital technologies as other top digital players — such as Microsoft, Google and Apple in the United States or Tencent in China — for whom digital patents account for close to or more than 70% of total patents. Most other companies on the list of the top 25 digital players seem to have a more diversified patent portfolio and do not focus exclusively on digital technologies.

Figure 30

Top 25 global digital players (left axis: patent share in %; right axis: patent count)



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

Note: The bars reflect the number of digital patents as well as the share of digital patents in the patent portfolio of each company from 2000 to 2018. The figure only includes companies with a minimum of 30% digital patents in their total patent portfolio. The colours refer to different countries (blue = European Union; red = Japan; grey = United States; orange = China; green = Korea).

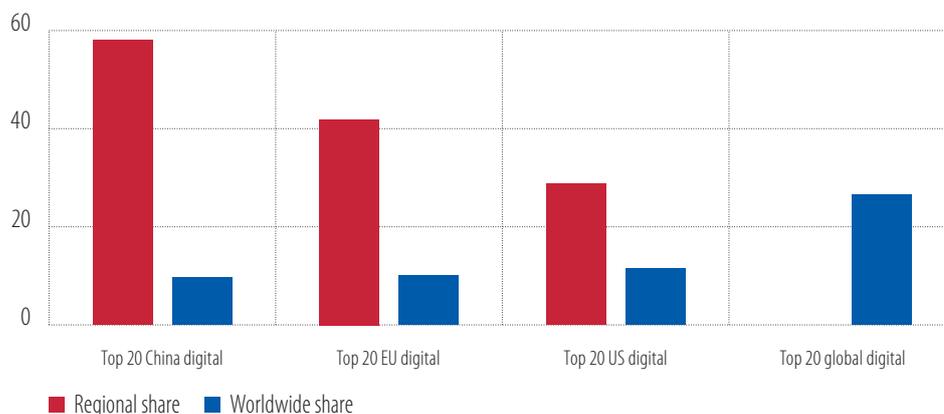
The digital sector is often criticised for a lack of competition, enabling some companies to profit from winner-takes-all dynamics. A key question is whether the high concentration of key players in the digital market is also present in digital innovation. The economic literature argues that as soon as a leading technology is successful, it is rapidly implemented by leading firms (Akcigit and Ates, 2019). This rapid adoption may discourage smaller firms from innovating, thereby slowing down evolution of cutting-edge innovation. Competition is an important force that pushes down the cost of goods and

improves public welfare. Some economists argue that having a few firms with significant market power is necessary to foster innovation, while others fear that market concentration leads to a general slowdown in economic progress and innovation (Philippon, 2019).

In spite of the winner-takes-all dynamics often witnessed in the US digital sector, digital innovation tends to be less concentrated in the United States and the European Union than in China. The top 20 EU digital companies hold 40% of all EU digital patents, while the top 20 US digital companies hold 30% of all US digital patents (Figure 31). In China, this share is close to 60%. This suggests that digital innovation in China is heavily concentrated among a few large digital players, particularly compared to the United States or the European Union. However, the lower concentration does not necessarily result in lower winner-takes-all dynamics in certain subdomains in these regions. For example, some of the top US digital players are particularly active in big data analytics and currently also dominate enabling technologies.

Figure 31

Digital patents held by the top 20 digital players in each market (in %)



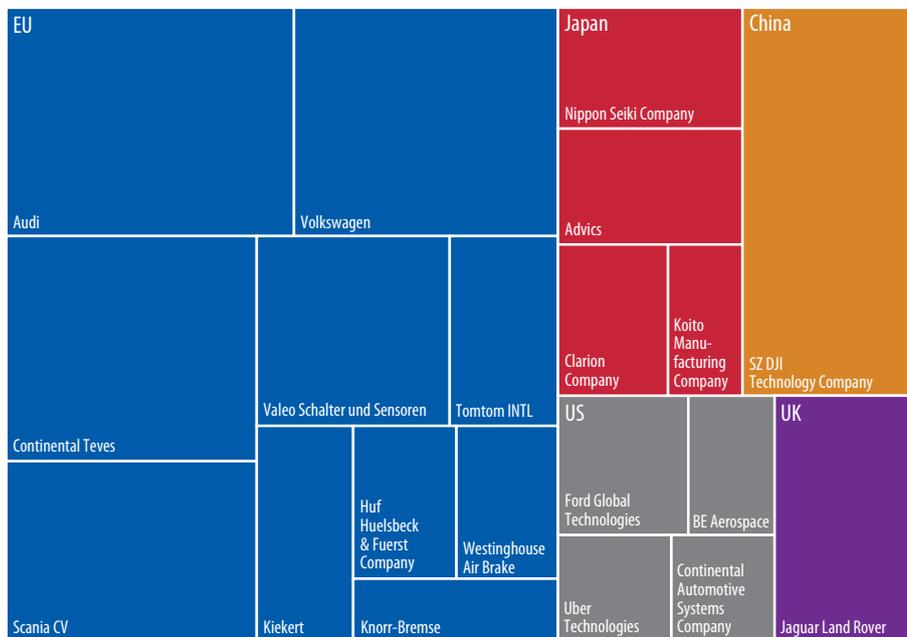
Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

Note: The red bars reflect the number of digital patents held by the top 20 domestic digital patentees as a share of the respective domestic digital patent portfolio from 2000 to 2018. The blue bars reflect the number of digital patents held by the top 20 domestic digital patentees as a share of the global digital patent portfolio. The last blue bar reflects the number of digital patents held by the top 20 global digital patentees as share of the global digital patent portfolio.

The diversified nature of digital innovation still leaves space for EU players in several areas. For example, European firms like Audi, Volkswagen, Continental and Scania excel in specific domains, such as vehicle applications (Figure 32).⁸ Whether this will be sufficient to maintain the global competitiveness of the European Union is up for debate. However, it indicates that the digital innovation landscape is sufficiently diverse enough for the European Union to still leverage its competitive advantage and digital skills.

⁸ The dominance of EU market players in this subdomain is the exception rather than the norm. As shown above, the European Union does not necessarily lead overall digital technology development.

Figure 32
Top 20 global players in digital vehicle applications



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

Note: The top players in the vehicle application subdomain are represented by their patent counts. The figure only includes companies with a minimum share of 30% vehicle application patents in their total patent portfolio. The size of the tiles reflect the patent count in the vehicle application subdomain.

Box B

Measuring digital innovation with patent data

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).⁹ The classification identifies three broad categories of patents, each of which is further subdivided into specific technological domains. The resulting map aims to capture the buildings blocks of industry 4.0, at least for patent applications. The tables below give an overview of the different domains and their sub-technologies, as reported by the EPO.

The three main sectors identified in the classification are “core technologies,” “enabling technologies” and “application domains.” Core technologies are considered to be the basic building blocks upon which the technologies of the fourth industrial revolution are built. This class consists of inventions that contribute to three of the established fields of information and communications technology (ICT) inherited from the previous industrial revolution.

Table B.1

Core technologies	Including
Hardware	Sensors; advanced memories; processors
Software	Intelligent cloud storage and computing structures; adaptive databases; mobile operating systems; virtualisation
Connectivity	Network protocols for massively connected devices; adaptive wireless data systems

⁹ This box was prepared by Julie Callaert (ECOOM, KU Leuven).

The second domain captures enabling technologies. These technologies are further built upon and complement the core technologies. The EPO subdivides this second domain into seven technology fields.

Table B.2

Enabling	Including
Analytics	Diagnostic systems for massive data
User interfaces	Virtual reality; information display in eyewear
3-D support systems	3-D printers and scanners for parts manufacture; automated 3-D design and simulation
Artificial intelligence	Machine learning; neural networks
Position determination	Enhanced GPS; device-to-device relative and absolute positioning
Power supply	Situation-aware charging systems; shared power transmission objectives
Security	Adaptive security systems; intelligent safety systems

The third “application” domain captures technologies that are closest to the market and reflect the final applications of digital technologies. This domain is subdivided into six different sectors of applications to indicate in which part of the economy the various technologies can potentially add value.

Table B.3

Application domain	Including
Personal	Personal health monitoring devices; smart wearables; entertainment devices
Home	Smart homes; alarm systems; intelligent lighting and heating; consumer robotics
Vehicles	Autonomous driving; vehicle fleet navigation devices
Enterprise	Intelligent retail and healthcare systems; autonomous office systems; smart offices; agriculture
Manufacture	Smart factories; intelligent robotics; energy saving
Infrastructure	Intelligent energy distribution networks; intelligent transport networks; intelligent lighting and heating systems

Depending on the focus of the analysis, different levels of aggregation are used in this chapter. Digital patents refer to all patents belonging to one of the three main domains of industry 4.0. In other cases, the indicators are broken down into the three main classes, namely core technologies, enabling technologies and application domains. Throughout the chapter, the subdomains of these three building blocks of digital patents are only used in some specific settings.

The crossroads between digital technologies and innovation

Digital innovation could play a major role in a multitude of existing economic sectors. Some of Europe's traditional economic sectors could potentially find themselves in a new era of innovation thanks to major changes triggered by digital technologies (Haskel and Westlake, 2017; Cockburn, Henderson and Stern, 2018; Branstetter, Drev and Kwon, 2019; Ghobakhloo, 2020).

Digital technologies could enable certain industries to meet strict climate targets and could transform the automotive sector. If emerging digital technologies are properly employed, they could play an essential role in tackling environmental challenges (GeSI 2019; Intergovernmental Panel on Climate Change (IPCC), 2021). Digital technologies could be instrumental for the European Green Deal and in reaching carbon neutrality. The automotive sector, one of the European Union's main traditional sectors, is being transformed by the need to develop engines that are not reliant on fossil fuels. The automotive sector is also witnessing an increased use of digital technologies and new trends such as autonomous driving and car sharing (MIT Energy Initiative, 2019).

Digitalisation could also play a major role in other sectors such as healthcare — especially in light of the coronavirus pandemic. The recent health crisis has put enormous pressure on the healthcare system. Not only were hospitals faced with a large influx of new patients, they also had to cope with the indirect victims of the crisis, namely patients with existing conditions that were left untreated. In addition, the pandemic brought about an unprecedented search for COVID-19 treatments and prevention, such as vaccines (International Monetary Fund (IMF), 2021). Innovation in healthcare could benefit massively from digital technologies (Kraus et al., 2021).

The European Union's position on innovation targeting healthcare, the automotive industry and climate change

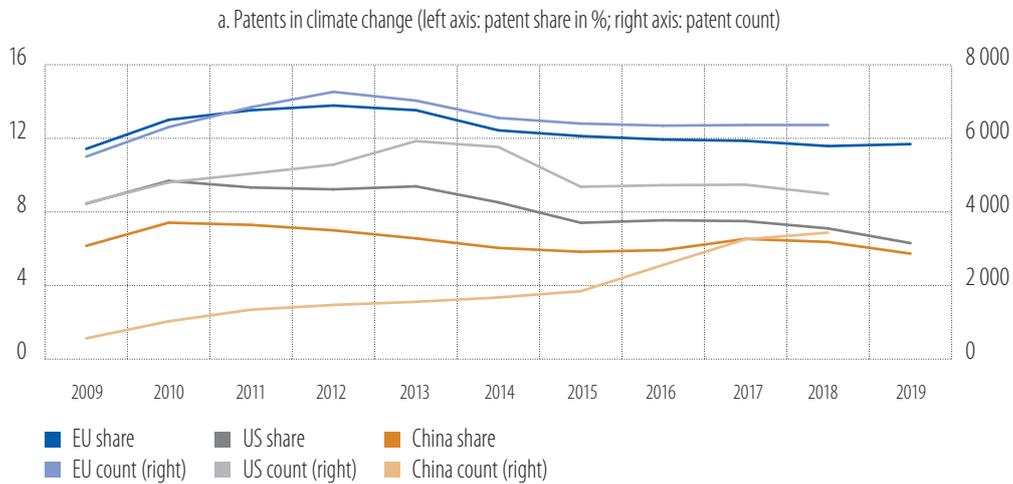
The European Union continues to be one of the main players in new technologies developed to tackle climate change. The European Union has many climate change-related patents and is far ahead of the United States and China (Figure 33a). However, Europe's climate change innovation is stagnating and has even been declining in recent years (see Chapter 6).

The European Union is a leading innovator in the automotive sector. The European Union continues to show a steady upward trend for automotive patents (Figure 33b).¹⁰ China is lagging behind the European Union with less than half the amount of patents and lower specialisation (as measured by the patent share) in automotive technologies.

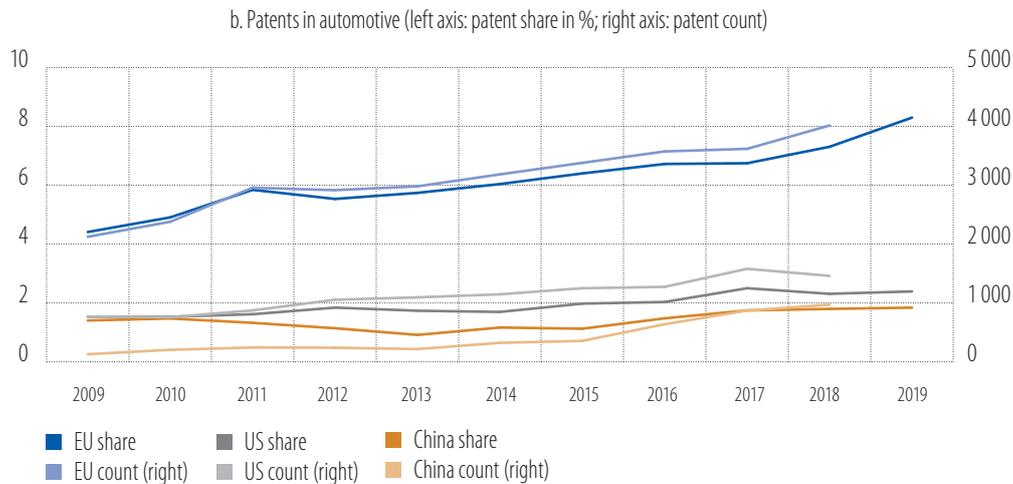
The European Union's relative position is weaker in healthcare technologies. But Europe remains ahead of China, in absolute (patent count) and relative (patent share) terms. Until 2019, before the outbreak of the COVID-19 pandemic, the increase in patent applications in healthcare was mainly driven by US patentees. In the European Union and China, healthcare patenting activity has remained relatively stable since 2012 (Figure 34a).

¹⁰ The patent classification in different technologies — such as digital, transportation, climate change and healthcare — is based on the classification established by Katholieke Universiteit Leuven, among others. The exhaustive classification of key technologies and priorities was developed as part of the P&L project INCENTIM-KU Leuven, with the support of Bocconi University, Technopolis and numerous experts from the European Commission. A modular approach was developed, resulting in IPC based search keys for a majority of themes.

Figure 33
Patents in climate change and automotive



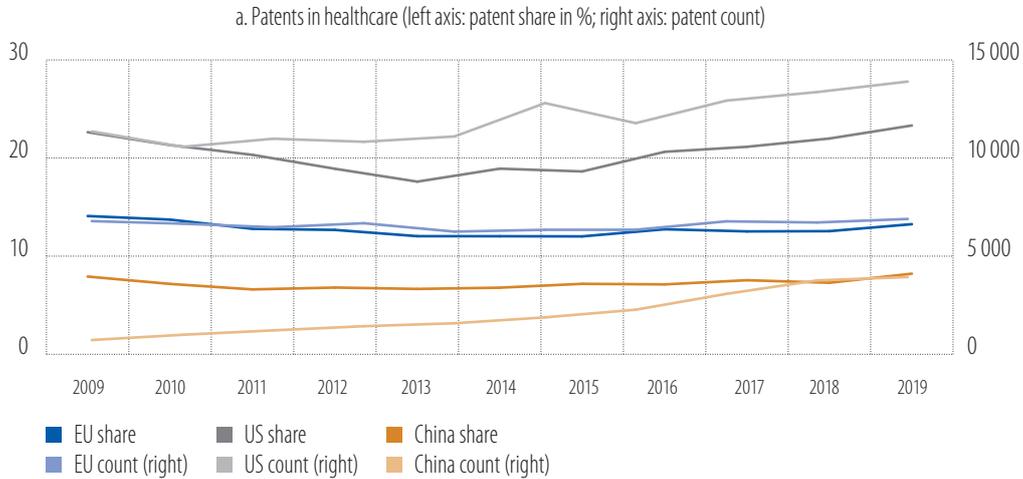
Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
Note: The light lines show the number of climate change patents (right axis); the dark lines show the share of climate change patents in the total portfolio of domestic patents (left axis).



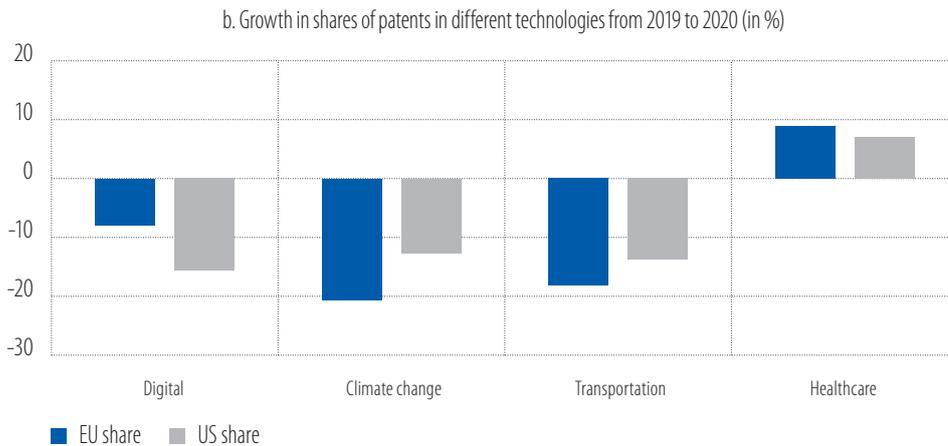
Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
Note: The light lines show the number of automotive patents (right axis); the dark lines show the share of automotive patents in the total portfolio of domestic patents (left axis).

Nevertheless, preliminary patent data for 2020 suggest that firms have responded to the COVID-19 crisis by increasing their healthcare innovation. The statistic is preliminary because it is only based on a partial count of patent applications in 2020. However, there is a strong contrast with the 2019-2020 trends in digital, climate change and transportation patenting activity (Figure 34b). The data indicate strong activity in patent applications and a focus on healthcare technologies at the beginning of 2020. New updates of patent data will confirm whether this strong increase continued for the rest of 2020.

Figure 34
Patents in healthcare and patent growth in different technologies



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
Note: The light lines show the count of healthcare patents (right axis); the dark lines show the share of healthcare patents in the total portfolio of domestic patents (left axis).



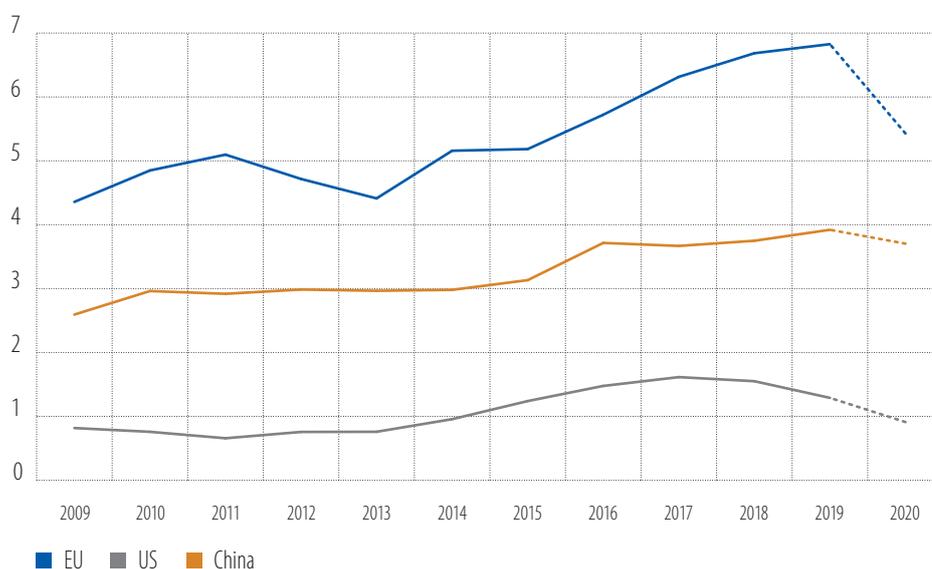
Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
Note: The bars show the growth rate of the share of patents in the listed technologies in the total portfolio of domestic patents from 2019 to 2020. PATSTAT data do not yet include all patents filed in 2020 and the figure is only indicative of a potential future trend. China is excluded from this chart due to a very low number of patents in 2020.

Digital technologies enable healthcare innovation

The COVID-19 crisis could spark a digital revolution in healthcare. The analysis of healthcare data has been integral to the pandemic response. The sharing of healthcare research and data helped spur the development of vaccines (like Pfizer BioNTech), for example. Digital technologies have also been used for remote doctor consultations, which oftentimes replaced in-person visits during the pandemic. In addition, artificial intelligence could lead to major changes in healthcare by enhancing medical devices, sometimes in combination with robotic technology.

Patenting activity combining digital and healthcare applications did not pick up immediately during the crisis, however, unlike overall healthcare innovation. The development of patenting activities in digital and healthcare technologies, or even the citing of digital technologies in healthcare patents, appears to have slowed down in the patent data available for 2020 — numbers for 2020 are preliminary and only based on a partial count of patent applications (Figure 35). The falloff in healthcare patents using digital technologies, however, contrasts sharply with overall healthcare patenting activities and the trend of strong specialisation in healthcare technologies at the beginning of 2020 (Figure 34b). This suggests that the surge in healthcare patents at the beginning of 2020 did not focus on digital technologies. Until 2019, patenting activity in healthcare technologies that co-develop or cite digital technologies rose, especially in the United States.

Figure 35
Healthcare patents citing digital technologies (in %), 2009-2019



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

Note: The lines show the share of healthcare patents with digital citations in the total portfolio of domestic patents.

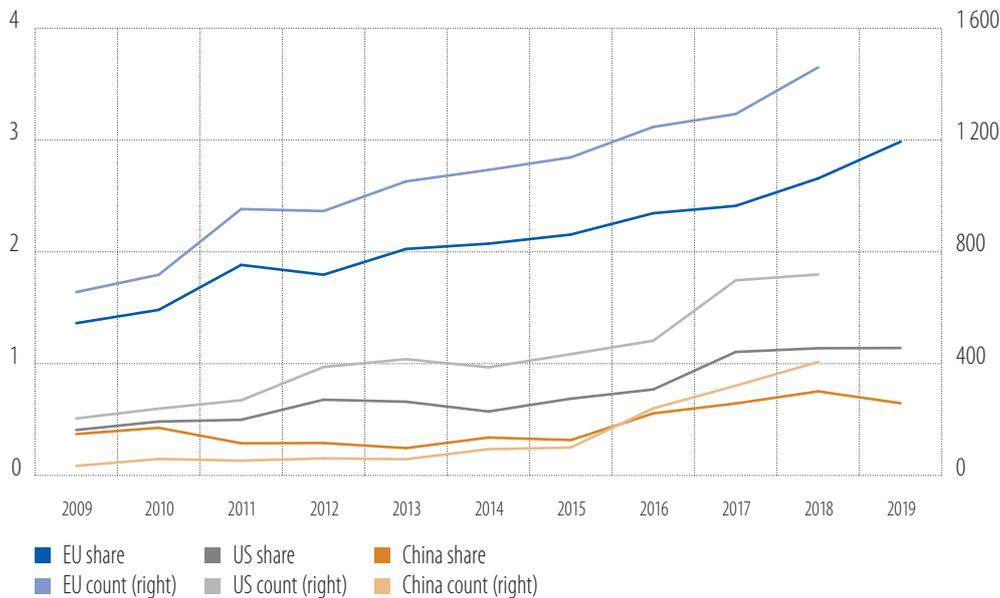
Digital innovation in the automotive sector

The digitalisation of the automotive sector is an integral part of the European Green Deal. Demand for personal mobility services that offer convenience and flexibility is expected to increase. However, environmental challenges are expected to push the evolution of mobility and related services, leading to a more sustainable transportation model. Overall, the technologies and infrastructure currently used are not adapted to 21st century needs. Even before the announcement of the European Green Deal, the European Commission highlighted increased digitalisation in transport as a key priority.

The European Union has had a significant head-start in technologies at the crossroads of automotive and digital services. Although the European Union is lagging behind in most sectors of digital innovation and digital adoption, the automotive sector is following a different pattern (Figure 36). The European Union is more active in innovation in digital automotive technologies than the United States and China. In addition, the European Union has been able to further strengthen its leading position in these technologies over the past decade.

Figure 36

Patents at the crossroads of digital and automotive, 2009-2019 (left axis: patent share in %; right axis: patent count)



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

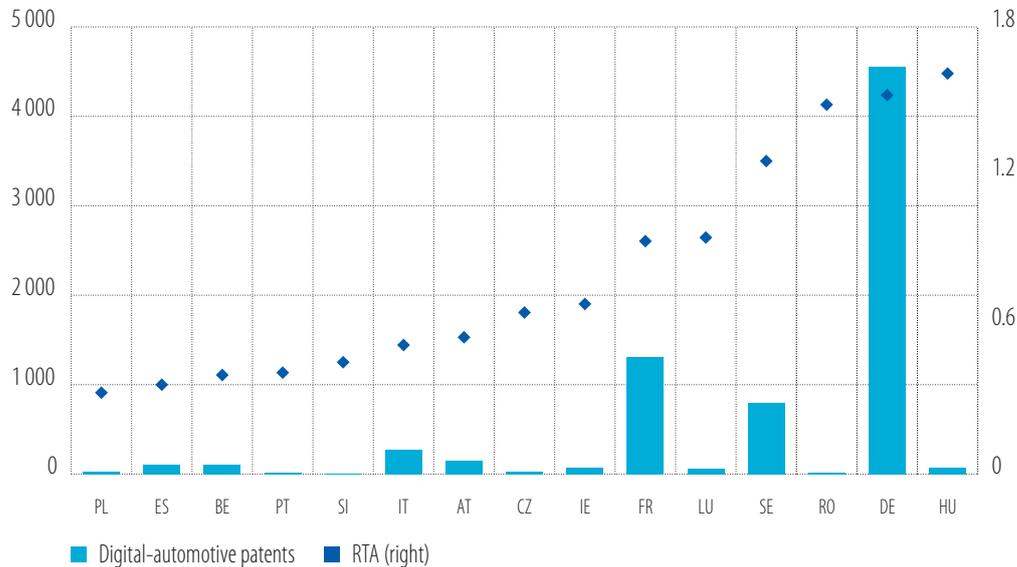
Note: The light lines show the count of patents that can be categorised as digital and part of the automotive sector (right axis); the dark lines show the share of patents that can be categorised as digital and part of the automotive sector in the total portfolio of domestic patents (left axis).

Within the European Union, Central and Eastern Europe have been very active in digital automotive patenting. Although the region produces relatively few patents overall, its specialisation in automotive patenting (measured as revealed technological advantage, or RTA) has increased in the past decade. The automotive sector is core to the economies of Central and Eastern Europe. The automotive patent activity highlights that countries in this region are also engaged in cutting-edge research, development and innovation, going well beyond basic car assembly or parts manufacturing. Nevertheless, the large automotive players in Western and Northern Europe are clearly the technological leaders (for patenting activity). Within Western and Northern Europe, the main driving force behind digital automotive patenting is, not surprisingly, Germany. Sweden and France are strong runners-up (Figure 37).¹¹ See Box C for a discussion of the radical transformation of the automotive sector expected from the electric revolution, and the consequences the revolution is expected to have in the European Union and in particular Central and Eastern Europe.

Automotive patents that use digital technologies mainly focus on vehicles, hardware and analytics (see Box C for a description of the different automotive domains). While the automotive sector needs to undergo a massive transformation, it is somewhat surprising that digital domains such as power supply, artificial intelligence and position determination combine fewer automotive and digital technologies (Figure 38). The lower prevalence of automotive technologies co-developing digital infrastructure could be addressed by policies that create incentives for innovation and the development of new applications.

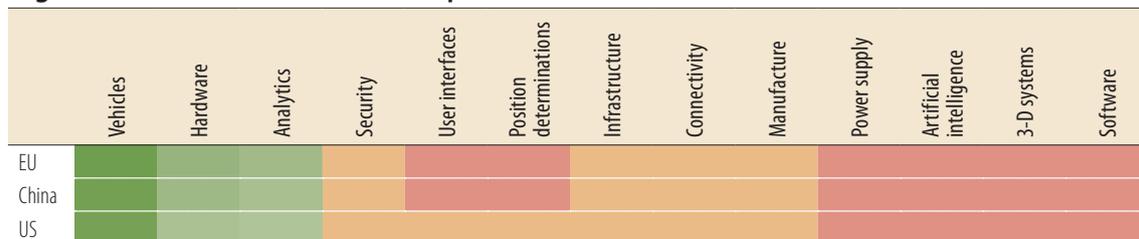
¹¹ The companies leading automotive patenting are very much in line with Figure 32, which shows EU companies leading in innovation in digital vehicle applications.

Figure 37
Digital automotive patents in selected EU members (left axis: patent count; right axis: RTA)



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
 Note: The figure shows the number of digital and automotive patents (bars, left axis) and the RTA (diamonds, right axis). The revealed technological advantage (RTA) index is the share of digital and automotive patents in the country portfolio relative to the share of digital and automotive patents in the European Union. The graph excludes EU countries with a total number of patents below 500. The index was calculated for 2012-2017.

Figure 38
Digital domains used in automotive patents

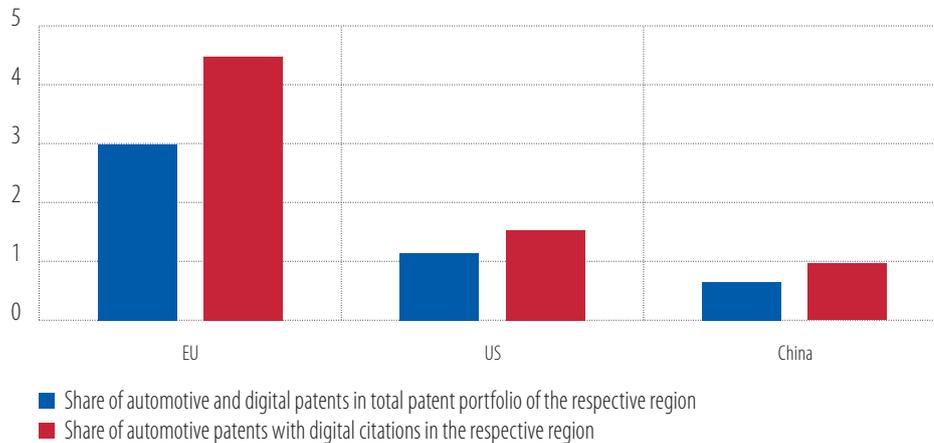


Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.
 Note: The green areas indicate digital domains that are often co-developed with automotive applications. The red areas indicate digital domains that are less intensely co-developed with automotive applications. The yellow-orange area is the continuum in between. Digital domains that are rarely co-developed with automotive patents, such as home or personal applications, are not shown.

The European Union is not only co-developing automotive and digital technologies in combination, it is also actively citing digital patents when developing automotive technologies. Instead of co-developing technologies, it may be easier to integrate existing digital technologies into automotive innovations.¹² Close to 5% of all patents in the European Union were automotive patents citing digital technologies in 2019 (Figure 39). The trend has grown steadily in the European Union in recent years, while it seems to be stabilising in the United States and China. This suggests that Europe could be one of the driving forces behind the mobility revolution. At the same time, incentives for innovation will need to be aligned if the automotive transformation is to be successful. European policymakers could make a difference by laying a strong foundation that would enable the revitalisation of the automotive industry and innovation to bring it into the future.

12 Figure 39 explores digital subdomains in the automotive patents. The figure would be similar for digital domains cited in transportation patents.

Figure 39
Digital automotive patents and automotive patents that cite digital technologies in 2019 (in %)



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

Box C

The electric revolution in the automotive sector

The future of the automotive sector — at least in Europe — is fully electric.¹³ After 120 years of producing and improving petrol and diesel engines, most major automakers (original equipment manufacturers, or OEMs) are phasing out new investments in internal combustion engines and announcing new targets for electric vehicle production. The targets are typically more ambitious in Europe than in other regions where electrification is also advancing at a fast pace (such as China and the United States).

The market is reacting quickly. While new sales of pure electric, plug-in hybrids and hybrids accounted for a mere 1% of the vehicles in circulation in the European Union in 2019, new sales of those vehicles¹⁴ were responsible for 18% of total auto sales in 2020 and 35% in the first part of 2021, thanks in part to public incentives.

The electric revolution is expected to gain further momentum following a series of legislative changes. Under the umbrella of the European Green Deal, the European Commission is proposing the Fit for 55 package (presented in July 2021), which targets a 55% reduction in carbon emissions by 2030 and 100% from 2035. The European Commission will soon introduce new, stricter **Euro7 emissions standards**. Moreover, some countries are announcing specific dates for the phasing out of sales of new internal combustion engine cars over the next decade.

¹³ This box was prepared by Matteo Ferrazzi and is based on Delanote et al. (2022).

¹⁴ Electrification can take different forms, as the family of electric and hybrid vehicles is composed of various categories: pure electric models (BEV — battery electric vehicles), plug-in hybrids (PHEV — plug-in hybrid electric vehicles, which use both petrol and a battery pack that can be plugged in to charge it up) and hybrid models (HEV — hybrid electric vehicles).

The combined effect of the carbon-emission regulations, public policies at the local level and automakers' plans suggest that a de facto ban on internal combustion engines will materialise in Europe before 2035. The increased cost of internal combustion engine powertrains (including for plug-in hybrids and hybrids) will make them less competitive and push them out of market, at least for light vehicles. In less than 15 years, pure electric models, which represented only 0.2% of the cars in circulation in Europe in 2019, may dominate the entire range of new car sales.

The electric revolution has taken off against a backdrop of numerous other changes affecting the sector, which had already been moving quickly in recent years. Looking at longer-term trends, car production moved to emerging markets. The so-called Triad (EU15, the United States and Japan) produced 70% of cars in 2000, but it now accounts for less than 33% of global production. More recent trends, such as shared mobility (especially related to mobility-as-a-service and car sharing), and connectivity also reflect the sector's evolution (Cassia and Ferrazzi, 2018). In addition, the coronavirus pandemic caused a collapse in production (down 25% in 2020, with only a partial recovery in 2021), and supply bottlenecks (including a shortage of computer chips). The possible effects of changes in mobility due to increased teleworking arrangements are still not fully clear (Klein, Høj and Machlica, 2021). While automotive players are working on providing incremental automation capabilities, autonomous vehicles — one of the most ground-breaking innovations to ever come out of the automotive industry — may gradually arrive on the market before the end of the current decade. In the meantime, new cars are concentrating digital technologies on improving comfort, entertainment and safety.

Batteries and charging infrastructure are key for the electrification of Europe's automotive sector. Batteries, the prices of which are falling fast, are becoming the most important component in electric vehicles. They currently account for one-third of the weight and 30% of the value of a vehicle, figures similar to those of internal combustion engines in the past. Battery production is dominated by China (75% of global capacity) and the European Union is lagging behind (currently less than 10%, thanks solely to factories in Poland and Hungary). Around 20 new production sites for electric batteries are needed in Europe over the next ten years to serve the growing needs of automotive players, and various projects are ongoing. Some automakers are establishing joint ventures with battery producers or implementing vertical integration strategies.

Around 213 000 publicly accessible rechargers had been deployed in the European Union by the end of 2020, of which around 10% were fast chargers. However, the distribution of charging points remains very uneven across Europe, with significant gaps in the network. At least 1 million publicly accessible charging stations must be put in place by 2025 (according to the European Green Deal) to support an expected 13 million electric vehicles, and 3.5 million stations by 2030 (Fit for 55 package) to support an expected 30 million vehicles.

Various factors will shape the electrification of the “machine that changed the world” (Womac, Jones and Roos, 1990) in Europe over the next few years. Firstly, technological advances, regulations and price convergence will soon make electric vehicles more affordable than internal combustion engine vehicles. The localisation of battery cell production and the deployment of recharging infrastructure will also affect electrification, as will supply chains and the geographical distribution of activities. In this context, Germany appears to be the best positioned to become the new electrification hub of Europe, for electric car production and battery production. Countries strongly integrated into German supply chains — the Czech Republic, Slovakia, Poland and Hungary in particular — are expected to be among those that will benefit the most from the transformation of the European Union's automotive industry (Transport & Environment, 2021).

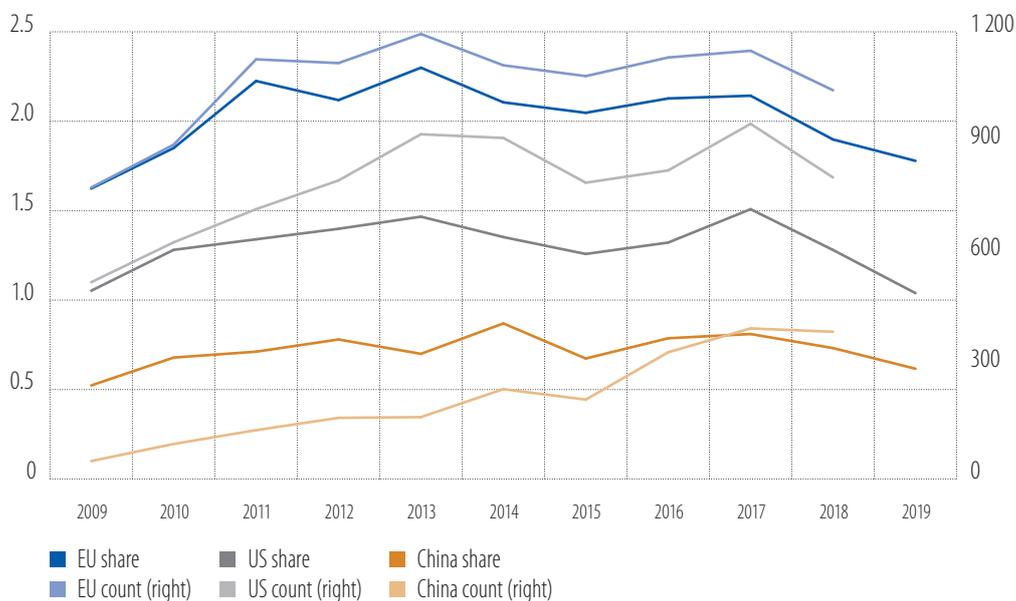
The twin transition: green and digital

Digital technologies are expected to be critical to the green transition and to meeting the sustainability goals defined in the European Green Deal. Many of the digital technologies being developed in transportation could help combat the devastating impacts of climate change. The development and rollout of a wide range of technologies with environmental benefits are crucial for green growth (Aghion et al., 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, 3-D printing creates opportunities for manufacturing goods locally, leading to quicker turnaround of 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 European Union is currently a global leader in innovation that combines digital and green applications. While Europe may not be a global leader when it comes to digital innovation (Figure 25), it clearly is at the forefront of green technologies (see Figure 33a and the discussion in Chapter 6) and a leader in combining digital and green innovations (Figure 40). This trend has been clear for a while (EIB, 2021b). Nevertheless, in recent years, patenting that combines green and digital technologies seems to have stabilised. That slowdown should be a wake-up call for policymakers, as the transition will rely on green and digital innovations.

Figure 40

Green and digital patents, 2009-2019 (left axis: patent share in %; right axis: patent count)



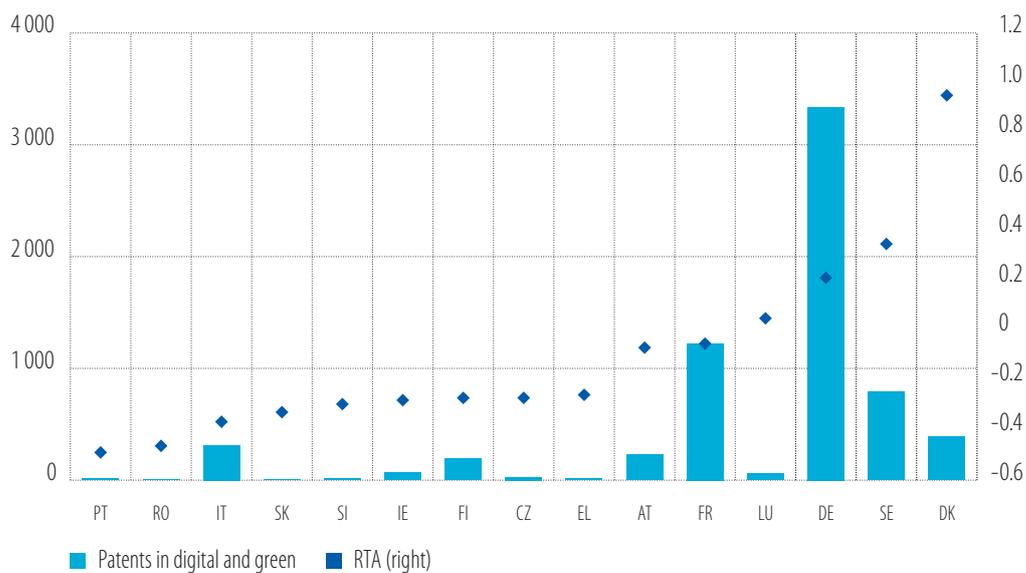
Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

Note: The light lines show the count of digital and green patents (right axis); the dark lines show the share of digital and green patents in the total portfolio of domestic patents (left axis).

Sweden, Denmark, Germany and France are leading green and digital innovation. Within the European Union, countries in Western and Northern Europe clearly lead the way — with an above-average score in the revealed technological advantage (RTA) index in the digital and green domain and/or an above-average number of patents in both green and digital innovations (Figure 41). Overall, patenting of green and digital innovations is mainly driven by a handful of countries that tend to be specialised in these technologies.

Figure 41

Green and digital patenting in selected EU members (left axis: patent count; right axis: RTA)



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

Note: The figure shows the number of digital and green patents (bars, left axis) and the RTA (diamonds, right axis). The revealed technological advantage (RTA) index is the share of digital and green patents in the country portfolio relative to the share of digital and green patents in the European Union. The graph excludes EU countries with a very low number of patents. The index was calculated for 2013-2018.

The European Union is not only a leading force combining digital and green development in patents, but also in adopting existing digital knowledge in its green patents. In addition to patents combining digital and green technologies (Figure 40), the European Union has the highest share of green patents in which digital technologies are cited. The United States and China have, on average, 50% fewer digital citations in their green patents than the European Union. This citation pattern provides a clear view on the extent to which digital technologies are adopted (and not necessarily co-developed) in green innovation. The citations indicate that digital technologies are successfully circulating and becoming more integrated into green technologies, especially in the European Union.

Conclusion and policy recommendations

The pandemic has accelerated the digital transformation, but European policymakers should be concerned that the COVID-19 crisis may exacerbate the digital divide. Although 34% of firms that do not already use advanced digital technologies have taken steps to become more digital as a response to the pandemic, a significant share of firms, 26%, still have not started to invest in the digital transformation. These firms are lagging behind, as they have not adopted advanced digital technologies or used the crisis as an opportunity to become more digital. The share of non-digital firms is particularly large among small firms. Major barriers to investment in digital technologies include finding employees with the right skills to identify and implement digital technologies, the cost of the investments and access to digital infrastructure.

Dealing with laggard, non-digital firms and pushing EU digital innovators to catch up with their US peers should be high on the policy agenda. Digitalisation needs to be dealt with urgently, as Europe lacks global digital champions that produce cutting-edge innovation. Europe has only a handful of firms among the top digital innovators, and it is strong only in one digital domain (vehicle applications). As a result, Europe has a long way to go to catch up with the competition. Nevertheless, the diversified nature of digital innovation — being an area that covers many different domains and sectors — still leaves space for EU firms. Box D discusses EU programmes to support digitalisation and research and innovation activities in the digital field.

Advanced digital technologies must enter general use for the productivity and innovation benefits to be shared widely across the European Union. Furthermore, digital technologies could be critical enablers in meeting the European Union's strict targets for tackling climate change and for the automotive sector. The digital transformation could also play a major role in other sectors, with one important example being healthcare — especially in light of the coronavirus pandemic. While the United States leads innovation in healthcare, the European Union is on top for the development of new technologies in the automotive sector and for combatting climate change.

The European Union seems to have had a strong head-start in technologies that combine automotive and digital innovations. In addition, the European Union has further strengthened its position in the development of digital technologies as critical enablers of the green transition. Given the key importance of transportation and the fact that the world has reached a critical juncture for climate change, it is crucial for Europe to keep its advantage in these domains, which are to a large extent interrelated. Nevertheless, European policymakers will have to do everything it takes to ensure that this dominant position is not rapidly lost. The strong position of the United States 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 European Union'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.

Box D

Digitalisation and EU research and innovation policy

Digitalisation has accelerated the pace at which research and innovation activities emerge and has transformed them in several ways.¹⁵ Firstly, it has renewed the DNA of innovation, and the convergence of the digital and physical worlds has enabled a deep-tech wave of science-based, digitally enabled innovations (European Commission, 2020). A few remarkable examples are new battery technologies, precision agriculture, 3-D bioprinting and autonomous vehicles. Secondly, digitalisation has intensified the spread and application of knowledge by boosting open innovation — facilitating the relationship

¹⁵ This box was prepared by Ana Correia, Océane Peiffer-Smadja and Julien Ravet (DG Research and Innovation).

between supply and demand for technology, services and skills — and by opening up access to larger talent pools. Thirdly, digitalisation has increased the speed at which technology proliferates. This is especially true for consumer-driven innovations, which spread faster than ever due to the transition from physical to digital goods and powerful network effects in the digital age. For example, while it took 75 years for 100 million people to have a landline telephone, it only took two years and eight months for Skype to reach 100 million users worldwide.

Digitalisation can be also regarded as a game-changer for scientific research, considering its potential for increasing the productivity of science, enabling novel forms of collaboration and discovery, and enhancing research reproducibility (Organisation for Economic Co-operation and Development (OECD), 2019). All areas of research are becoming data-intensive, increasingly relying upon and generating big data. The most evident consequence is that digitalisation poses a challenge in terms of intellectual property production, protection and sharing, and calls for new methods of intangible asset management. It also affects the set of skills that researchers need to master; they must have a good command of digital tools such as gathering, digitising or curating information, but also using computational modelling and simulation methods (OECD, 2020), to name just a few.

To exploit the full potential of science digitalisation, policies must be adapted to reinforce researchers' digital skills and promote open science while preserving intellectual property and ensuring the necessary investment in high-quality data infrastructure. The promotion of the FAIR (findability, accessibility, interoperability and re-usability) principles and the **European Open Science Cloud** will foster the creation of interlinked digital research resources (research data, methods, software and publications). The European Open Science Cloud will enable the vision set out in the communication on "a **European strategy for data** of a single European data space — a genuine single market for data". As noted in the 2020 communication for a **New European Research Area**, the European Commission will, "together with the Member States [...] work towards a world-class research infrastructures ecosystem focusing on the broader range of the EU's policy priorities and improve its governance [...] and establish a new governance structure for Technology Infrastructures."

Research and innovation is critical to delivering on the European Commission's twin priorities of the green and digital transition. The Commission's analysis of digital investment gaps¹⁶ in the European Union relative to its main competitors reveals that EUR 20 billion more per year in public and private investments are needed to foster the development of artificial intelligence, EUR 6 billion per year to support digital green technologies, and EUR 5 billion per year for digital innovations, data and next generation internet. As outlined by European Commission President Ursula von der Leyen in the 2020 State of the European Union Address, both the European Green Deal and the EU Digital Strategy constitute the cornerstone of the recovery plan for Europe, a EUR 1.8 trillion stimulus package. National recovery plans also had to dedicate at least 20% of their funds to supporting the European Union's digital transformation.

New investments are key to boosting productivity and supporting the European Union's twin transitions, as well as to reinvigorating the continent's positioning in digital technologies. The European Union trails behind the United States and China in the number of firms active in artificial intelligence and their patenting activity (De Prato et al., 2019). The United States and China also lead for blockchain startups, with the European Union accounting for only 15% of these startups (Anderberg et al., 2019). Moreover, funding for blockchain startups also appears more readily available in the United States than in the European Union. When it comes to quantum computing, the largest number of applicants are headquartered in the United States, followed by Japan, Canada, and then Europe (Travagnin, 2019). Currently, the market for cloud infrastructure is US-centric, with the top three cloud providers accounting for around 60% of the market. The analysis in the EU **Industrial Strategy** also

¹⁶ DG CNECT estimates, 2 May 2020. The investment gap estimated as a difference between what EU competitors (the United States and China) and the European Union invest (including both private and public investment). Table 2 of **Commission SWD/2020/98 final**.

confirms that the European Union's competitive position appears to be weaker in strategic fields such as artificial intelligence, high performance computing, big data, cloud, industrial biotech and micro-electronics (including semi-conductors).

At the EU level, **Horizon Europe** has also a key role to play, in full synergy with other programmes in enabling the deployment, uptake and rollout of its digital research and innovation activities. Horizon Europe will contribute to these efforts with a substantial increase of spending in digital research and innovation activities compared to the Research and Innovation Framework Programme Horizon 2020 (from which EUR 13 billion was invested in digital research and innovation activities from 2014 to 2020). This should ensure that Europe remains at the forefront of global research and innovation in the digital field.

Horizon Europe features European missions focusing on ambitious but time-bound and achievable goals, such as adapting to climate change or unlocking the potential of smart, climate-neutral cities. Missions can therefore serve as enablers and accelerators for the European Union's digital objectives, by creating experimental spaces for new solutions and serving as focal points for technological applications. For instance, the cancer mission contributes to creating and funding research programmes for developing artificial intelligence screening and diagnostic tools. At the same time, artificial intelligence is also developed and harnessed to research new drugs through intelligent protein and RNA folding research. **European Partnerships** are another key implementation feature of Horizon Europe, which also contributes to achieving the European Union's political priorities. In the digital field, for instance, Horizon Europe has the following candidate partnerships: European Partnership for High Performance Computing, European Partnership for Key Digital Technologies (KDT), European Partnership for Smart Networks and Services and the European Partnership on Artificial Intelligence, Data and Robotics.

Across the European Union, governments have also strengthened both investments and policies to support digitalisation and research and innovation activities in the digital field at a national level. In 2019, the European Union's five biggest public funders of ICT research and development were Germany (EUR 1.8 billion or 26% of public funding in the European Union for ICT), followed by Italy (EUR 802 million or 11%), France (EUR 689 million or 10%), the United Kingdom (EUR 652 million or 9%) and Spain (EUR 523 million or 7%). Together, those five countries accounted for 63% of total public funding for ICT research and development. However, when looking at the rates of ICT public funding as a proportion of total public R&D investments, Cyprus led the way in the European Union with the highest rate (29%), followed by Ireland (15%), Latvia and Sweden (both close to 13%), Finland (12%) and Hungary (11%).

In 2021, national governments have chosen to allocate more than the required 20% of funding to digitalisation in their recovery and resilience plans. In total, across the European Union, more than 27% (about EUR 135 billion) of the Recovery and Resilience Facility is dedicated to digital, and 43% (EUR 210 billion) to green priorities (Darva et al., 2021). Moreover, it appears that artificial intelligence is the largest emerging trend in science, technology and innovation for a number of policies put in place at national level, gathering schemes that support the development, use, adoption or rollout of artificial intelligence systems (OECD, 2020).

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Chapter 6

Living up to Europe's green ambitions

Europe has made significant progress with its climate policies in recent years. The **European Green Deal** outlined its ambition to become the first carbon-neutral continent by 2050, and set an interim goal of cutting emissions by 55% (compared to 1990 levels). The **Fit for 55 package** proposes concrete legislative steps to meet the climate objectives. Other initiatives, such as the **EU Taxonomy for sustainable activities** and the new requirements for corporate disclosure of climate-related information, are improving the understanding and transparency of sustainable activities. Financial intermediaries and investors should now be able to measure and assess climate risks. At the same time, the **Recovery and Resilience Facility**, which is providing EUR 723.8 billion in loans and grants to EU members, will allocate at least 37% of its funds to climate investment and reforms. The European Investment Bank (EIB) has committed to its role as a climate bank by setting operational targets outlined in its **Climate Bank Roadmap**. Taken together, these elements illustrate the central role the climate is playing in European policymaking.

Within this framework, the decisions public and private sector players make about tackling climate change today will affect their future prosperity and determine the ultimate success of decarbonisation efforts. Firms are critical to closing the yawning gap for climate investments and reaching the goal of carbon-neutrality. Pricing climate risks accurately will help the financial sector evaluate projects and potentially redirect savings. In parallel, local governments need to guide the transformation at a local level. Innovation is essential, as some green technologies are still being developed.

The EIB Investment Survey (EIBIS) shows that European firms' climate investments stalled during the COVID-19 crisis, but firms are now eager to restart those investment plans. Large firms and those in green (low-emission) or brown (high-emission) sectors are more likely to invest in climate measures. Small firms and those in transition sectors are less aware of the effort required. Advancements in the regulatory framework are crucial, as uncertainty about regulation and taxation remains the biggest obstacle for EU firms' climate investments. As the framework evolves, EU firms will benefit from a clear path to decarbonisation set out at the national and EU level. Advice on funding and technical support is important to help accelerate the green transition. Those firms with more advanced green management practices are more likely to invest.

The green transition also relies on the transformation of the financial sector and local governments, as well as an enhanced focus on innovation. EU corporate bond markets are showing evidence of a "greenium," or a premium paid for green assets. Urban areas are responsible for a large share of global emissions, making their future infrastructure decisions and other projects essential to tackling climate change. An analysis from the EIB Municipalities Survey shows that addressing climate-related issues is a challenge for smaller municipalities, which can oftentimes lack technical capacity and funding. The climate transition also presents opportunities, particularly in Europe, which already has an early lead in green innovation. If Europe can become a market leader in emerging green technologies, it could reap economic benefits comparable to those gained by the United States because of its digital dominance.

Introduction

Adapting to the potential effects of climate change is a complex and ongoing process requiring actions by firms, individuals, local and national governments, financial market players and international agencies. While the COVID-19 crisis stalled climate investment, the road to recovery presents an opportunity to act and contribute to regional and international climate objectives. The ambitious European Green Deal set out long and short-term decarbonisation targets and a comprehensive set of measures aligning market incentives with the green transition. The Recovery and Resilience Facility will also unleash resources conditional on climate investment and reforms. Overall, the European Union's recovery strategy has the potential to be the much-needed push to accelerate the response to the climate emergency and to contribute to the EU pledge of becoming the first carbon-neutral continent by 2050.

Against this background, this chapter aims to act as a guide for understanding and interpreting the ongoing changes and strategies developed in response to the climate threat. It relies on data from the EIBIS, the EIB Municipalities Survey, and other external data sources to answer key questions concerning the transition to a low-carbon and sustainable economy.

The chapter starts by discussing the greenhouse gas emissions trends in the European Union and the evolution of EU policies addressing the green transition. It then looks in depth at firms' carbon strategies, and assesses the role of the perception of climate risks, the availability of financial resources and other firm characteristics that factor into decision-making. The chapter also focuses on the transformation of the financial sector and provides initial evidence of the existence of a "greenium" (a premium paid by investors with strong preferences for green assets). It then turns to the public sector and assesses how the current transition is forming sustainable development models among municipalities and examines Europe's innovation activities by assessing strengths and weaknesses in the areas of energy and transport and mobility. Lastly, it provides policy recommendations on how to address the obstacles on Europe's road to a clean, affordable and secure energy future.

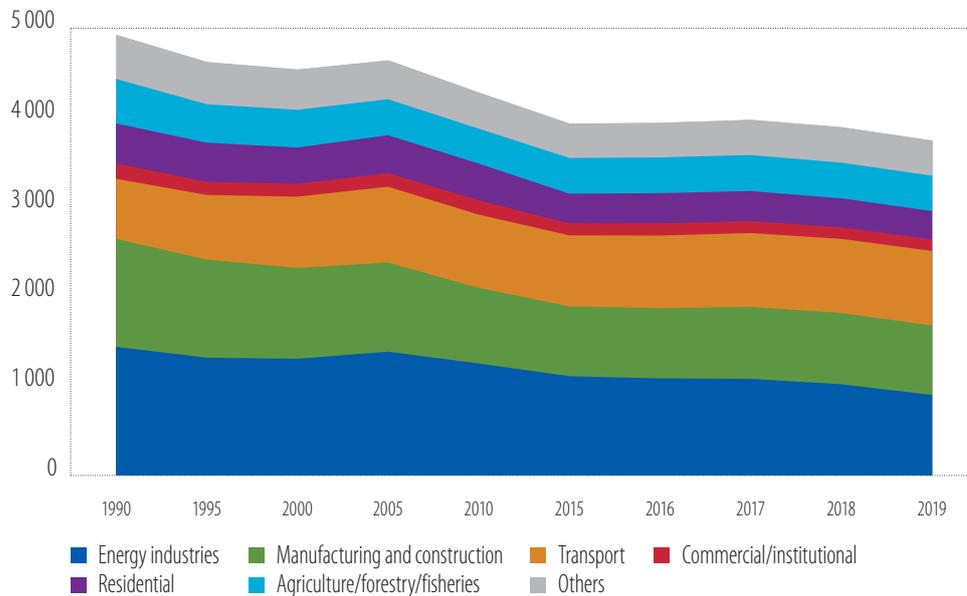
EU policies to address climate change

Europe has made significant progress in acting on its decarbonisation ambitions in recent decades. With the European Green Deal, the European Union clearly stated its goal of becoming the first carbon-neutral continent by 2050 and set an interim goal of cutting emissions by 55% (compared to 1990 levels) by 2030. Greenhouse gas emissions data for the European Union are only available through 2019 (before the COVID-19 crisis), but they point to a 26% overall decline in emissions vs. 1990 levels. Emissions likely fell further in 2020 and the first half of 2021, but the reductions were most probably COVID-19-related and temporary. Similarly, the COVID-19 crisis temporarily resulted in global emissions reductions of 5.8% in 2020, but emissions quickly rose again with the economic recovery.

Before the COVID-19 crisis, decarbonisation efforts were mainly focused on energy efficiency and renewable energy. Figure 1 shows the trend of greenhouse gas emissions in Europe and their distribution across sectors, including households, since 1990. All sectors reduced their greenhouse gas emissions from 1990 to 2019, except for the transport sector. Energy industries and manufacturing accounted for about 55% of the decrease from 1990 to 2019, while the residential sector accounted for about 13%.

By the end of 2019, the overwhelming majority of greenhouse gas emissions in the European Union were from non-residential sources, underlining the importance of reducing emissions in key areas like manufacturing, energy industries and transport. Energy industries, together with transport and manufacturing, accounted for two-thirds of emissions in 2019. By contrast, households represented 8% of greenhouse gas emissions, resulting mostly from higher demand for electricity and heating.

Figure 1
Greenhouse gas emissions from energy and non-energy sources in Europe (Mtoe), 1990-2019



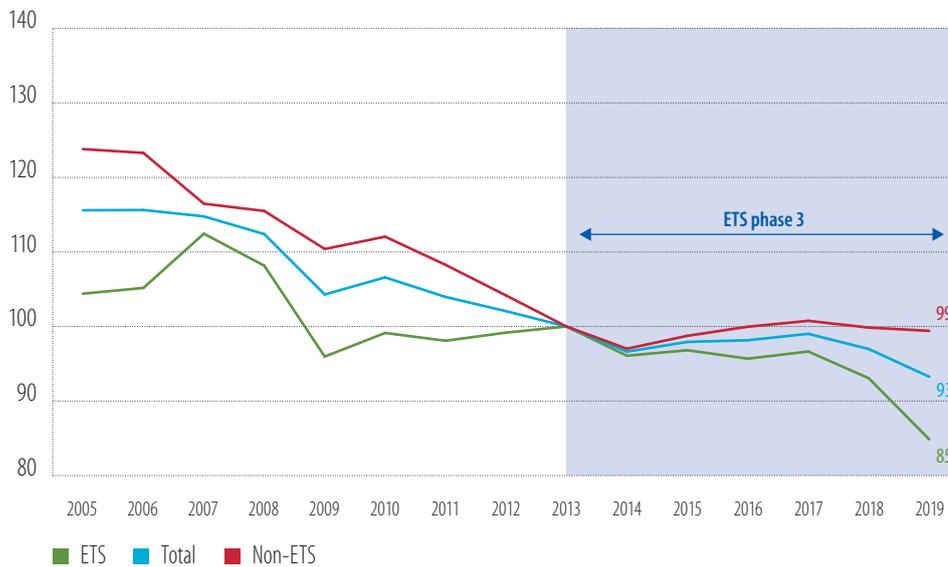
Source: Eurostat.

Notes: Mtoe stands for metric tonnes of oil equivalent.

Most sectors are not held liable financially for the social cost of their emissions, and hence have little incentive to reduce their carbon footprint. If sectors had to pay the true social cost of their emissions, they would be motivated to cut them by changing production and organisational processes, employing different technologies, introducing innovations or simply reducing output. Greenhouse gas emissions could be reduced by making emitters pay for the costs that they impose on others — whether by introducing a tax per unit of emitted greenhouse gas or by requiring the purchase of emission credits.

The European Union Emissions Trading System (ETS), the first large-scale greenhouse gas emissions trading scheme in the world, is showing how greenhouse gas emissions can be reduced by placing a price on them. The EU ETS began operating in 2005 with emission permits mostly freely allocated to greenhouse gas emitting sectors in participating countries. Permit allocations have been centralised since 2013, and many are now auctioned. The ETS has led to a noticeable decline in greenhouse gas emissions from the sectors participating in the scheme compared to those not covered (Figure 2). Free allocations are mostly limited to very carbon-intensive industries (that are included in the carbon-leakage list), whose competitiveness internationally may be endangered by higher production costs. However, the emissions trading system currently only covers 40% of the EU economy.

Figure 2
EU greenhouse gas emissions of ETS and non-ETS sectors (2013=100)



Source: European Environment Agency and European Commission.

Note: The shaded region marks phase 3 of the EU ETS.

Public policies are needed to address market failures, barriers to the abatement of greenhouse gases and distributional impacts. Innovation in decarbonisation technologies needs to rapidly accelerate for enough greenhouse gases to be abated to meet the climate targets. Without government intervention, innovation will remain below the optimal level. Furthermore, information asymmetries prevent investors from assessing how exposed their investments are to climate risks and hinder the mobilisation of private capital for green investment. Lastly, lower income groups are disproportionately affected by carbon pricing because many goods with high carbon content are considered necessities, and spending on these necessities eats up a larger share of income. Government support is therefore needed to address these issues.

The European Green Deal and the subsequent Fit for 55 package constitute a major step forward in strengthening policies to deal with climate change. The European Green Deal and the **European Climate Law**, which codifies Europe's climate targets, represent a credible commitment to the Paris Agreement. Fit for 55 (European Commission, 2021) is a comprehensive package of legislative proposals aimed at meeting the intermediate target of reducing greenhouse gas emissions by 55% by 2030 (relative to 1990 levels). The package contains sweeping measures that, if implemented, will make achieving the 55% target feasible. Directives on renewable energy and energy efficiency contain even more ambitious targets.

Under Europe's climate policies, the Emissions Trading System will be expanded and strengthened, while its distributional impacts will be mitigated. The proposed policy package reinforces carbon pricing by expanding the existing trading system to include the construction and transport sectors from 2026. Further measures, including changes to the framework of EU energy taxes, will also help decarbonise these two sectors. Recognising the implications of these measures on different social groups, the European Commission proposed a Social Climate Fund that will use revenues from the new ETS to help vulnerable households and small businesses integrate these new policies. In addition, the European Union will put in place a carbon border adjustment mechanism to ensure that products from carbon-intensive industries remain competitive and do not have to face imports from regions with less stringent climate policies.

In addition, the Fit for 55 package has updated the Effort Sharing Regulation (ESR) to assign more ambitious emissions reduction targets to EU members. The ESR concerns all sectors that are not covered by the ETS,¹ which together are responsible for about 60% of total EU emissions. Unlike the Emissions Trading System, the ESR is not based on EU-wide price signals. Instead, it consists of regulatory mechanisms that aim to promote specific measures for energy efficiency, renewable energy, eco-design, buildings' energy performance, carbon emission standards for cars and charging infrastructure. Under the ESR, each EU member is assigned a specific emission target based on the country's relative wealth, as measured by gross domestic product per capita.

The introduction of standards for sustainable investments and green bonds, and of new climate disclosure rules for financial investments, will help flow more money to sustainable investment. The European Union is putting in place new regulations to improve the transparency of green investments. The **EU Taxonomy for sustainable activities** (in force since July 2020) provides a common classification system that determines whether an economic activity qualifies as "environmentally sustainable." The taxonomy applies to (i) financial market participants; (ii) entities² falling within the scope of the Non-Financial Reporting Directive (NFRD, in force since 2014); and (iii) EU members and the European Union more generally when setting out requirements for financial products dealing with environmentally sustainable investments. The **European Green Bond Standard** (July 2021) creates a gold standard for issuers seeking to use green bonds to raise funds on capital markets. The Sustainable Finance Disclosure Regulation (in force since 2019) requires financial market participants and financial advisers to provide investors with sustainability-related information for financial products and the underlying assets. The regulation set out clear guidelines on how financial intermediaries should measure and assess climate risks embedded in their portfolios, and included provisions for climate stress tests.

Requiring firms to be more transparent about the climate risks they face will improve the flow of information, and therefore capital. The Non-Financial Reporting Directive requires large public companies with more than 500 employees to disclose information on environmental protection, social responsibility, respect for human rights, diversity, and anti-corruption and bribery. The European Commission adopted the Corporate Sustainability Reporting Directive (CSRD) in April 2021, which effectively amends NFRD reporting requirements. The proposal (i) extends the NFRD's scope to all large companies and all companies listed on regulated financial markets (except listed micro-enterprises); (ii) requires the audit (assurance) of reported information; (iii) introduces more detailed reporting requirements according to mandatory EU sustainability reporting standards; and (iv) requires companies to digitally tag the reported information. All of these measures are helping to build a regulatory framework around climate risk and environmental sustainability.

Enhanced transparency and the recognition of climate risks will likely put pressure on the prices of assets related to carbon-intensive activities. Higher carbon prices and EU targets for renewable energy and energy efficiency, enhanced corporate disclosure and increased investment in sustainability activities will eventually push investors to offload assets in carbon-related industries. Those shifting investment patterns will reduce the value of carbon-related assets and increase the cost of finance. Many assets will become too costly to operate or will simply become obsolete because of new regulations (stranded assets). Carbon-related assets will slowly be replaced by greener, more sustainable ones. Whether these new assets will be more productive and make the economy more efficient is unclear. In the benign scenario, the new assets will result in higher productivity that will ease the cost of the green transition, while in a more conservative scenario, the new assets will just replace the old assets.³

1 Agriculture, buildings (such as commercial services), transport, waste management and small industry.

2 Large listed companies, banks and insurance companies with more than 500 employees are required to disclose non-financial information under the NFRD.

3 Box A elaborates further on this issue.

Box A**Transition policies from a macroeconomic perspective**

This box discusses the implications of climate mitigation policies on the wider economy. Climate policies primarily aim to cut greenhouse gas emissions by absorbing the social cost of carbon emissions into market prices. These social costs will eventually increase the price of carbon-intensive goods and services, making them less competitive. As climate targets become binding, part of the existing capital stock might have to be written off before its economic life is over. The speed of the transition to a carbon-neutral economy will partly determine how much productive capital will need to be written off before the natural end of its economic life.

The less optimistic view is that that large-scale asset substitution could negatively affect economies (Pisani-Ferry, 2021). In the short to medium term, the high level of investment required for the green transition will increase aggregate demand and therefore boost economic activity and create new jobs. However, if the rise in aggregate demand is not accompanied by a rise in productivity, the positive effects of green investments might be limited. As the green investments would replace discarded brown ones, they would not necessarily increase supply. The degree to which aggregate demand would benefit from new, green investments therefore would depend on existing slack in capacity. Otherwise, increasing investment would put pressure on prices and real interest rates, and would absorb more savings.

For individual firms, their leverage will likely increase as green investments simply replace brown assets. The totality of a firm's assets will remain broadly unchanged, while investment in new, green assets will be financed, at least partially, with debt. The increased leverage would likely affect the firms' ability to borrow, especially firms that are already highly leveraged. Moreover, not all firms will survive the transition to a low-carbon economy. A firm's success will depend on its financial condition, managerial skills and existing production technologies. The very nature of some industries (like coal mining) means they are destined to vanish. The losses incurred from such stranded assets pose a threat to the financial sector, too, as firms losing money or forced to write off assets will have less collateral to offer investors and could more generally fail to repay their loans. Significantly large losses could adversely affect the supply of credit, which would further weigh on investments — creating a vicious cycle.

The green transition will also burden the public sector. Governments will need to increase investments in green infrastructure and in spending to compensate vulnerable households for the increased cost of living. Revenues from carbon taxes could help finance part of this expenditure, but probably not all (Pisani-Ferry, 2021). Furthermore, if the green transition slows down economic growth, it will create deficits in public finances already stretched by the pandemic. Less developed countries will have more difficulty raising money for green projects, because their ability to borrow is more restricted and because they tend to pay higher interest rates.

The more optimistic views factor in a significant role for innovation in reducing the cost of greening the economy. The economic literature suggests that innovation is endogenous and can be steered by policies (Acemoglu, 2002). Higher carbon prices will squeeze the market for carbon-intensive goods and therefore likely stimulate innovation, effectively reducing the cost of the green transition. Another well-established feature of innovation is path dependency – once knowledge starts accumulating in a certain area, it facilitates and accelerates further innovations in that area. Past experience attests to the power of directed technical change and path dependency. Aghion et al. (2016), for instance, find that high oil prices boosted energy efficiency innovations in the automobile industry. The impressive decline in the cost of renewable energy in recent decades also points at the potential role of innovation. Stiglitz and Stern (2021) stress that progress in green innovation so far has taken place with modest policy support. They argue that well-designed policies could further boost the pace of innovation.

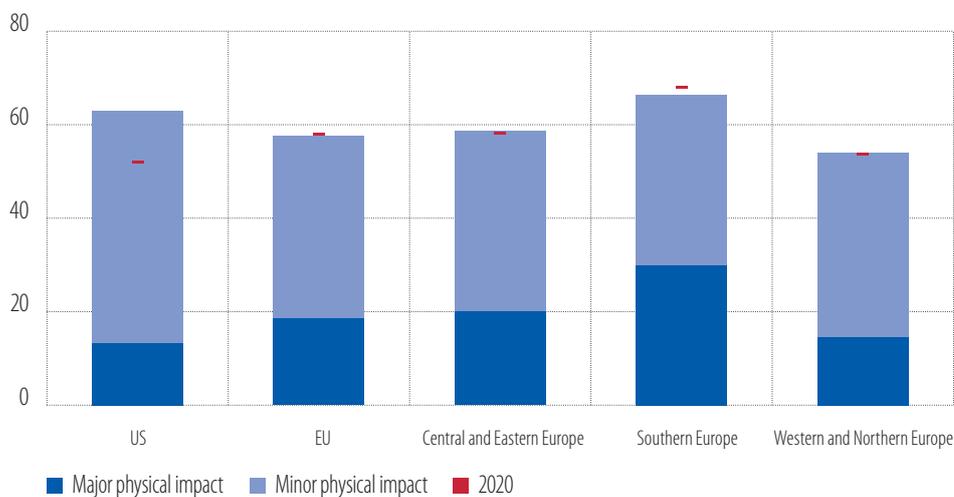
Despite the formidable uncertainties involved, it is widely accepted that the green transition is the only way forward. Most experts liken the effect of higher carbon prices to the oil shock of the 1970s, although policy decisions steer carbon prices, and governments have some freedom in their path. Moreover, other challenges exist, such as providing the workforce with the skills needed to meet the new era, and the need for countries to coordinate policies. Innovation, however, could facilitate the transition by boosting productivity, and therefore could be more akin to a process of creative destruction on a massive scale.

Firms' awareness of climate change

Perceptions of physical risks

A myriad of extreme weather events across the globe in 2021 resulted in human and economic loss. From extreme heatwaves and wildfires in western North America to deadly flooding in Western Europe and Asia, weather events are having repercussions that can be felt by firms. The widespread flooding in Europe in early July alone killed more than 200 people and caused an estimated EUR 2.5 billion in property damage⁴. The consequences of climate change will differ across regions and sectors.

Figure 3
Firms (in %) whose business activities are affected by physical climate risks, by region



Source: EIBIS 2020 and EIBIS 2021.

Base: All firms (data not shown for those who said don't know/refused to answer).

Question: Thinking about climate change and the related changes in weather patterns, would you say these weather events currently have a major impact, a minor impact or no impact at all on your business?

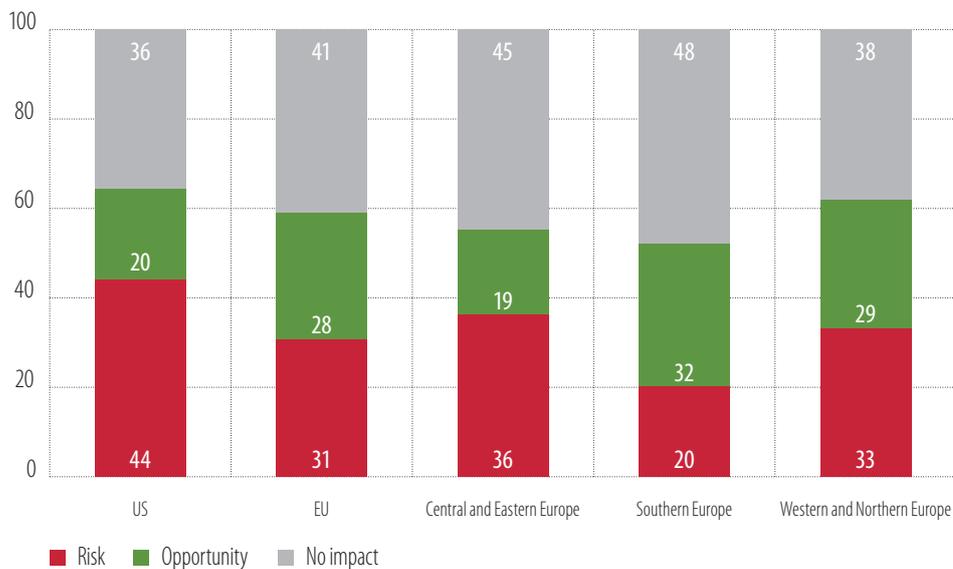
Firms have a rather good understanding of the physical risks of climate change. According to the EIBIS 2021, 58% of European firms say they are affected by physical risks (Figure 3). In the United States, 63% of firms say they face a physical risk from climate change – a substantial increase of 11 percentage points compared to the previous year. Within the European Union, more firms in the southern countries say they are vulnerable to physical risks. Spain has the highest share of firms that feel exposed to physical risks, followed by Romania and Portugal.

⁴ Berenberg sees USD 2 billion to 3 billion in reinsurance losses from European floods, overall losses higher | Reuters

Firms' perceptions of transition risks

Limiting global warming to 1.5°C compared to pre-industrial levels, in line with the climate pledges made at COP26, will require transforming business models. Besides tackling physical climate risks, firms must also prepare for the transition risks caused by the shift to net-zero emissions. Firms face risks as they transform their businesses and adapt to new regulations. They also have to deal with changing market preferences and standards as a country embarks on the path to decarbonisation.

Figure 4
Impact of the energy transition on firms (in %), in the United States and European Union



Source: EIBIS 2021.

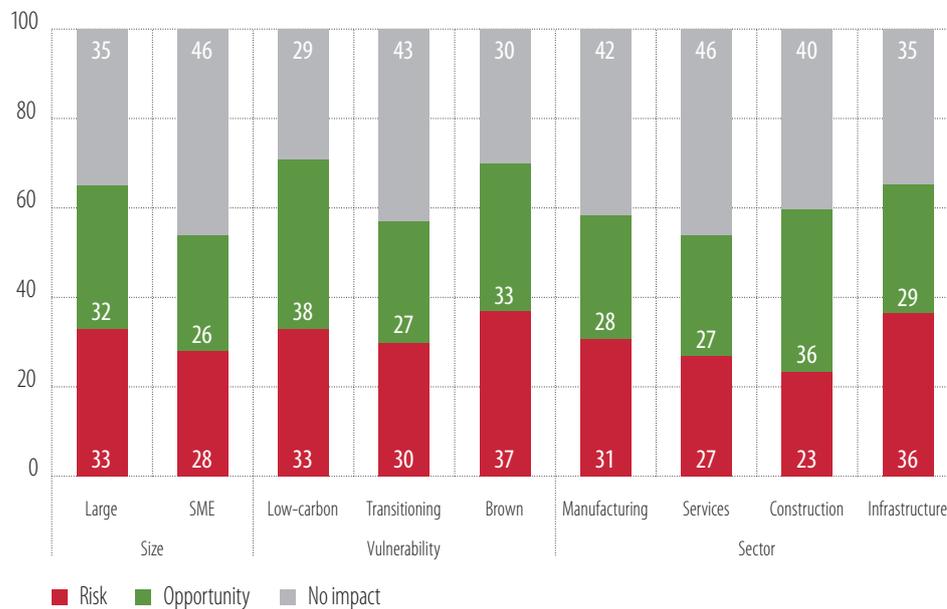
Base: All firms (data not shown for those who said don't know/refused to answer).

Question: Thinking about your company, what impact do you expect this transition to stricter climate standards and regulations will have on your company over the next five years?

The majority of firms in the United States and the European Union expect the green transition to have an impact on their business, with US firms being more concerned about overall negative effects. In the European Union, 41% of firms (Figure 4) believe the transition will not affect their business. This figure is substantially lower than the previous year (51%), signalling that firms are preparing themselves as EU climate ambitions and new regulations come into force. While the majority of EU firms acknowledge that the transition will affect their business, they have a balanced view of whether it presents a risk or an opportunity. US firms overwhelmingly feel that the climate transition represents a risk to their business, with only 20% feeling that they are in a good position to gain from it.

A higher share of firms in Western and Northern Europe believe the transition to a low-carbon future will affect their activities. Nevertheless, these firms hold relatively balanced views on whether the transition will present a risk or an opportunity for their business. Firms in Central and Eastern Europe, on the other hand, seem to be more afraid of the risks, while firms in the south are more focused on opportunities emerging from the green transition.

Figure 5
Impact of the energy transition on EU firms (in %), by firm characteristics



Source: EIBIS 2021.

Base: All firms (data not shown for those who said don't know/refused to answer).

Question: Thinking about your company, what impact do you expect this transition to stricter climate standards and regulations will have on your company over the next five years?

The perception of transition risks varies according to firms' areas of activity, with firms in green and brown sectors⁵ being more aware of risks and opportunities. Almost two in five firms in brown sectors state the climate transition represents a risk (Figure 5). Brown sectors are often subject to increasing regulations related to emissions as well as environmental concerns such as local air quality, water, soil pollution and safety. In contrast, 38% of firms in low-carbon sectors consider they are well positioned to gain from the transition. Firms in transition sectors, which represent the bulk of the EU firms interviewed for the EIBIS, are less worried about the effect the transition will have on their businesses, with 43% expecting no impact.

Large firms tend to cite more transition effects than small firms. Around two-thirds of large firms believe that they will be affected by the climate transition (either positively or negatively), whereas almost half of small and medium-sized enterprises (SMEs) do not perceive any impact (Figure 5). Large firms are more likely to be subject to regulations such as the EU Emissions Trading System (ETS) and have already accounted for the energy transition objectives in their business strategies. However, progressively more restrictive regulation and policy developments could lead to uncertainty and the associated risks.

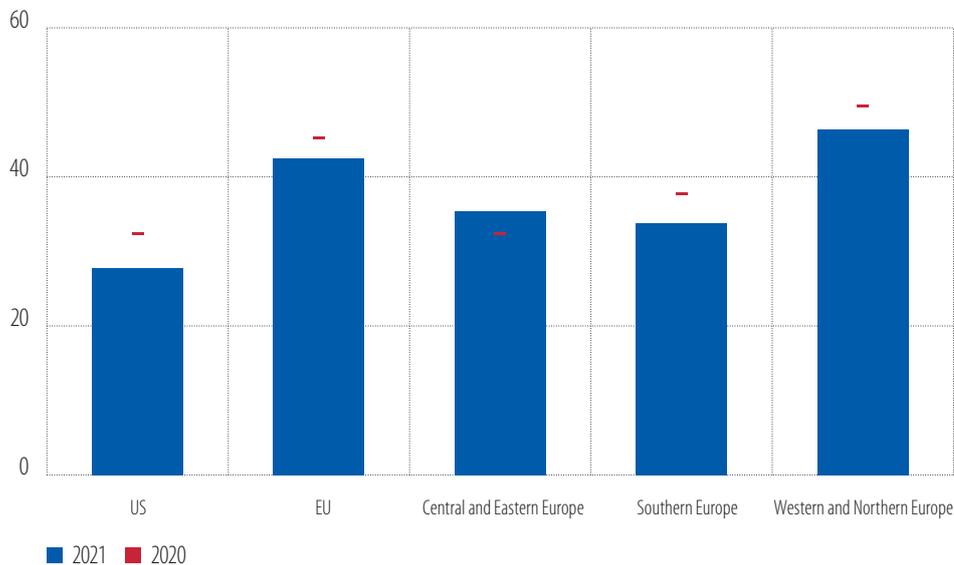
5 The classification takes into account the EIB's climate risk assessment framework and allocates sectors at NACE-4 digit level into the three categories based on their transition risk profiles. For example, railways and electricity networks are considered as low-carbon; consumer goods and retail, and automotive as transitioning; and oil, gas and mining as brown sectors.

Firms' climate investment strategies

Investment in climate change

Around 43% of European firms invested in climate measures to address physical and transition risks, more than in the United States, despite some investment stalling because of the pandemic. The proportion of firms investing in climate measures is marginally below the 45% reported in 2020 (Figure 6), which could be driven by the repercussions of the pandemic on firms' investment plans. Overall, the share of EU firms investing in the climate remains significantly higher than in the United States, where this share dropped to 28% from 32% in the previous year. Firms in Western and Northern Europe are more likely to invest, with the share of firms investing being the highest in the Netherlands.

Figure 6
Firms (in %) investing in climate-related measures to tackle climate change risks



Source: EIBIS 2020 and EIBIS 2021.

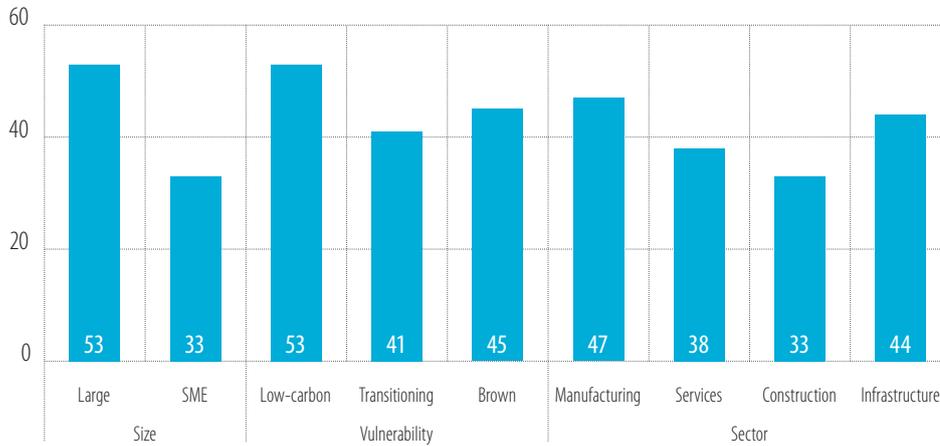
Base: All firms (data not shown for those who said don't know/refused to answer).

Question: Has your company already invested to tackle the impacts of weather events and reduction in carbon emissions?

Energy-intensive and large firms are more likely to invest in climate measures. Energy is an important input for the production process of these firms, and as a result they give higher priority to climate-related projects (Kalantzis and Revoltella, 2019). By contrast, SMEs and less energy-intensive firms consider investments in energy efficiency as low priority, devote fewer resources to energy management, and exhibit lower adoption rates for climate-related measures (Cagno et al., 2010; Gruber and Brand, 1991). The attitude of small firms goes hand in hand with lower awareness of transition risks.

European firms operating in low-carbon sectors are much more likely to invest in climate-related measures, whereas those in transition sectors are investing the least. Some 53% of firms in low-carbon sectors indicate they invest in climate measures (Figure 7), whereas this share drops to 45% in brown sectors and 41% in transitioning sectors. Furthermore, firms in manufacturing and infrastructure are much more likely to invest in climate-related measures. Firms in infrastructure tend to be large, are subject to significant investment costs and are often covered by the EU Emissions Trading System.

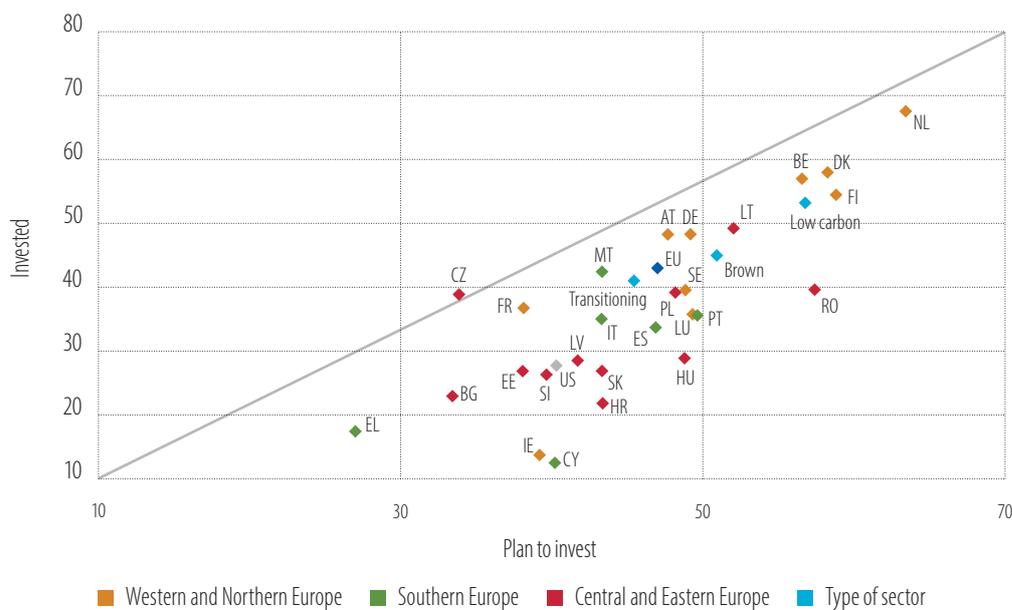
Figure 7
Firms (in %) investing in climate-related measures to tackle climate change risks, by sector and score



Source: EIBIS 2021
Base: All firms (data not shown for those who said don't know/refused to answer)
Question: Has your company already invested to tackle the impacts of weather events and reduction in carbon emissions?

Looking ahead, 47% of EU firms report that they have plans to invest to address climate issues. More European firms plan to invest in climate measures than in the United States, where 40% of firms have investment plans and only 28% have already invested (Figure 8). Within Europe, more firms in Western and Northern countries have invested and are planning to do so in the future than in the rest of Europe.

Figure 8
Past and planned investment in climate-related measures (in %), by country and sector



Source: EIBIS 2021.
Base: All firms (data not shown for those who said don't know/refused to answer).
Questions: Has your company already invested to tackle the impacts of weather events and reduction in carbon emissions?
Does your company plan to invest (more) to tackle these impacts in the next 3 years?

Box B

Five facts on adaptation to climate change

Investments in adaptation will help the existing infrastructure and assets to become climate-resilient and will make the economy less vulnerable to climate change effects that are widespread, rapid and continue to intensify. The funding gaps in adaptation are large, even if there are still considerable uncertainties over the amount of investments needed. Two different estimates show that the European Union will need to invest EUR 35 billion to EUR 500 billion annually (European Commission, 2017). Public sources alone will not be sufficient to meet countries' adaptation needs, meaning that the participation of the private sector is crucial for achieving its goals.

Given the amount of resources that will need to be allocated to adaptation in the coming years, understanding how firms are preparing to invest will be key for policymakers. Using the results from the EIB 2020 add-on module survey, which interviews SMEs in the manufacturing and services sectors, this box presents five facts characterising firms that are already investing or planning to invest in adaptation in the next three years:

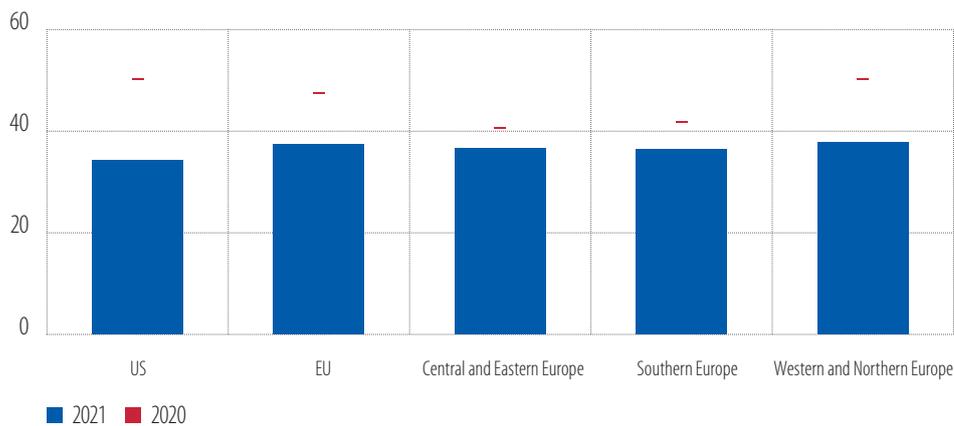
- (1) Plans to invest in adaptation are more frequently mentioned by medium-sized firms than small ones. Approximately 32% of EU SMEs already invest or plan to invest in adaptation over the next three years. Medium-sized firms (39%) are more likely to mention adaptation investment activities or plans than small ones (25%).
- (2) Firms investing in adaptation or with plans to do so are more likely to state that climate change has had an impact on their businesses. Around 52% of firms planning or already making investments in adaptation are aware of climate-induced physical risks, 8 percentage points higher than the share of firms that have no adaptation investments or plans.
- (3) Uncertainty about regulation and taxation, the obstacle most frequently cited by EU firms as reducing the likelihood of investing in climate measures, is also a relevant barrier for firms investing in adaptation or with plans to do so (78%). Clarity on what constitutes an investment in adaptation is also crucial for developing appropriate incentive measures. The European Union's new taxonomy regulation and specific screening criteria for sustainable activities will help reduce uncertainties and improve transparency.
- (4) Almost half of the firms that have received public funding to make their business activities climate-resilient are likely to invest in adaptation. Some 49% of firms that received public support for making climate change investments over the past three years are currently investing in adaptation or are planning similar investments, as opposed to 42% of firms that have not received this public support.
- (5) Almost half of the firms that used the crisis as an opportunity to accelerate already planned changes to their business processes already invest or have plans to invest in adaptation (47%). On the other hand, firms for which the crisis poses an existential threat to their business are less likely to state that they are investing or plan to invest in adaptation in the next three years (36%).

Overall, these insights show the urgency of appropriate policies to support adaptation, not only to enhance awareness, but also to remove barriers to finance by actively providing public funding to support investments. Having the appropriate policies in place will be especially relevant for national governments that need to decide how and where to invest the Recovery and Resilience Facility funds that the European Commission has dedicated to the transition to a greener economy. As part of the EIB's new Climate Adaptation Plan, the Bank is considering increasing its share of adaptation finance to 15% of its total climate commitment, which calls for climate action and environmental sustainability to account for 50% of lending by 2025.

Energy efficiency investments

With the pandemic raging, energy efficiency investments slowed down on both sides of the Atlantic in 2021. However, the share of EU firms investing in energy efficiency decreased less than that in the United States (Figure 9). The significant drop in the share of EU firms investing in energy efficiency was primarily driven by firms located in Western and Northern Europe.

Figure 9
Firms (in %) investing in energy efficiency measures



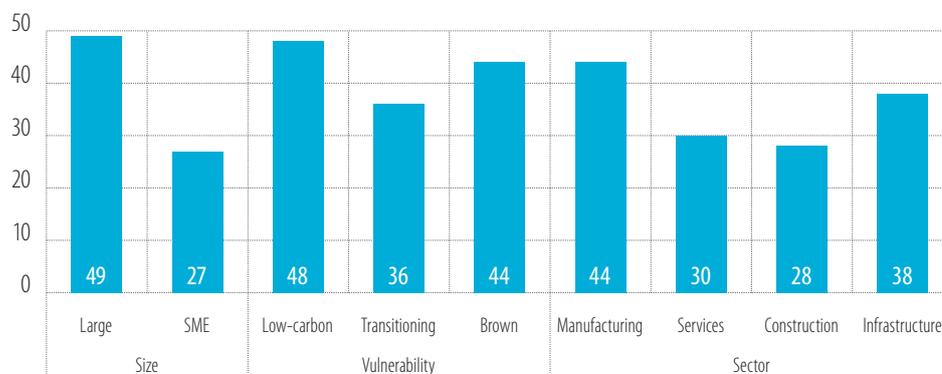
Source: EIBIS 2020 and EIBIS 2021.

Base: All firms (data not shown for those who said don't know/refused to answer).

Question: What proportion of the total investment was primarily for measures to improve energy efficiency in your organisation?

Large firms and those in low-carbon sectors were the most likely to invest in energy efficiency. Similar to climate investments, large firms invested substantially more in energy efficiency than SMEs (Figure 10). Some 48% of firms operating in low-carbon sectors also invested in energy efficiency, compared with 44% of firms operating in brown sectors and 36% in transitioning sectors. The manufacturing sector had the highest share of firms investing in energy efficiency, followed by the infrastructure sector.

Figure 10
Firms (in %) that invested in energy efficiency, by firm characteristics



Source: EIBIS 2021.

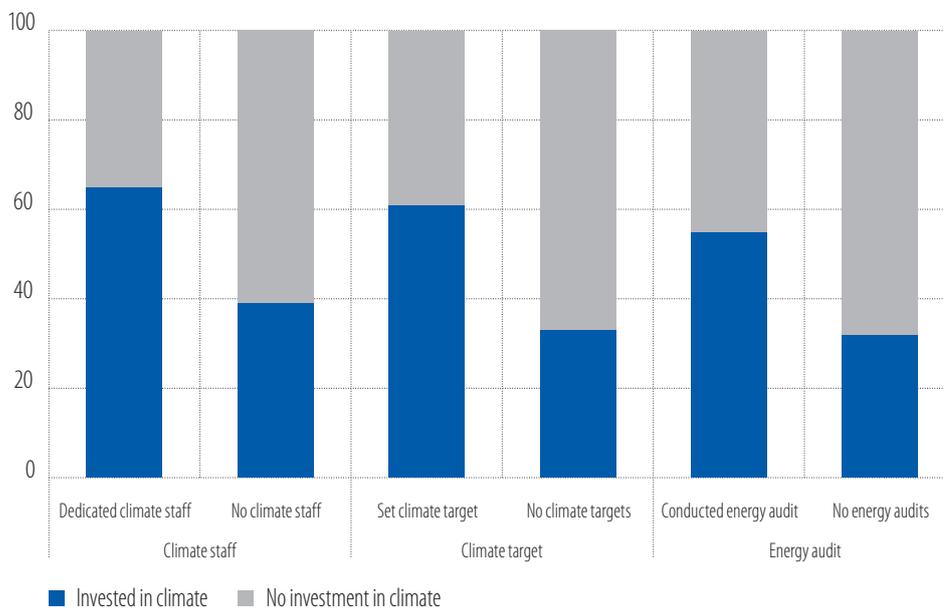
Base: All firms (data not shown for those who said don't know/refused to answer).

Question: What proportion of the total investment was primarily for measures to improve energy efficiency in your organisation?

The role of green management practices and climate perceptions in investment

Green management practices are an important determinant of firms' decisions to invest in climate-related measures. European firms that make an effort to improve their preparedness by implementing energy audits, hiring dedicated climate staff, and setting and monitoring decarbonisation targets are more likely to invest in climate measures (Figure 11).⁶ Around 65% of firms that have dedicated climate staff invested in climate measures, compared with 39% of firms without. Similarly, 61% of firms with internal climate targets and 55% of firms that had an energy audit in the past four years invested in climate measures. In contrast, only 33% of firms that do not set internal climate targets and 32% of firms that have not had an energy audit in the past four years invested in climate measures.

Figure 11
Firms (in %) investing in climate measures



Source: EIBIS 2020.

Base: All firms (data not shown for those who said don't know/refused to answer).

Question: Did your company set and monitor internal targets on carbon emissions and energy consumption? In the past four years has your company had an energy audit? By this, I mean an assessment of the energy needs and efficiency of your company's building or buildings.

⁶ As shown in the EIBIS 2020 (EIB, 2021), a positive link exists between implementing green management practices to improve access to information about climate needs and investment in climate-related measures.

Box C

Corporate disclosure of climate-related information

Corporate disclosure of climate-related information is an important predictor of whether firms' will invest in the climate transition. From the EIBIS 2021, we estimate that half of European firms set and monitor internal targets on carbon emissions and energy consumption. This is a much larger share than in the United States (21%). The share is much higher for large firms (62% in the European Union).

The following text mining analysis assesses how often EU firms disclose their climate-related information based on keywords proposed in the literature. An algorithm in Bloomberg browses all the EU company filings to supervisory authorities and corporate communication documents and traces these keywords at different instances in time, namely in 2015 and 2020. The different elements of climate-related information and examples of keywords used (in parenthesis) were:

- Carbon governance spanning organisational involvement and risk management (plans for organisational involvement; environment committee; workshops; dedicated climate staff; energy managers; energy/climate risk management; risk management procedures; climate change risks and opportunities).
- Carbon measurement and compensation (greenhouse gas emissions inventory; emission reduction targets; monitoring of emission reduction targets; carbon compensation/offsetting; Joint Implementation (JI); Clean Development Mechanism (CDM); Emissions Trading System (ETS)).
- Corporate communication (Global Reporting Initiative (GRI); Carbon Disclosure Project (CDP); ISO26000).
- New markets and product development (new products/markets; research partnerships).
- Process and product improvements (eco-friendly; energy-efficient products; product improvements; new energy-saving equipment; fuel switch; renewable energy sources; process improvements; carbon emissions saved; energy savings), and stakeholder engagement (voluntary initiatives and agreements with non-governmental organisations (NGOs); research institutes related to climate change mitigation voluntary initiatives).

The occurrence of climate-related information in companies' communications has increased compared to 2015 (Figure C.1). The occurrence is particularly pronounced for companies in Western and Northern Europe — where the largest companies in the European Union are located. These firms tend to be covered by regulation on climate-related disclosures. The global trend to move capital towards more sustainable economic activities and the regulatory push in that direction are likely behind the increased occurrences, as well as social awareness of climate change adaptation and mitigation.

Firms are increasingly communicating about their climate preparedness to shareholders and the general public. Communications on climate-related issues increased in last half decade, while corporate communication remained stable. Increased awareness of sustainability issues among stakeholders, demand from business partners and changing social preferences could all be behind the increased communication.

The financial and consumer products sectors drove the increase over time. Climate-related communications from European firms in the consumer goods sector were stable. In contrast, the increase in climate-related communication was most striking for European firms in the financial sector. The rise could be driven by increased regulation for financial disclosures and prudential regulations related to climate change for financial firms.

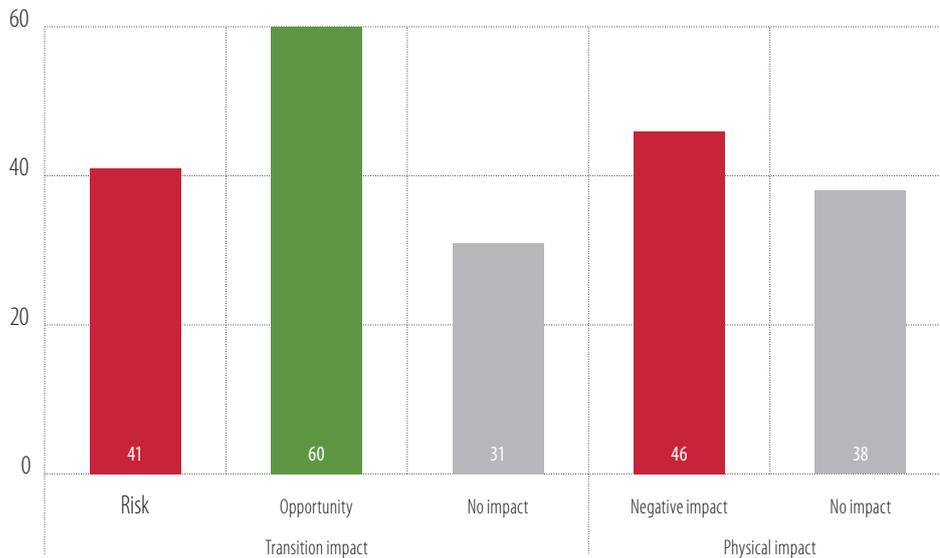
Figure C.1
Number of occurrences, by EU region, component and sector



Source: Bloomberg and authors' calculations.

European firms aware of physical and transition risks tend to invest more in climate measures. In 2021, 46% of European firms whose business was affected by physical risks invested in climate measures, while 38% of firms that did not see an impact still invested (Figure 12). Firms that believe they are well positioned to gain from the climate transition also invested more. Around 60% of EU firms that see the energy transition as an opportunity invested in climate measures. The share drops to 41% for firms that see climate risk as a threat. Firms that do not expect the transition to affect their business activities invested less frequently, with only 31% of those firms investing in climate measures.

Figure 12
Climate investment by firms (in %), according to their perception of physical and transition risks



Source: EIBIS 2021.

Base: All firms (data not shown for those who said don't know/refused to answer).

Question: Has your company already invested to tackle the impacts of weather events and reduction in carbon emissions? Thinking about climate change and the related changes in weather patterns, would you say these weather events currently have a major impact, a minor impact or no impact at all on your business? Thinking about your company, what impact do you expect this transition to stricter climate standards and regulations will have on your company over the next five years?

Box D

Firms' profiles and carbon strategies

Firms' climate investment choices and green practices are part of overarching carbon strategies emerging in businesses. With climate change being recognised as a topical issue affecting business, new literature has explored various corporate carbon strategies in different contexts.

Based on cluster analysis, Lee (2012) identifies six types of strategies using data on six different carbon management activities. The defined firm carbon groups are: "wait-and-see observers," "cautious reducers," "product enhancers," "all-round enhancers," "emergent explorers" and "all-round explorers." While a significant relationship between a firm's carbon strategy and its sector and size was found, no significant relationship between a carbon strategy and firm performance was confirmed.

Other studies have followed a similar approach using clustering techniques and have identified similar corporate carbon strategies. Using firm survey data on emission reduction targets, policies, activities and measurement, and their perceptions of climate change, Kolk and Pinkse (2005) also identify six profiles firms can adopt to address components related to climate change: "cautious planner," "emerging planner," "internal explorer," "vertical explorer," "horizontal explorer" and "emissions trader."

Following a similar line of thought, this analysis opts for a deterministic clustering approach to identify different profiles. Choosing to invest in the climate, planning to do so in the future and setting climate

targets are indicators that communicate part of a firm's carbon strategy. The approach partitions firms into distinct groups based on their similarities across these indicators. Five corporate carbon strategies are then identified: "wait-and-see observers," "planners," "cautious reducers," "short-term explorers," and "forward-looking explorers," as illustrated in Table D.1.⁷

- **Wait-and-see observers** are firms that have not invested in climate measures, do not have any plans to do so in the future and have not set climate targets.
- **Planners** are firms that have not yet invested in climate measures, but have plans to do so in the next three years, irrespective of whether they set climate targets or not.
- **Cautious reducers** are firms that have invested in climate measures but do not have plans to continue these investments in the future. This group also accounts for firms who have set climate targets but have not yet invested in climate nor have plans to do so.
- **Short-term explorers** are firms that have set climate targets and have invested in the past. They are perceived to be short-term thinkers because they do not have further plans to continue investing in climate measures in the future.
- **Forward-looking explorers** follow the most sophisticated strategy with a long-term vision. This group accounts for firms who are investing in climate measures and have plans to continue such investments in the next three years, as well as firms that fulfil the three criteria: they have invested in climate measures, have plans to continue in the future and have set climate targets.

Table D.1
Deterministic cluster approach

	Wait-and-see observer	Planner	Cautious reducer	Short-term explorer	Forward-looking explorer
Climate targets	No	No, Yes	No, Yes	Yes	Yes, No
Climate investments	No	No, No	Yes, No	Yes	Yes, Yes
Climate plans	No	Yes, Yes	No, No	No	Yes, Yes
Observations	3 564	3 380	2 084	1 121	2 516

Source: EIBIS 2021.

Base: All firms (data not shown for those who said don't know/refused to answer).

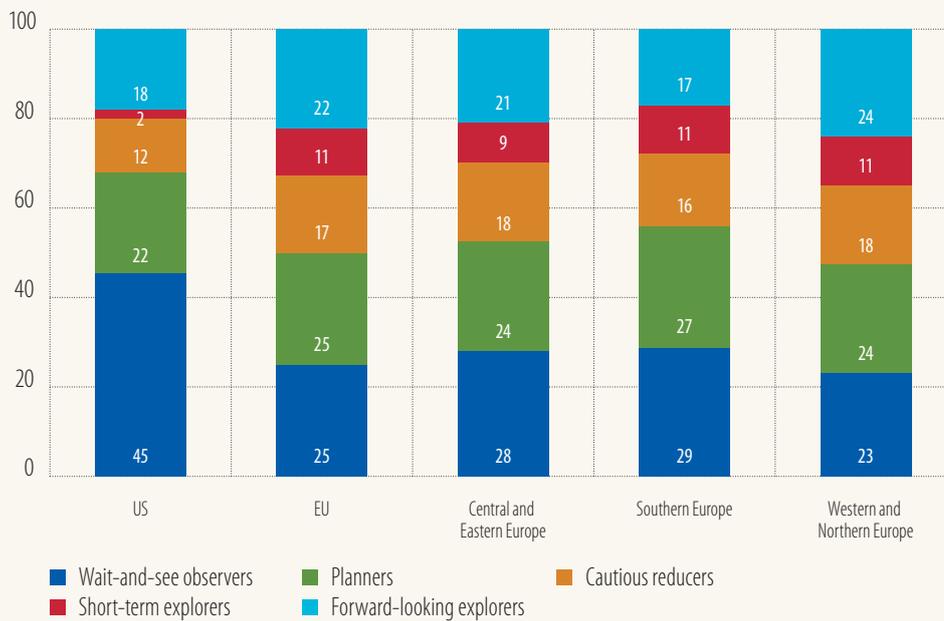
Question: Has your company already invested to tackle the impacts of weather events and reduction in carbon emissions? Does your company plan to invest (more) to tackle these impacts in the next three years? Did your company set and monitor internal targets on carbon emissions and energy consumption?

European firms adopt more climate-friendly strategies than those in the United States (Figure D.1). While the most prevalent carbon strategies among European firms are wait-and-see and planners, the share of wait-and-see observers is substantially lower than the 45% in the United States. Among the more sophisticated strategies, short-term and forward-looking explorers represent 33% of European firms, while this number drops to 20% in the United States. Within Europe, Western and Northern European firms present the lowest share of wait-and-see observers in the European Union and exhibit the largest share of sophisticated strategies in the region.

⁷ The last two clusters encompass more sophisticated strategies, with firms incorporating at least two of the three more active criteria onto their practices

Firms' carbon strategies are positively associated with their perceptions of climate risks. Figure D.2 shows that the marginal effect — or the likelihood that a firm will adopt a certain carbon strategy — depends on their perception of climate risks or their other characteristics. Firms that are aware of physical risks are more likely to be planners or forward-looking explorers than those that do not feel vulnerable to the effects of climate change. Similarly, if firms perceive the energy transition to be a threat, the probability of being planners or forward-looking explorers is higher than for those that do not acknowledge any impact. On the other hand, if a firm feels it is well positioned to gain from the transition, the likelihood of being a forward-looking explorer increases even further. Finally, the results also suggest that firms that are more aware of climate-related risks are less likely to be wait-and-see observers, especially if they have a positive view of the transition.

Figure D.1
Firms' carbon strategies (in %), by region



Source: EIBIS 2021.

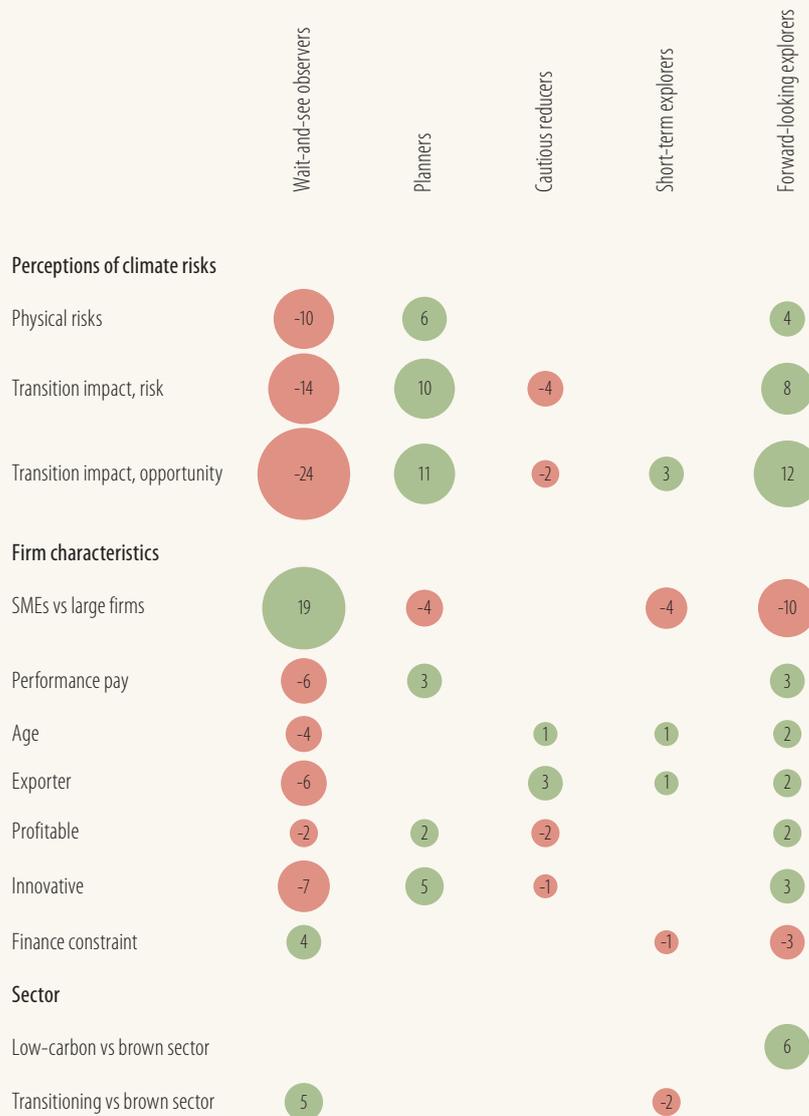
Base: All firms (data not shown for those who said don't know/refused to answer).

Question: Has your company already invested to tackle the impacts of weather events and reduction in carbon emissions? Does your company plan to invest (more) to tackle these impacts in the next three years? Did your company set and monitor internal targets on carbon emissions and energy consumption?

Frontier firms are also more likely to employ more active strategies, namely forward-looking explorers. The probability of companies adopting a forward-looking strategy increases with age, when firms are engaged in an exporting activity, as well as in innovative activities. Similarly, firms with advanced management practices, such as those with performance pay systems, are also more likely to adopt forward-looking strategies.

Conversely, SMEs are more likely to be wait-and-see observers compared to larger companies. Being an SME also decreases the probability of a firm employing a forward-looking strategy. Firms operating in low-carbon sectors are more likely to be forward-looking explorers than those in brown sectors. Meanwhile, the probability of being a wait-and-see observer increases for firms in transitioning sectors compared to brown sectors. This suggests that firms in brown and low-carbon sectors are more motivated to adopt active profiles than those in transitioning sectors.

Figure D.2
Marginal effects of the determinants of carbon strategies



Source: Authors' estimates

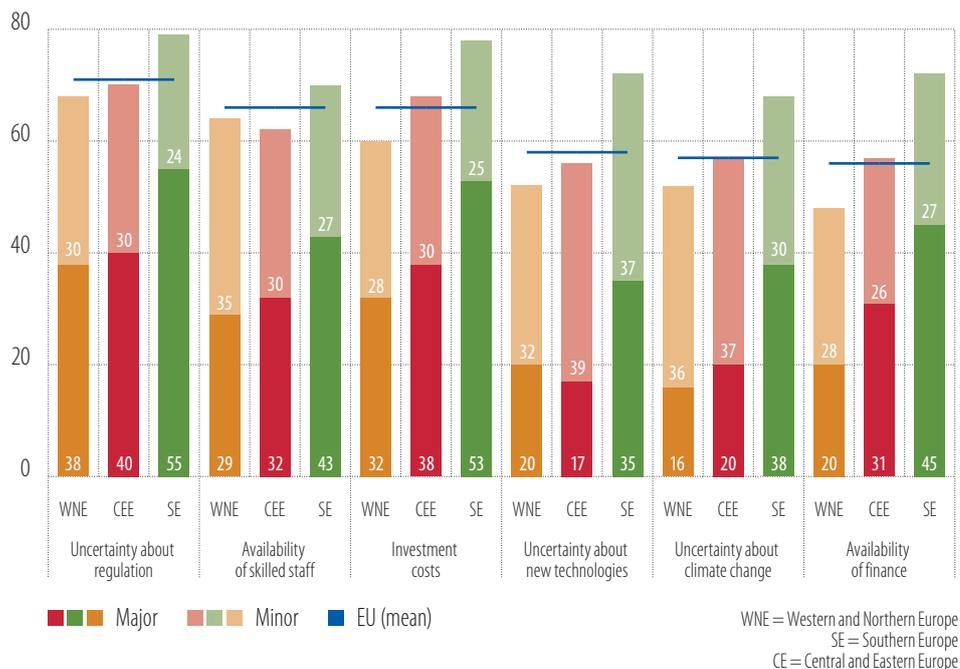
Note: The marginal effects have been estimated based on a multi logit regression, where the dependent variable reflects the carbon strategy (wait-and-see observers, planners, cautious reducers, short-term explorers and forward-looking explorers) and the independent variables concern perceptions of climate-related risks and firm-specific characteristics. The results show only statistically significant coefficients of at least 10%.

Obstacles to climate investment and areas of support for small and medium-sized enterprises

A majority of SMEs (71%) cite uncertainty about regulation and taxation as a factor that would reduce their likelihood of investing in climate measures (Figure 13). Regulations and taxation affect the cost-benefit analysis of climate investments and thus need to be structured in a way that facilitates long-term

climate objectives. Uncertainty about regulation can cause firms to delay or cancel investment plans, as firms need a full picture of the expected cost benefits before investing. These findings are supported by the results of a special module of the EIBIS targeting SMEs in the manufacturing and service sectors.

Figure 13
Obstacles to climate investment in the European Union (in %)



Source: EIBIS 2021 add-on module (AOM) – sample of EU SMEs in manufacturing and services.

Base: All firms (data not shown for those who said don't know/refused to answer).

Question: To what extent, if at all, is each of the following an obstacle to investing in activities to tackle the impacts of weather events and carbon emissions reduction?

High upfront costs and difficulties in finding skilled staff are the other main issues small and medium firms say constrain their investments. SMEs consider high upfront costs to be a significant constraint despite their long-term returns. Firms often do not consider climate change investment to be a core business investment activity, and thus they neglect low-risk investments that have a predetermined and relatively short payback period. To address this issue, firms require specific expertise to conduct the necessary due diligence and successfully identify climate opportunities. However, a large share of SMEs report that a lack of skilled staff prevents them from investing in climate measures.

Small and medium firms in Southern Europe are more likely to identify obstacles to climate investments than firms in the rest of Europe (Figure 14). This is true for all six obstacles. In addition, over three-quarters of firms in Southern Europe report high upfront investment costs as an impediment to climate investment, much higher than the EU average.

Measures to incentivise climate-related investment take several forms. To identify areas of support, the EIBIS 2021 asked firms which measures would encourage them to pursue climate investments, including:

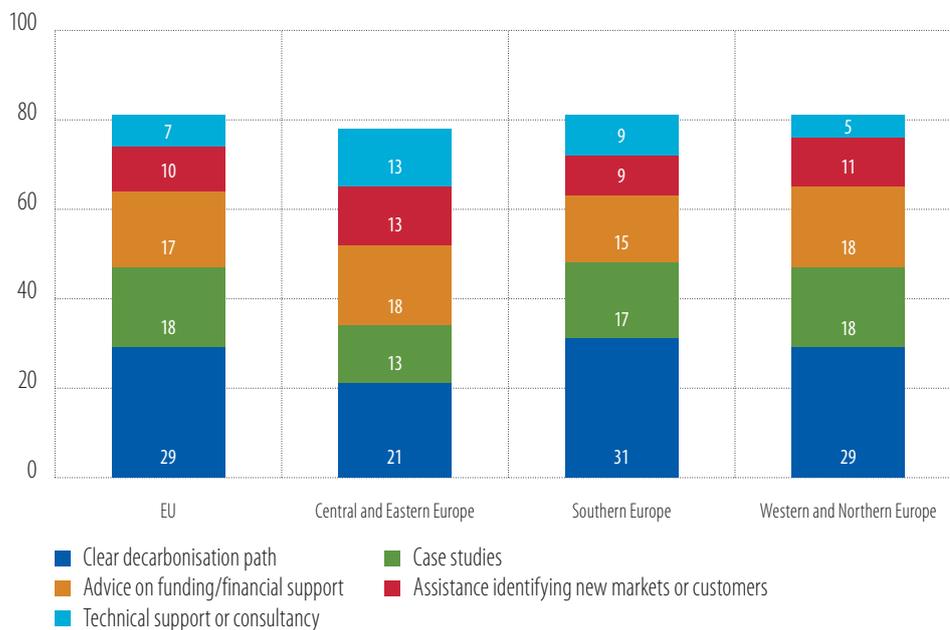
- Advice on funding/financial support available.
- Assistance identifying new markets or customers.
- Technical support or consultancy.

- Case studies of investments and actions that have a positive impact on weather events and carbon emissions.
- A clear decarbonisation path set out at the national or EU level.

Some 29% of small and medium firms say that setting a clear decarbonisation path for the European Union would encourage them to make climate investments. Technical and advisory support would also help. These results follow on previous evidence that regulation and taxation are the most prevalent constraints for climate investment. Advice on the funding and financial support available for projects and technical support or consulting services could also help EU firms to invest in climate measures.

Figure 14

Identified areas of support to advance climate investments in the European Union (in %)



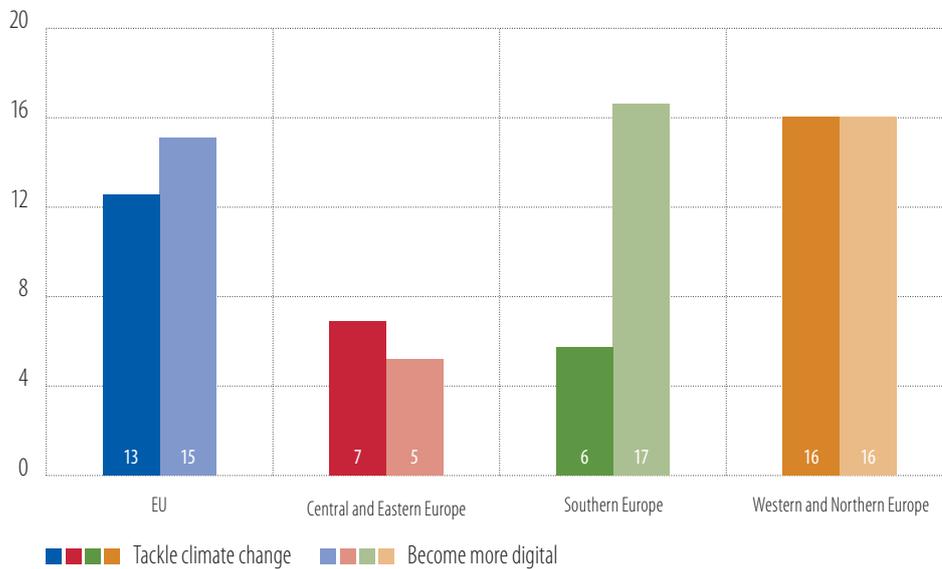
Source: EIBIS 2021 AOM – sample of EU SMEs in manufacturing and services.

Base: All firms (data not shown for those who said don't know/refused to answer).

Question: When thinking about investments or actions to tackle the impact of weather events and carbon emissions reduction, which of the following would you find most helpful?

Providing firms with adequate financial support could encourage them to undertake climate investments despite the high upfront investment costs. Over the past three years, policy support has more often targeted digitalisation than it has climate change efforts, and more EU firms have benefited from public support to advance digital rather than climate investments. Although small, the difference between support for digital and climate investments (2 percentage points more firms received support for digital purposes) is driven largely by firms in Southern Europe, where 6% of firms report receiving public support to tackle climate change compared with 17% of firms who received funds to improve digitalisation. In Central and Eastern Europe, direct support for digitalisation and climate change was substantially lower than in other regions.

Figure 15
Firms (in %) receiving public support to advance climate and digital investments



Source: EIBIS 2021 AOM – sample of EU SMEs in manufacturing and services.
 Base: All firms (data not shown for those who said don't know/refused to answer).
 Question: Have you received in past three years public support (e.g. government grants, subsidies, subsidised finance from the public sector) to accelerate investments in order to ...

The emergence of a green premium in climate financing — evidence from corporate green bonds

The green transition is also linked to the transformation of the financial sector and the emergence of a premium paid for climate-friendly activities. Recent evidence suggests two different sources of a green premium, or greenium, emerging. On one side are investors with a strong appetite for green assets, fuelling demand over and above that of vanilla bonds. These investors might favour assets and companies with a sustainable profile — whether it comes from environmental, social and governance (ESG) standards or the area of activity — and may be ready to pay a premium. At the other end of the spectrum, climate risks might affect the valuations of firms exposed either to physical or transition risks.

Evidence of a green premium in market pricing is gradually emerging. The European Central Bank (ECB, 2021) shows that firms disclosing a climate target have reduced their emissions more than other firms. More ambitious and forward-looking targets are associated with better credit ratings. The EIB Investment Report 2020-2021 shows that as European companies' ESG standards rise, their shares tend to outperform the rest of the European equity market, while a portfolio of green equities has typically outperformed a portfolio of brown equities since the global financial crisis. Alessi et al. (2021) show the existence of a negative green trend in the European equity market. Investors are willing to earn lower returns to hold greener stocks, but only if these companies are also more transparent about their environmental performance. ECB (2021) also notes that initial evidence of a pricing of transition risks is beginning to emerge.

The following analysis investigates the emergence of a greenium in the EU corporate bond market — an initial sign of shifting trends in EU corporate bond markets. The issue of green corporate bonds in Europe has reached record highs. The arrival of the coronavirus pandemic coincided with a significant increase in the issuance of European corporate bonds whose proceeds were earmarked for green projects or activities promoting climate change mitigation or adaptation, or for other environmental sustainability purposes. The share of green bonds in total European corporate bond issuances almost doubled within a year to 8.3% at end-2020 — a record high — and continued increasing (Figure 16). In contrast, the share of non-green corporate bond issues shrank to 92% of total issuances at end-2020. The introduction of the European Green Deal in December 2019 was a defining moment, signalling the determination of the European Union to build a new economic model and make the continent climate-neutral by 2050. Financial investors and firms took note of the new EU climate strategy, implemented the structural changes for their financing required by the incoming regulation and progressively increased the share of green bonds in total corporate bond issuances.⁸

Figure 16
Green bonds (in %) in total European corporate bond issuances



Source: Bloomberg and authors' calculations.

Looking ahead, the share of green bonds in total corporate bond issuances is expected to increase. The further standardisation of green bonds is expected to spark more investor interest and to accelerate the increase in the share of green bonds in total corporate bond issuances. Greater standardisation will improve the comparability of bonds and address concerns about greenwashing or bond issuers' exaggerated claims concerning the environmental quality of underlying projects.

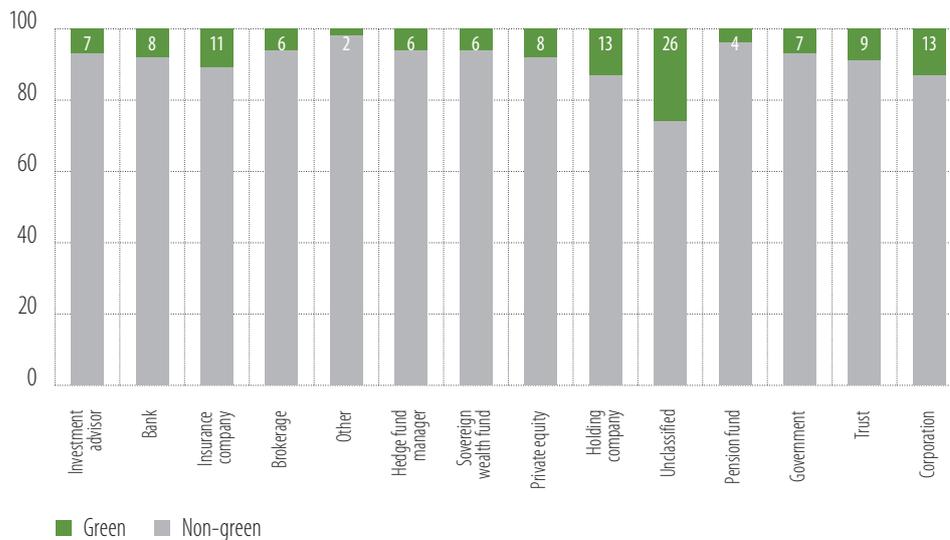
To that effect, the European Commission has proposed the European Green Bond Standard. This initiative aims to create a gold standard for green bonds that can be compared to, and potentially aligned with, other market standards. Its key features include:

- **Inclusivity:** it will be open to all EU and non-EU issuers.
- **Voluntary nature:** it will be a voluntary standard setting out uniform requirements.
- **Alignment with the EU taxonomy:** issuers must allocate 100% of the issue proceeds to economic activities that meet the EU Taxonomy Regulation EU/2020/852.
- **Support for issuers during the transition:** green bonds can be used to fund long-term projects of up to ten years that are engaged in an economic activity aligned with the Taxonomy Regulation's environmental objectives.

⁸ The battery of regulations that followed with the Taxonomy Regulation in 2020, the Sustainable Financial Disclosure Regulation and the adoption of the EU Green Bond Standard in 2021.

- **External review:** European green bonds will be subject to external review to ensure that the bonds are compliant with the requirements proposed by the standard.
- **Grandfathering:** should the EU taxonomy Technical Screening Criteria (TSC) change after a bond issuance, issuers can continue to qualify under pre-existing criteria for a further five years.

Figure 17
Green bonds (in %) in European corporate bond holders' portfolios, by investor type



Source: Bloomberg and authors' calculations.

Non-green corporate bonds dominate investors' bond holdings. The share of non-green corporate bonds in investors' total corporate bond portfolios exceed 70% for most types of investors, and rises to 96% for pension funds (Figure 17). The largest holders of green bonds are corporations, holding companies and insurance companies, in that order.

Box E

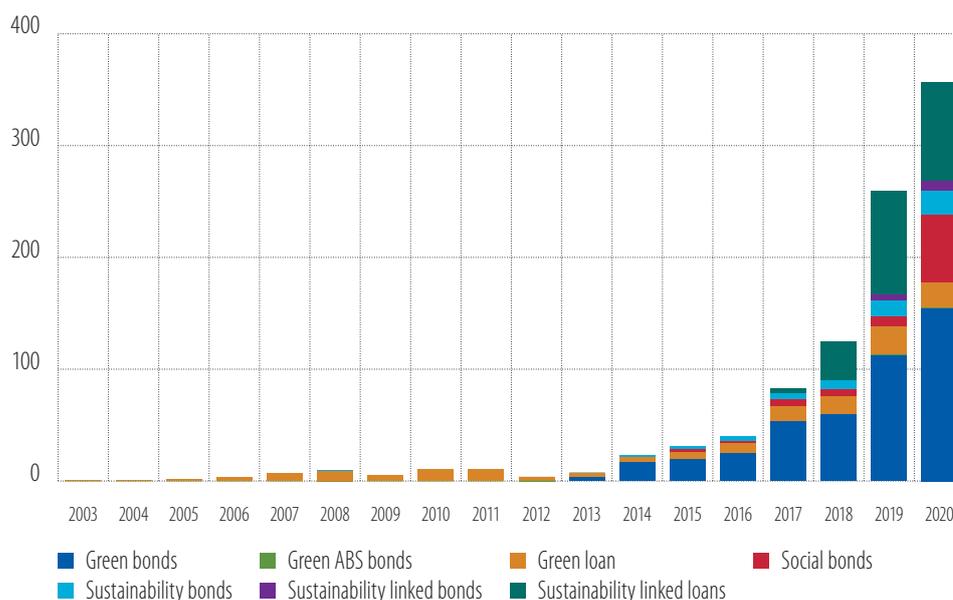
Classification of sustainable debt labels

European firms are issuing record numbers of ESG bonds, with the number of social bonds increasing significantly. Bloomberg categorises sustainable debt as follows (although other labels do exist):

- **Green bond/loan:** proceeds of the fixed income instrument will be applied to green projects or activities that promote climate change mitigation or adaptation, or other environmental sustainability purposes.
- **Sustainability bond:** proceeds will be applied to projects that are dedicated to environmentally sustainable outcomes (a combination of green and social activities as eligible projects).
- **Social bond:** proceeds will be applied toward projects that promote improved social welfare and positive social impact directly for underprivileged, low income, marginalised, excluded or disadvantaged populations.
- **Sustainability-linked bonds:** proceeds where the terms of a fixed income security are aligned with company's (issuer/borrower) performance against relevant predetermined sustainability targets to boost their sustainability profile.

Investors favour ESG bonds over time. According to the above-mentioned sustainable bond classification (see Box E), the issuance of ESG bonds by European entities increased substantially to almost USD 350 billion in 2020, from USD 259 billion a year earlier and USD 40 billion five years before that, attesting to the growing demand for the asset class (Figure 18). The increase was the most pronounced for social bonds, which rose to USD 61 billion in 2020 from USD 8 billion in the previous year, as the coronavirus pandemic increased the financing needs for social welfare projects and projects designed to prevent vulnerable people from sinking further into poverty.

Figure 18
ESG debt issued by European entities (USD billion), by debt type



Source: Bloomberg and authors' calculations. ABS refers to asset-backed securities.

Table 1
Determinants of European corporate bond metrics

Variables	(1) Spread	(2) Rating	(3) Probability of default
ESG	-1.09* (0.56)	0.05* (0.03)	-0.02** (0.01)
Debt to assets ratio	0.28 (0.25)	0.002 (0.01)	0.03*** (0.01)
Revenue (log)	-6.55** (2.61)	2.59*** (0.18)	-0.01 (0.05)
Constant	204.8*** (37.41)	-11.02*** (2.19)	4.68*** (0.94)
Observations	1 120	1 120	1 120
R-squared	0.28	0.27	0.39
Country fixed effects	YES	YES	YES
Sector fixed effects	YES	YES	YES

Source: Authors' estimates.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

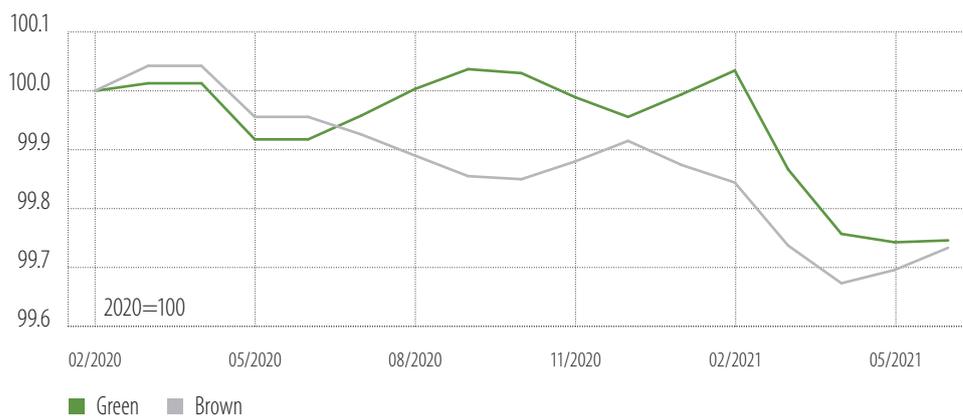
Climate considerations affect the pricing of European corporate bonds. These considerations can be measured through a firm’s environmental, social and corporate governance (ESG) score, which reflects a firm’s performance on a wide range of environmental, social and governance topics.

Higher ESG scores lead to a lower yield spread of European corporate bonds, relative to comparable sovereign yields. This implies that ESG investments are valued more highly than normal corporate investments (Table 1).⁹ A higher ESG score also results in a lower risk of default and a better debt rating for European corporate debt issuers. This implies that the debt of more environmentally aware European firms is of better quality. A better quality fixed income instrument is more likely to be included in investment portfolios, increasing the demand for such assets.

The impact on debt costs is consistent with the available literature. For example, Ginglinger and Quentin (2019) found that greater climate risk led to lower leverage in the period after 2015 and Capasso et al. (2020) suggested that companies with a high carbon footprint were perceived by the market as more likely to default. In addition, Allman (2020) reports that firms exposed to higher sea level rises in the United States pay a premium when issuing bonds, while Bolton and Kacperczyk (2021) report that firms with higher emissions compensate investors by offering higher returns.

Portfolios of green European corporate bonds slightly outperform brown bonds, suggesting that the corporate bond greenium is priced in. The analysis subsequently builds on a brown and green corporate bond portfolio using euro-denominated, bullet, fixed coupon, investment grade European corporate bonds issued after the global financial crisis and available from Bloomberg. On the one hand, the green portfolio consists of equally weighted corporate bonds with an ESG score higher than the median ESG score of corporate bonds issued after the global financial crisis. On the other hand, the brown portfolio includes equally weighted corporate bonds with an ESG score lower than the median ESG score of corporate bonds issued after the global financial crisis. Zooming in on the last two years, which saw a spike in the issuance of green corporate bonds, the analysis finds that the price of the green European bond portfolios observed is higher than that of the brown portfolios, even though the two started at the same level, suggesting that there is a premium for greener corporate bonds (Figure 19).

Figure 19
Prices of green and brown portfolios of European corporate debt (EUR index)



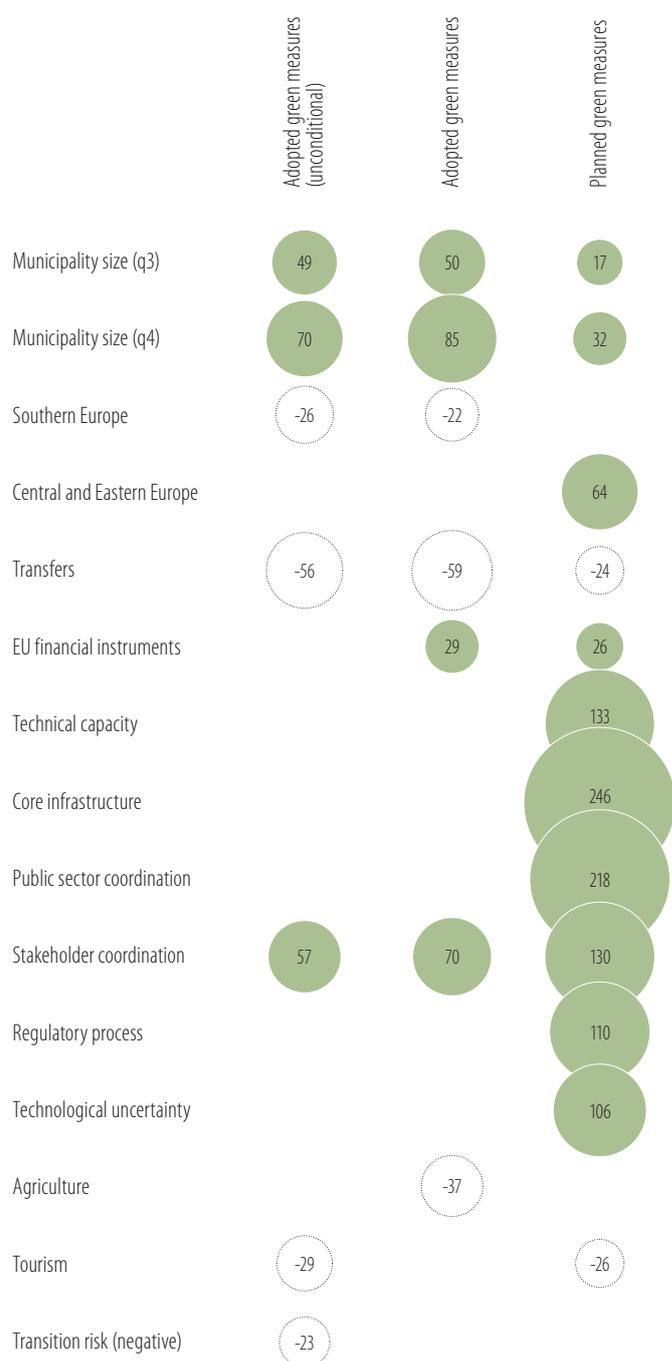
Source: Bloomberg and authors’ calculations.

⁹ The analysis is performed at issuance, for the EU corporate bonds issued since 2010 for which all data were available from Bloomberg. In Table 1: spread is the spread between corporate and government bond yields of comparable maturities; rating is the corporate bond rating provided by Bloomberg (the higher the better); probability of default is the corporate bond’s default probability calculated by Bloomberg (the higher the worse off); debt to assets ratio is self-explanatory; revenue (log) is the logarithm of company revenues; and ESG is Bloomberg’s ESG score (the higher the better).

Municipalities' investment in climate measures

Municipalities are key players in the climate transition. Making use of the EIB 2020 Municipality Add-On Module Survey, an analysis was performed on the factors that influence municipalities' adoption of green initiatives and projects. A number of factors were identified, such as a municipality's geographical position and size, financing sources for recent infrastructure investments, primary sector of employment and the perceived barriers and risks to the green transition (Figure 20).

Figure 20
Factors influencing the planning and adoption of green measures



Source: EIB Municipality add-on module 2020.

Note: The table shows results from poisson regressions. The reported figures are exponentiated coefficient to express percentage differences in the number of measures planned/adopted. The omitted categories are: for regions, Western and Northern Europe; for sectors, the service sector as main employer; for barriers, no barriers reported. Only statistically significant coefficients of at least at $p < 0.1$ are reported.

Larger municipalities and those located in Western and Northern Europe are leading the green transition. The larger municipalities have adopted nearly twice as many green measures. The results also show that municipalities in Southern Europe have adopted about 20% fewer measures than those in Western and Northern Europe, while plans to do so are similar. At the same time, municipalities in Central and Eastern Europe are more ambitious in the number of planned measures, even when those already adopted are taken into account.

The adoption of green measures is linked with municipalities' ability to tap their own financial resources. Municipalities that were able to finance their recent infrastructure investment from their own revenues report having adopted green budgeting. At the same time, municipalities that have financed their recent infrastructure investments largely from project-specific transfers cite a smaller number of measures adopted. In addition, the analysis indicates that municipalities that have recently benefited from EU-funded financial instruments report more green measures, both already adopted and planned.

Municipalities in areas dominated by agriculture are lagging behind. Municipalities engaged in mainly agricultural activities tend to have adopted about 40% fewer green measures than those where employment is dominated by the services sector. In addition, these municipalities are lacking plans to adopt additional measures. The analysis also shows that municipalities that rely more heavily on tourism lag behind when it comes to the number of measures already adopted, but they are making ambitious plans to speed up their climate transition. Municipalities with an extensive financial services sector are more likely to budget for green projects, while those engaged primarily in construction are less active, and are refraining from adopting smart energy grids.

Green transition leaders tend to bemoan a lack of coordination, whereas green planners report issues with infrastructure and technical capacity. When municipalities are asked what is holding them back from green infrastructure investment, the main obstacle mentioned is a lack of financing. However, municipalities' perceptions differ widely depending on where they stand in the green transition. Municipalities with more measures already adopted ("leaders") more frequently mention coordination with stakeholders and prospective users as a key barrier.¹⁰ At the same time, municipalities that have not yet adopted green measures, but are motivated to plan several ("planners"), also cite other barriers. Ambitious planners are more likely to consider a lack of core infrastructure and difficulties in coordinating with other municipalities or higher levels of regional government as the most pressing issues.

Municipalities leading the green transition view climate risks as less pressing. Perceptions of economic gains or losses related to the physical and transition risks of climate change are not only related to actual climate change hazards. They also depend on the steps already taken. Municipalities that have already adopted several green measures are somewhat less likely to expect negative economic consequences from climate risks, and are even less likely to expect a negative outcome from transition risks. Specifically, municipalities that have adopted smart grid technology are less worried about the negative consequences of the green transition.

Innovation and climate change

Patenting for climate change mitigation technologies in the European Union

The development and rollout of technologies that generate environmental benefits is crucial for green growth. It is evident that the climate change challenge cannot be tackled without technological

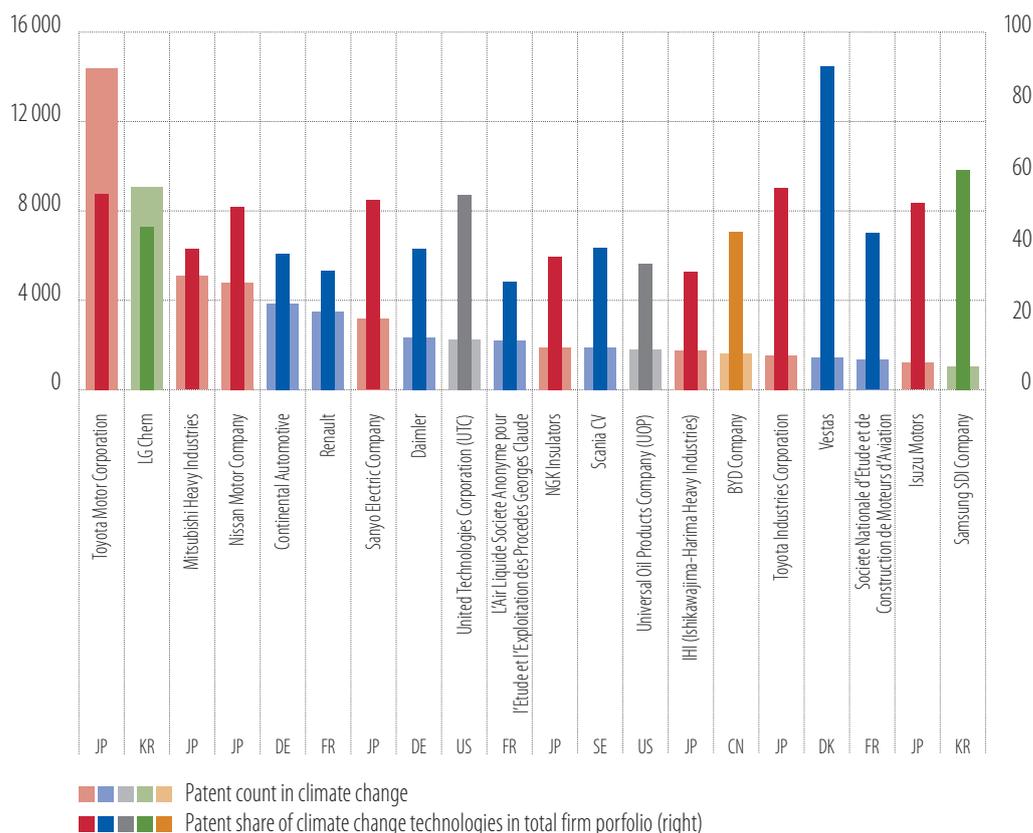
¹⁰ These findings are similar to Aguiar et al. (2018), where barriers to climate change adaptation include insufficient resources and dependence on external financial support, technical capacity, political commitment and uncertainty.

advances (Aghion et al., 2019). Technical progress must be made in a variety of sectors, and green innovations covering a wide array of fields are key. Investing in environmentally friendly technologies and supporting innovation in the private sector are clearly stated ambitions of the European Green Deal (European Commission, 2019). Even though the European Union is one of the main players in green patenting (as discussed in Chapter 2), the trend in climate change-oriented patents appears to be stagnating following a decline in recent years. This seemingly stands in contrast with the high need for new technologies to be developed in this area.

The top 20 companies for climate change patenting are located in the European Union and Japan. The United States and South Korea only have two players and China one (Figure 21). The leading companies in climate change innovation can be measured by the number of patents they hold as well as by the share of climate change patents in their total patent portfolio. Figure 21 clearly shows that the number of patents is not always proportional to the share. A company like Vestas in Denmark, for example, is not at the absolute top for the number of patents produced, but it has a very high relative specialisation in climate change innovations (with more than 90% of the firm's patents in this area). Most of the other companies in the top 20 seem to have a more diversified patent portfolio and do not focus exclusively on climate change innovations.

Figure 21

Top 20 players in climate change innovation worldwide (left axis: patent count; right axis: patent share in %)

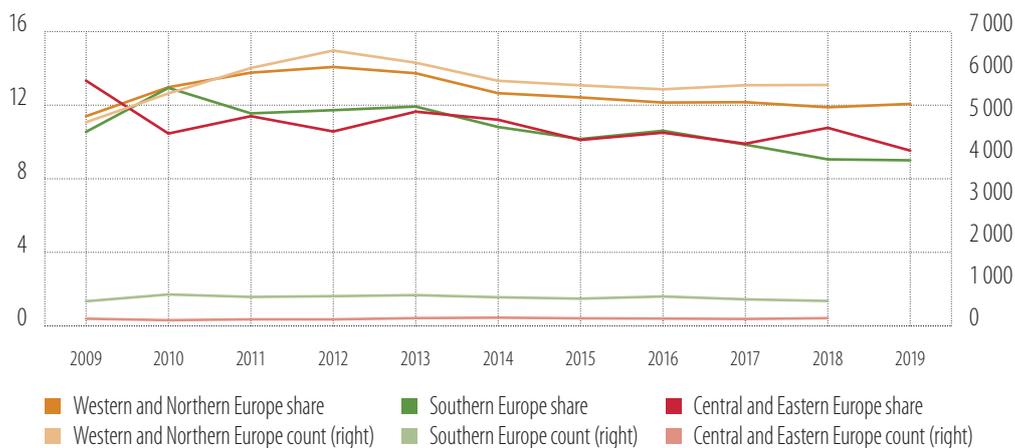


Source: The European Patent Office's Worldwide Patent Statistical Database (PATSTAT). Patent Cooperation Treaty (PCT) data prepared in collaboration with the Centre for Research and Development Monitoring (ECCOM).

Note: The bars reflect the number of climate change patents as well as the share of climate change patents in their patent portfolio for each company from 2000 to 2018. The figure only includes companies with a minimum share of 30% climate change patents in their total patent portfolio. The colours refer to different countries (blue = European Union; red = Japan; grey = United States; orange = China; green = Korea).

Within the European Union, Western and Northern Europe dominate climate change patenting (Figure 22). The number of patents created in Western and Northern Europe surpasses the numbers in Southern Europe and Central and Eastern Europe by an impressive margin. Nevertheless, although Southern Europe and Central and Eastern Europe have a relatively low overall patent count, their relative specialisation levels in innovations tackling the impacts of climate change are similar to those in Western and Northern Europe.

Figure 22
Climate change patents in the European Union (left axis: patent share in %; right axis: green patent count), 2009-2019



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

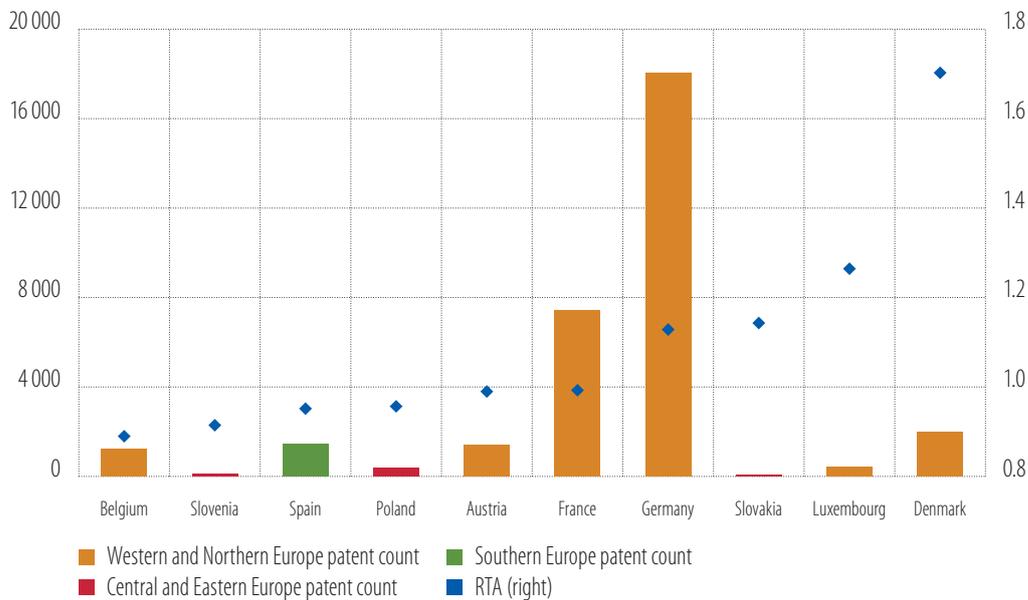
Note: The light lines show the count of green patents (right axis) and the dark lines show the share of green patents in the total domestic patent portfolio (left axis).

Patenting activity in Germany and France stands out, while Denmark, Luxembourg and Slovakia specialise the most in developing green technologies. Overall, above-average patenting is concentrated on a handful of countries with a revealed technological advantage (RTA) above 1 (Figure 23). Most of these top European players focus on innovations related to energy generation, transmission and distribution, and to transport and mobility, except for Denmark, which focuses mainly on energy generation, and Luxembourg, which is mainly active in environmental management innovations.

Europe is strongest in electrification, energy efficiency, and transport and mobility. Not only does Europe have the most internationally oriented climate-related patents in these areas (more than China and the United States), but it has also 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, accounted for almost half of total emissions in 2018. To assess Europe's performance in some of these key domains, this chapter builds on the methodology of Haščič and Migotto (2015) to classify the patented inventions (see Table 2).

Figure 23

Advantage in green patenting across the EU members (left axis: count of patents related to climate change; right axis: RTA), 2013-2018



Source: Authors' calculations based upon PATSTAT (PCT) data in collaboration with ECOOM.

Note: The RTA (revealed technological advantage) index is the share of green patents in the country portfolio relative to the share of green patents in Europe. Only countries with a sufficient number of green patents are shown in the graph. The index was calculated for the time period 2013-2018.

Table 2

Different patent domains in climate change mitigation

Climate change mitigation	Including
The transport and mobility sector and its enabling technologies	Road transport; enabling technologies in transport such as electric vehicle charging and application of fuel cell and hydrogen technology to transportation
Electrification and its enabling technologies	Electrification technologies; supporting technologies in the energy sector; energy efficiency in buildings
Capture, storage, sequestration or disposal of greenhouse gases	Carbon capture or storage; capture or disposal of greenhouse gases other than carbon dioxide

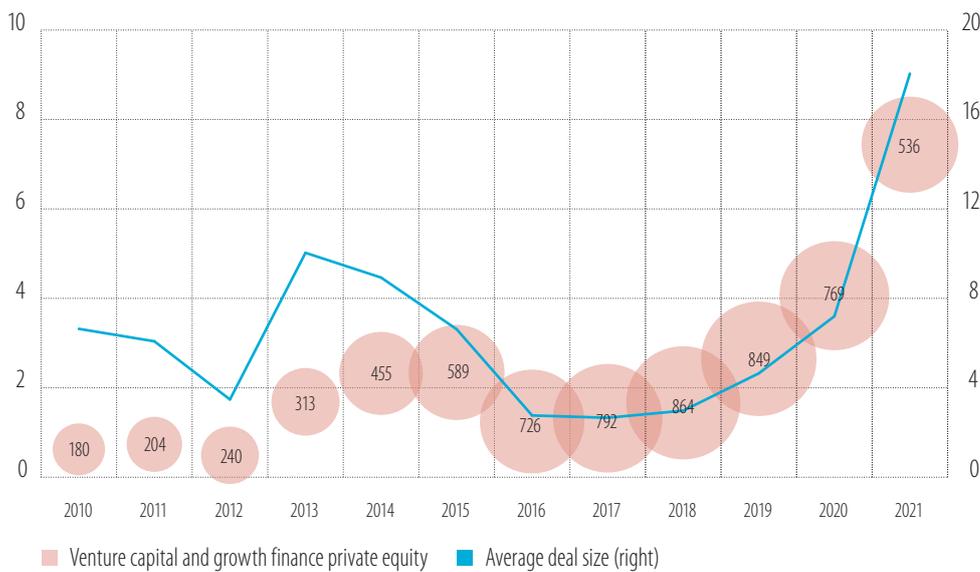
The EU greentech sector¹¹

Supporting innovation among firms focusing on green technologies is a key element of Europe's net-zero emissions strategy. By lowering the cost of greenhouse gas abatement or pollution reduction, greentech innovation can ensure the European Union reaches climate neutrality in a cost-efficient manner. Moreover, innovation can help EU firms to adapt to the reality of an altered climate, for example through the introduction of new crop management or irrigation techniques in agriculture, better weather forecasting technologies, or advances in the field of disease control.

¹¹ The analysis in this section is based on the EIF's European Small Business Finance Outlook. For more detailed information about the data this section is based on, please see Kraemer-Eis et al. (2021).

Financing for greentech innovation has been on the rise in recent years (Figure 24). After a minor setback from 2013 to 2016, venture capital and private equity investments in European greentech companies increased sharply from 2017 onwards, reflecting growing societal concerns about the environment and sustainability, and the increased focus of EU policymakers on private financing as a catalyst for the green revolution.

Figure 24
Innovation finance for European greentech companies (left axis: EUR billion), **venture capital and private equity in the EU27*** (right axis: EUR million)



Source: Kraemer-Eis et al. (2021), based on Pitchbook.

Note: *The bubble surface area indicates annual number of deals in the venture capital and growth finance private equity sphere.

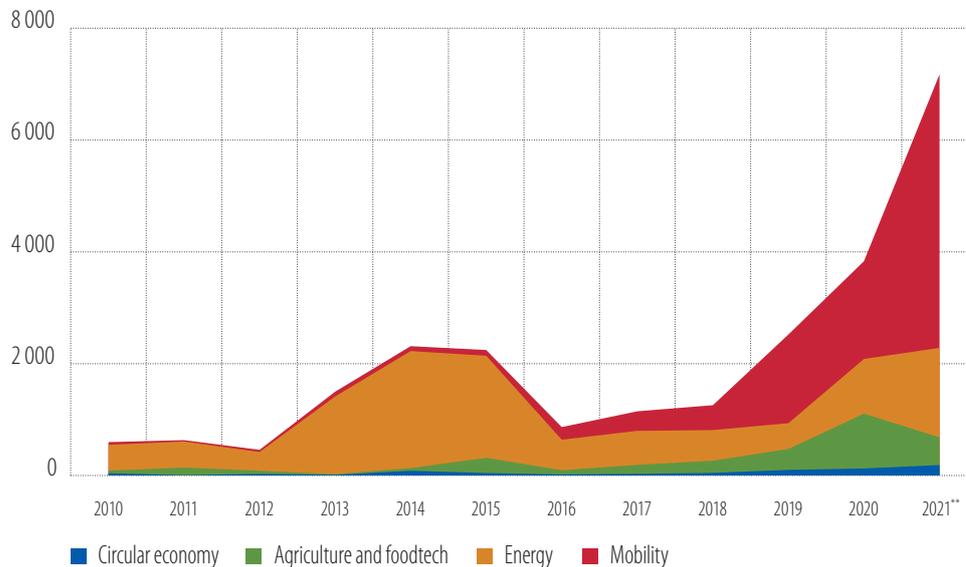
**Incomplete yearly total at the time of data extraction (18 October 2021).

From the third quarter of 2015 until 2021, about half of total investments (venture capital and scale-up) in European greentech flowed to firms focused on mobility and transport solutions (Figure 25). These solutions included electric vehicles, electric vehicle batteries, e-scooters, IT platforms for shared micro-mobility solutions, hydrogen power technologies with applications in transport, electric vehicle technology in the aviation industry, etc.

Another 35% of money invested went to companies working on green energy applications. These businesses are focusing on renewable energy infrastructure (wind farms, solar power generation plants) or equipment (such as photovoltaic panels), new-generation nuclear energy, biogas production, etc. Sustainable food and agritech made up 13% of green tech investments in the EU27 greentech sector (insect-based protein production, sustainable soy production, internet of things technology for vertical farming systems, etc.). Companies active in the circular economy, focusing mostly on waste management and recycling technology, made up 3% of investment.

Investments in European greentech ecosystem are increasingly focused on mobility solutions in recent years. Investments in mobility and transport greentech drove the investment growth, with mobility accounting for nearly 70% of investments during the first three quarters of 2021. This is a welcome trend, considering that decarbonising the transport sector will likely be one of the most challenging aspects of Europe's net-zero emissions plan. Mobility has lagged behind in Europe's sustainability revolution, and current technological developments will ensure that cutting emissions in the transport sector in the next decade will not be too costly.

Figure 25
Trends in the EU greentech ecosystem (EUR million)*



Source: Kraemer-Eis et al. (2021), based on Pitchbook.

Note: * Totals do not perfectly coincide with the volumes represented in Figure 24, as a limited number of deals were not categorised under any of the four categories and were therefore omitted from the analysis. Moreover, the classification method was not designed to construct mutually exclusive categories, leaving open the possibility of a minor degree of overlap.

** Incomplete year data extracted at the time of writing (19 October 2021).

The European Union's path to lower carbon emissions: electrification, energy efficiency, transport and mobility

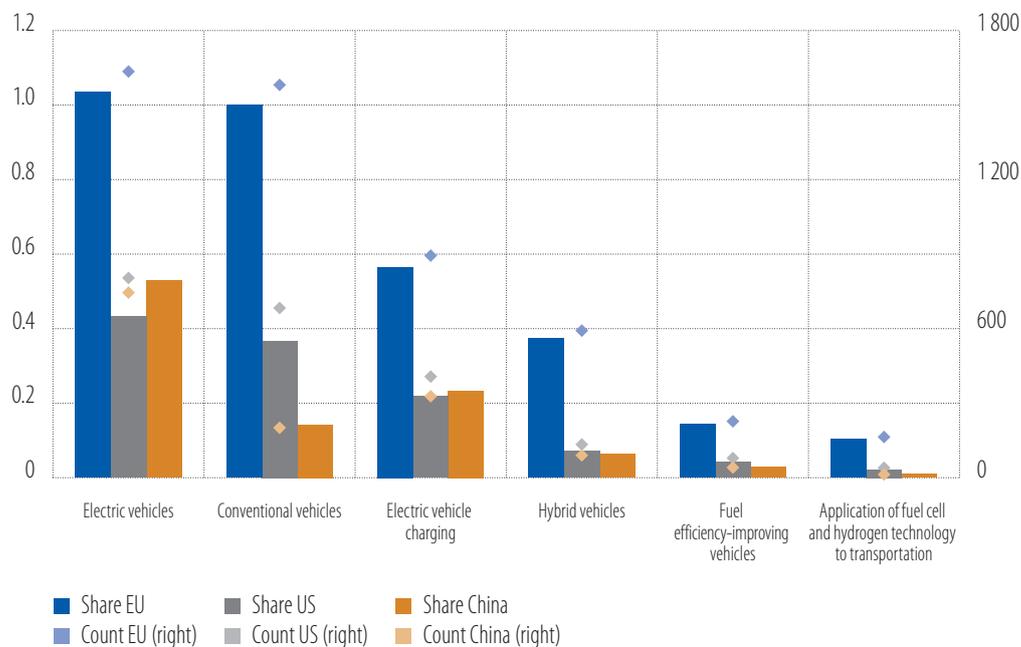
Just as it is leading in overall international patent applications for climate change technologies, Europe is also ahead in transport and mobility, as well as in innovations related to electrification and energy efficiency. Europe is at the forefront of international patenting in these areas, in absolute patent counts and in the share these patents make up of the total domestic portfolio. However, China is rapidly catching up and is intensifying its international presence, especially in inventions related to energy efficiency (see discussion in Chapter 2).

When it comes to transport and mobility, the main focus is currently on electric vehicles, an evolution that goes hand in hand with EU priorities (see Box C in Chapter 5). Still, transport and mobility continue to account for 24% of direct carbon emissions, and the sector needs a radical shift to clean energy (International Energy Agency (IEA), 2020b). Figure 26 shows that Europe is not only prioritising development in electric cars, but is also investing in the charging technologies.

The green premium being paid for investments in electric vehicles and tightening emissions regulations are actually spurring innovation in conventional vehicles. The European Commission's Fit for 55 package targets a 55% reduction in carbon emissions by 2030. In that aim, the Commission will soon introduce new, stricter Euro7 emissions performance targets. These targets are putting pressure on car manufacturers to further improve the internal combustion engine while at the same time investing in electrification. Electric vehicles also come with a green premium, although that premium does not fully compensate for the convenience of conventional vehicles when it comes to autonomy or fuelling time.

Figure 26

Climate change mitigation technologies related to transport and mobility (left axis: patent share in %; right axis: patent count), 2017-2019



Source: Authors' calculations based upon PATSTAT (PCT) data in collaboration with ECOOM.

Note: The diamonds show the count of climate change mitigation technologies related to transport and mobility (right axis); the bars show the share of patents in the respective total domestic patent portfolio for the climate change mitigation technologies related to transport and mobility (left axis).

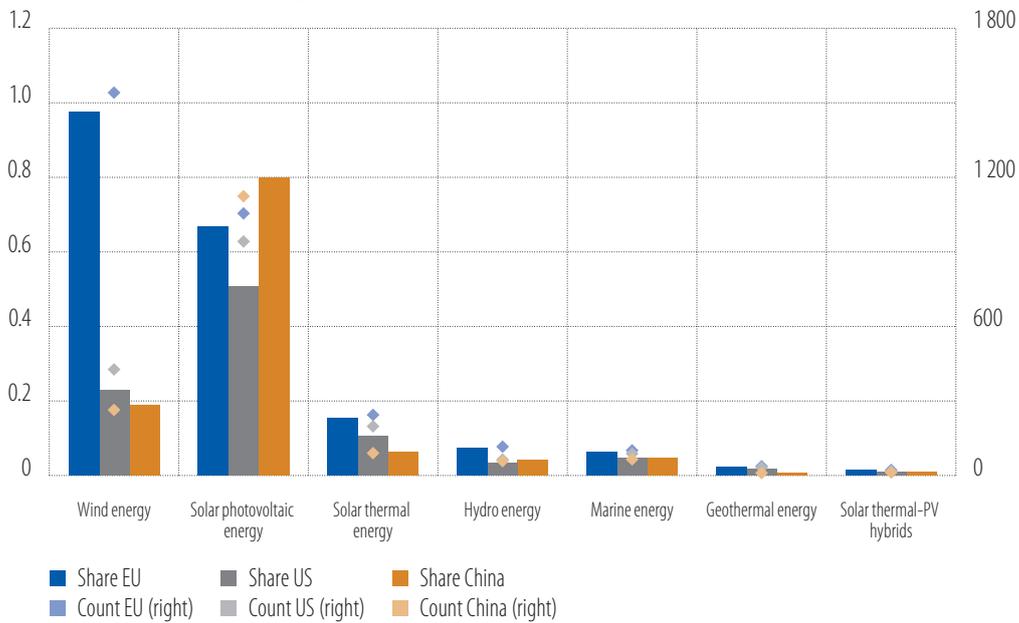
Some of the technologies developed in the transport and mobility sector are closely related to energy efficiency. When it comes to fuel efficiency, electric vehicles or hydrogen technology, innovation is highly dependent on advances in the energy sector. If coal or other polluting fuels are used to generate the electricity needed to charge electric cars, for example, then climate objectives will be hard to achieve.

Europe seems to have a competitive advantage in innovations in wind energy, but not necessarily for solar. Patents in electricity generation are focused on two key technologies: wind and solar photovoltaic energy. While Europe is establishing its presence in the wind technologies, China remains the major force in solar power.

All three of the European regions are intensively developing smart grid and energy storage technologies. These technologies are key to advancements in the energy sector (Figure 27). Europe and China are ahead of the United States when it comes to innovation in both areas.

The world is still largely focused on technologies that are fairly well established, while technologies such as hydrogen require further development. As pointed out by Gates (2021), hydrogen technologies could be a valid alternative for storing electricity. Recent rises in oil and gas prices and the arising energy shortages have called into question Europe's focus on intermittent renewable energy sources. Against this backdrop, it seems even more important to follow the recommendation of the Intergovernmental Panel on Climate Change (2021) and the IEA (2019, 2020) to shift the focus towards a different set of technologies — including hydrogen — that could make it possible to store electricity coming from renewable energy for later use. Nevertheless, as Figure 28 shows, while Europe is putting considerable effort into developing hydrogen technologies, those technologies remain in their infancy.

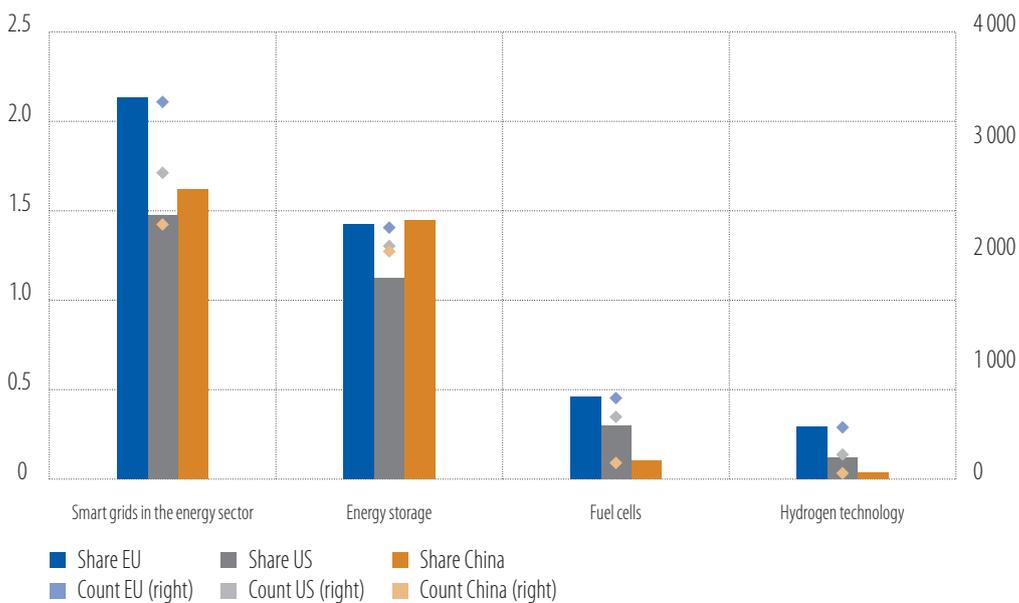
Figure 27
Climate change mitigation technologies related to electrification
(left axis: patent share in %; right axis: patent count)



Source: PATSTAT (PCT) data prepared in collaboration with ECOOM.

Note: The bars show the share of climate change mitigation technologies related to electrification in the total domestic patent portfolio (in %), the dots show the count of these patents in the respective region. PV stands for photovoltaic.

Figure 28
Climate change mitigation technologies supporting electrification
(left axis: patent share in %; right axis: patent count)



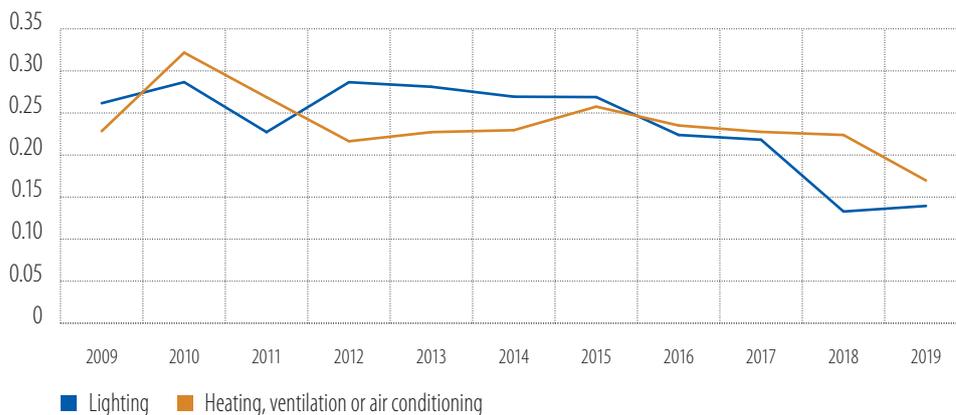
Source: Authors' calculations based upon PATSTAT (PCT) data in collaboration with ECOOM.

Note: The bars show the share of climate change mitigation technologies supporting electrification in the total domestic patent portfolio (in %), the dots show the count of these patents in the respective region.

While hydrogen can help to address the critical energy challenges, its production still depends to a large extent on fossil fuels. Very versatile in nature and easy to store, hydrogen is still almost entirely produced by fossil fuels, mainly natural gas. Nevertheless, hydrogen is often considered as a solution to store energy produced out of electricity, thereby saving renewable energy in peak hours that could otherwise be lost. This could ensure that Europe's bet on wind energy will pay off in the future, and improve the match of energy supply with demand.

Policymakers could also play a critical role in fostering innovations in underdeveloped energy applications. For example, despite the massive energy consumption of buildings (40% of final energy consumption), European patenting for energy efficiency in buildings is at best stagnating (Figure 29). The European Commission plans to introduce a new, separate emissions trading system to cover emissions from fuels in road transport and buildings (European Commission, 2021). Whether the new trading system will create a spur for innovation is yet to be seen, but previous trends suggest that similar policies could stimulate new technologies (see Chapter 8 in EIB, 2021 and Calel and Dechezleprêtre, 2016). Higher fuel prices could also boost innovation. For example, using patent data, Aghion et al. (2016) focused on the car industry, showing that higher fuel prices boost innovation in low-carbon technologies while curbing innovation in high-carbon ones.

Figure 29
Climate change mitigation technologies addressing building energy efficiency improvements in lighting and heating in the European Union (% of energy efficiency patents in total portfolio), 2009-2019



Source: Authors' calculations based upon PATSTAT (PCT) data in collaboration with ECOOM.

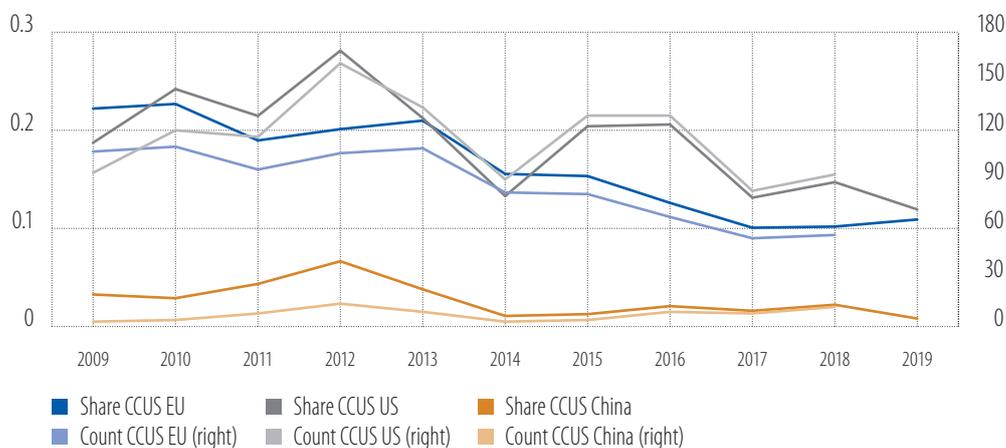
Other green approaches: capture, storage, sequestration or disposal of greenhouse gases

A different approach, such as the exploitation of carbon capture, utilisation and storage (CCUS) technologies, could play an important role in meeting global energy and climate goals. The most recent IPCC (2021) report puts capture and storage technologies at the heart of its proposed solutions, and the IEA (2021) also stresses the importance of these technologies.

While carbon capture and storage technologies are being deployed with increasing regularity, the technologies are still not living up to their full potential (IEA, 2021) — more innovation is needed. CCUS could tackle emissions from existing infrastructure and from the most polluting industries, supporting the production of low carbon hydrogen and, more ambitiously, removing carbon from the atmosphere. Nevertheless, more innovation is needed — and fast — to deploy these technologies against a ticking clock.

Figure 30

Technologies related to carbon capture and storage (left axis: % of patents in total portfolio; right axis: patent count), 2009-2019



Source: Authors' calculations based upon PATSTAT (PCT) data in collaboration with ECOOM.

Innovation in carbon capture and storage is moving very slowly, and the current trend shows a decline in patenting (Figure 30). The decline in patenting contrasts with the increased deployment of these technologies across regions and applications (IEA, 2021). In spite of greater momentum, larger-scale technological development is still required to make this technology commercially viable and ready for wider deployment.

However, as with climate change innovation in general, market prices do not factor in the potential environmental benefits of these technologies. The incentives for private market players to invest in these type of technologies — without clear rewards and high risks — are very low (Popp, 2019). The lack of incentives for the development of these technologies has led to less-than-optimal levels of green investment. Policy support could help rectify the situation.

In addition, growing consumer and market pressure could motivate firms to further develop technologies such as carbon capture and storage and hydrogen. A large share of firms react to consumer preferences, market demand, energy prices and cost savings. These findings are supported by the trend in patent applications and fossil fuel prices discussed in Chapter 8 of EIB (2021) and the patent trends observed in building energy efficiency.

Even if firms devote resources to green technologies, finding funding for energy innovations — and climate innovation in general — is challenging, especially for smaller firms. Due to the novelty of these technologies, the high risk of their benefits spilling over into other industries and high upfront costs, these technologies often have difficulty attracting financing. The often experimental nature of green innovations exacerbates the problems (Nordhaus, 2009; Rodrik, 2014; Popp, 2019).

For most newer technologies, the surrounding infrastructure would need to be adjusted or sometimes changed completely. Infrastructure plays a major role in the application of hydrogen, carbon capture and storage or any other type of technology. If these technologies are to achieve their full potential, existing infrastructure must be adjusted and new infrastructure built.

Conclusions and policy implications

This is the make-or-break decade for avoiding the adverse effects of climate change. Europe has shown leadership, committing to a net-zero economy by 2050 and integrating this commitment into its policies with the European Green Deal and the Fit for 55 legislative package. The EU Taxonomy will also improve transparency on sustainable investments, making them more attractive. This leadership is critical, not least because it provides clarity for firms, households and public authorities on the way ahead, limiting uncertainty.

While the pandemic stalled in climate investment, the road to recovery presents an opportunity to act and to contribute to regional and international climate objectives. The ambitious European Green Deal set out long- and short-term decarbonisation targets and a comprehensive set of measures for aligning the incentives of different players to the green transition. Resources are also being made available. The European Union's comprehensive recovery strategy — which encompasses dedicated climate resources — could be the much-needed push that accelerates the response to the climate emergency and contributes to the region's pledge to become the first carbon-neutral continent by 2050.

Firms are waking up to the reality of what climate change and the green transition mean for them. The EIBIS suggests that 58% of European and 63% of US firms are vulnerable to physical climate risks. Larger firms are more aware of the need to adapt to a low-carbon future, as are firms in low-carbon sectors (which are more inclined to see opportunities) and firms in brown sectors (which are more inclined to see risks). Small firms and firms in transition sectors — the bulk of firms in the European Union — tend to be unaware of the challenges ahead.

European businesses still need to understand what the climate transition means for them, if they are to invest, adapt and thrive in the new era. Firms face new reporting requirements on carbon emissions and sustainability. They also now need to understand their exposure to the risks of the climate transition and climate change itself. Though delayed by the pandemic, climate investments are set to grow, but they need to increase massively. Some 43% of EU firms have recently invested in mitigation or adaptation, while 47% plan to do so (compared with 28% investing and 40% planning to do so in the United States).

Clarity about Europe's plans and technical capacity are essential for firms to make investments in a timely and appropriate way. Interventions deemed "the most helpful" by firms include EU and national-level clarity on climate policy (29%), advice on financial support (18%) and technical support (17%). Greater clarity will help all economic sectors to avoid underestimating the benefits of climate investment. In addition, guidance on finding adequate finance support could encourage them to take on the upfront investment costs and overcome the limited availability of finance, which are obstacles to climate investment. Similarly, technical support would counter the limited availability of skilled staff.

Adopting green management practices — including hiring dedicated climate staff, setting and reporting climate targets or conducting energy audits — acts as a catalyst for climate investment. EIBIS results suggest that SMEs are lagging behind large firms in areas such as green management practices and adaptation investment, suggesting a need for targeted intervention. This support could then be directed at enhancing a firm's ability to adapt to the transition and improving its green capabilities (through technical support and skills training). Increasing technical capacity is also key to increasing municipalities' climate awareness and investment.

The push for greater disclosure of climate-related information is also important to guide and encourage investments in a carbon neutral future. Businesses' investors, customers and other stakeholders are demanding greater transparency and more disclosure of climate change risks. This demand has become so strong that businesses failing to disclose their climate change risks could jeopardise their reputations. In parallel, poor disclosure can lead to poor investment decisions, stranded assets, and the continuation of trade practices that contribute to climate change. Firms need to provide reliable, comparable and meaningful sustainability data. This information will enable institutional investors and banks to incorporate

long-term sustainability risks into their decision-making and to redirect finance towards sustainable investments.

Given that a substantial share of investment is going towards sustainable activities and growing evidence of a greenium in EU corporate bonds, a clear and reliable public framework for green bonds is needed. To this end, the Green Bond Standard needs to be adopted throughout the European Union. Therefore, the standard needs to be made mandatory for newly issued green bonds within a reasonable time period. Until the Green Bond Standard becomes mandatory, it should be encouraged at the European Union and national level by public policies that favour bonds complying with the standard.

The climate transition is a major economic opportunity for Europe, but Europe will only be able to seize it by building on its early lead in green innovation. Market leadership in emerging green technologies might bring economic benefits on a scale comparable with the United States' dominance of the digital domain. For now, Europe is in a lead position. As research and development in these technologies accelerate, Europe will be well placed to maintain its lead, but nothing can be taken for granted. Europe is particularly strong in electric vehicles and charging, wind power, smart grids, fuel cells and hydrogen technology, where its share of recent patents is greater than the United States and China combined. In the areas of solar photovoltaic generation and energy storage, patenting levels by the United States, European Union and China are similar. Moreover, while the United States continues to dominate digital innovation, followed by China, Europe has taken an early lead in patents that combine green and digital technologies.

Policy intervention is needed for clean technologies to be created, developed and rolled out with sufficient speed and at the appropriate scale. It is especially important that the policy instruments — carbon pricing, regulation and public support for clean R&D — are deployed simultaneously and in a coordinated manner, as major synergies could be exploited. Such intervention is needed to overcome inertia among investors and consumers and to stimulate demand for innovative green technologies. A coordinated push could increase firms' appetite for taking risks in the development of technologies (such as hydrogen and carbon capture and storage) that are necessary for Europe to reach carbon neutrality.

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Data annex

The availability and quality of the data on investment are critical to supporting effective policymaking. In addition to national accounts, economists need to rely on other sources of macroeconomic data to analyse important aspects of investment, including infrastructure investment and intangible investment, and they increasingly make use of firm-level data.

The EIB has taken important steps towards bridging some of the data gaps by developing an internally consistent methodology to estimate infrastructure investment and public-private partnership (PPP) finance. It also runs a survey on corporate investment and investment finance and has created a database on patents broken down by activity, based on patent data counted using the European Patent Office's PATSTAT database. Finally it has developed a database on investment in climate change mitigation. This annex outlines these datasets and provides references to detailed methodological notes.

Estimating infrastructure investment in the European Union

Data on infrastructure investment or its financing sources are not available in a ready-to-use form. Over the years, the EIB has developed a methodology to estimate infrastructure investment.

The basic idea is to use Eurostat's national accounts data on gross fixed capital formation (GFCF) in the sectors commonly considered to be "infrastructure sectors" (education, health, transport and utilities) to construct estimates of total and government infrastructure investment (Wagenvoort, de Nicola and Kappeler, 2010). Non-government infrastructure investment is then derived as the difference between the two.

Next, the aggregate non-government infrastructure investment is broken down into project-based and corporate infrastructure investment. Project-based infrastructure investment consists of public-private partnership projects and non-PPP projects. These components are obtained from IJ Global, where EPEC¹ data assist in delineating the portion represented by public-private partnerships. The total remaining after project-based infrastructure investment is subtracted from the non-government figure therefore serves as a proxy for corporate infrastructure investment.

Finally, Eurostat data on gross fixed capital formation in other buildings and structures were made publicly available after the publication of Wagenvoort et al. (2010). Thanks to these data, a more precise proxy for infrastructure investment can be used. These data have the advantage of excluding many non-infrastructure investments — such as investments in trucks or in other machinery and equipment (included in total fixed assets) — and therefore reduce the risk of overestimating infrastructure investments. The Eurostat data also enable us to differentiate between gross fixed capital formation in the transport sector and in the information and communication technology (ICT) sector (which were previously grouped together), giving us a more granular view of individual investment trends across different sectors.

Although the data on gross fixed capital formation in other buildings and structures capture infrastructure investment more closely, a few caveats remain. The most important one is that the data do not enable us to distinguish between GFCF in total fixed assets and in other buildings and structures for the government sector. We therefore have to calculate an approximate total for government investment in other buildings and structures. To do so, we use the following formula:

$$GGFCF(obs) = GGFCF(tfa) * \left(\frac{\text{government net capital stock}(obs)}{\text{government net capital stock}(tfa)} - implied\ depreciation \right),$$

1 European PPP Expertise Data Centre (EPEC) data portal: <https://data.eib.org/epec>

where $GGFCF(obs)$ and $GGFCF(tfa)$ are, respectively, government GFCF in other buildings and structures and in total fixed assets, where implied depreciation is derived for the total economy as:

$$implied\ depreciation = \left(\frac{total\ economy\ net\ capital\ stock(obs)}{total\ economy\ net\ capital\ stock(tfa)} - \frac{GFCF(obs)}{GFCF(tfa)} \right)$$

We therefore use the share of other buildings and structures in the government net capital stock as a proxy for the share of government GFCF in other buildings and structures (adjusted for differences in depreciation rates). In other words, we assume that the share of government GFCF in other buildings and structures is equal to its historical share.

Note that applying this formula requires us to make two minor data adjustments. First, when data on the net capital stock of a country are missing, we replace the missing value with the average net capital stock of the region in which the country is located (Western and Northern Europe, Southern Europe or Central and Eastern Europe). Second, to deal with outliers, we set negative implied depreciation differentials equal to zero.

EIB Investment Survey

General module

The EIB carries out an annual survey of firms in the European Union (EIBIS general module) with the aim of monitoring investment and investment finance activities and capturing potential barriers to investment. The survey covers approximately 12 500 companies across the European Union and the United Kingdom every year and slightly more than 800 firms in the United States for the last three waves. It is administered by telephone (in the local language) and takes an average of 20 minutes to complete. The first wave of the survey took place in 2016 and the survey completed its sixth wave in 2021, with interviews held between April and July 2021.

Using a stratified sampling methodology, the EIBIS general module is representative of all 27 Member States of the European Union, the United Kingdom and the United States. It is representative of four firm size classes (micro, small, medium and large) and four sector groupings (manufacturing, services, construction and infrastructure) within the individual countries.

Firms have to have a minimum of five employees to be interviewed, with full-time and part-time employees counted as one and employees working less than 12 hours per week excluded. Eligible respondents are employees in senior positions with responsibility for investment decisions.

The survey is designed to build a panel of observations over time, and is set up in such a way that survey data can be linked to firms' reported balance sheet and profit-and-loss data (see EIBIS-Orbis matched dataset below). Approximately 40% of the companies interviewed in each wave are companies that have already taken part in the survey in the previous wave.

The EIBIS general module complements pre-existing information on investment activities in the European Union. It adds a firm-level dimension to the macroeconomic data available and thus facilitates a more fine-grained analysis of firm investment patterns. It also adds to existing firm-level surveys at a national level by providing full comparability of results across countries. The survey complements the European Commission investment survey by asking a much wider set of qualitative and quantitative questions on firm investment activities. It rounds out the European Central Bank/European Commission SAFE survey by focusing on the link between firm investment and investment finance decisions.

Table 1
EIBIS at a glance

27	EU Member States are all consistently represented by the survey — more specifically, non-financial enterprises with at least five employees and belonging to NACE categories C to J.
4	industry groupings and size classes determine the representativeness of the data within almost every member country.
11 920	firms belonging to the European Union participated in the last wave of the survey.
802	US firms participated in the last wave of the survey.
43%	of all firms participating in the last wave responded in at least two consecutive waves.
89%	of firms surveyed in 2021 agreed to be contacted again for next year's survey.

The EIBIS is a very powerful instrument built according to the highest scientific standards. To guarantee top quality, every step of the survey process is executed and closely monitored by experts in the field. All steps — sampling and weighting, questionnaire development and translation, the fieldwork, and quality control and data processing — are also subject to strict controls and validation. More information on these technical aspects can be found in the technical report produced by the market research company conducting the survey (Ipsos MORI, 2020). Table 1 presents key numbers about EIBIS.

All aggregated data using the EIBIS general module in this report are weighted by value added to reflect the contribution of different firms to economic output more closely. The aggregate survey data and a detailed account of the survey methodology are available on www.eib.org/eibis.

Representativeness of the general module

The EIB Investment Survey is designed to be representative for the European Union, the United Kingdom and the United States at a country level and for most countries at a country-industry-group and country-size-class level.

In a recent EIB working paper (Brutscher, Coali, Delanote and Harasztosi, 2020), we assessed the data quality of the EIBIS in three steps. First, we benchmarked the sampling frame from which all survey respondents are drawn, the Bureau van Dijk Orbis database, against official statistics to see how well our sampling frame captures the relevant business population.

Second, we compared the final EIBIS sample against firms drawn at random from the same sampling frame and compared statistics constructed from the financial information included in that sampling frame. The purpose of this exercise was to assess whether and to what extent firms' willingness or unwillingness to participate in the survey may have led to a selection bias.

Last, we compared aggregate statistics calculated from the final EIBIS sample to corresponding statistics from Eurostat and the Organisation for Economic Cooperation and Development (OECD). In addition, we compared statistics based on financial information calculated from the EIBIS to the counterpart data obtained from the CompNet database. This purpose of this exercise was to evaluate both the level and dynamics of the financial information calculated from firm-level data.

Overall, the results from all three steps are very positive. First, the assessment of the sampling frame (a comparison of the Bureau van Dijk Orbis dataset with the Eurostat Structural Business Statistics (SBS) for the European Union and the United Kingdom² for the relevant sector/size classes) showed coverage ratios (number of firms in Orbis /number of firms in the SBS database) between 75% and 100% for the majority of countries. The ratio is between 50% and 75% in a few countries, and in only four — Cyprus, Greece, Luxembourg and Poland — does the coverage ratio fall below 50%.³

² For the United States, the statistics were compiled from the US Census Bureau and the Bureau of Economic Analysis.

³ An important driver of the positive coverage ratio is that the EIBIS samples firms with five or more employees. Coverage ratios tend to be higher for larger firms, so excluding the smallest firms from sampling significantly boosts coverage.

The sampling frame must cover a high percentage of the population of interest for the EIBIS survey results to reflect what is happening in the non-financial corporate sector in the European Union. However, this condition alone is not sufficient because, like any other survey, the EIBIS runs the risk of selection bias if there are systematic differences between firms that are willing to participate in the survey and firms that are not.

Secondly, to test whether (and if so, to what extent) the EIBIS sample is subject to such selection issues, we compared the distribution of a set of financial ratios in the final EIBIS sample against those of five samples drawn at random from the same sampling frame. The financial ratios were calculated using information in Orbis. The idea was that statistically identical distributions between the EIBIS sample and the random samples would provide evidence that selection bias does not pose a major issue for representativeness and vice versa.

Using a Kolmogorov-Smirnov approach to compare the two samples, we find that for almost all countries, the percentage of variables for which the null hypothesis of equal distribution in the EIBIS and random samples is rejected is very low, suggesting a high degree of resemblance between EIBIS and the random sample.⁴ In other words, comparing the final EIBIS sample with a series of random samples from the same sampling frame provides little evidence of sampling bias in our data.

Finally, a comparison of the financial information from Orbis for firms in the final EIBIS sample to CompNet data also suggests good coverage of both EIBIS and Orbis information. The CompNet data are based on a “distributed micro-data approach.” Relevant data are extracted from often-confidential firm-level datasets available within national central banks or national statistical institutes and aggregated so that the confidentiality of firm data is preserved. The outcome of CompNet is a wide range of indicators at the country-sector-size-class level.

To assess the final EIBIS sample, we reproduced the same country-sector-size-class level indicators using the Orbis information for firms in the EIBIS (where possible) and compared them to those in the CompNet dataset. What we found is a very close match between the two datasets, with the financial variables in the EIBIS and the CompNet database showing very similar trends.

More information on both the general module and the add-on module in the EIB Investment Survey is available upon request by email to eibis@eib.org.

Add-on module 2021

The add-on module changes every year to provide the EIB with the flexibility it needs to respond to new priorities. In 2021, the add-on module functioned as both an extension module for respondents who completed the general module and agreed to answer some additional questions, and a completely new survey for “fresh” respondents who went through a full set of questions that took approximately 20 to 25 minutes to answer. Approximately 80% of the questions in the full add-on module survey (put to “fresh” respondents) were taken from the general module. The add-on module aimed to gain additional insights into how COVID-19, climate change and digitalisation impacted companies’ investment needs across the European Union.

The 2021 add-on module targeted non-financial small and medium enterprises operating in the manufacturing and services sectors. It was administered in all 27 EU Member States, polling companies in NACE categories C, G and I with a minimum of five employees. No add-on module interviews were conducted in the United Kingdom or United States. Again, eligible respondents were employees holding senior positions in their companies with responsibility for investment decisions and how these are financed.

⁴ The Kolmogorov-Smirnov (KS) test is a nonparametric statistical test for the equality of probability distribution between two samples. Unlike a t-test, KS does not just compare the means of a variable, but also tests the null hypothesis that two samples are drawn from the same distribution by quantifying the distance between the empirical distribution functions of two samples. It therefore compares the shapes of the two distributions and evaluates whether the vertical differences between them are statistically significant.

Similar to the general module, the Bureau van Dijk Orbis dataset was used as the sampling frame for the add-on module in all countries. All data in this report that are taken from the EIBIS add-on module are weighted by value added to reflect more closely the contribution of different firms to economic output.

More information on both the general module and the add-on module in the EIB Investment Survey is available upon request by email to eibis@eib.org.

EIB Municipality Survey 2020

In 2020, the EIB Municipality Survey polled 685 municipalities in the European Union on their infrastructure investment activities and associated barriers.

The survey was administered by telephone (in the local language) among mayors, treasurers and/or municipalities' chief civil engineers. It took a median average of 20 minutes to complete. Fieldwork took place between June and August 2020. As part of the survey, 685 municipalities were interviewed in all 27 Member States, split across the following country groupings (regions).

Table 2
Number of interviews per country grouping

Western and Northern Europe	268
Southern Europe	168
Central and Eastern Europe	255

The sample frame from which municipalities were randomly selected was a comprehensive list of European municipalities. All larger municipalities were eligible to be included in the exercise. The exact size of the cut-off was decided country by country to ensure a minimum number of interviews for each country, which was between five and 57 (depending on the population size). The survey results can therefore be interpreted as reflecting the views of larger municipalities in each country.

Regional and European Union-wide figures are weighted based on the urban population in each country to take size differences into account. Within each country, the answers are unweighted, which gives each municipality the same weight.

More information about the design of the Municipality Survey can be found in the 2020 EIBIS technical report. The publication is available at www.eib.org/eibis.

EIBIS-Orbis matched dataset

This report includes analysis based on a dataset that combines firm-level information from Bureau van Dijk's Orbis with the EIBIS — the EIBIS-Orbis matched dataset. The matching was carried out by the current survey provider Ipsos to preserve firms' anonymity. Orbis is a proprietary dataset that contains firm-level accounting information and ownership data, gathered and standardised according to a global format that makes accounting data comparable across jurisdictions. Items from the balance sheet and profit-and-loss accounts have been used to construct standard financial ratios that reflect firms' financing activity and financial health. All data were reviewed following standard cleaning procedures to eliminate outliers and inconsistencies. Negative values for fixed assets, total assets and other stock variables were removed and all ratios have been winsorised at 1%.

The matched dataset complements the cross-sectional perspective of the EIBIS with time series information starting in 2000. Custom panel datasets used in several analyses in this report were constructed thanks to this dataset.

Patent data

Patents grant the applicant exclusive rights to produce or use a specific new device, apparatus or process for a limited period. More specifically, the legal protection gives patent-holders the exclusive right to make, use, sell or import the patented invention for a set period of time, usually 20 years from the filing date, in the country or countries covered.

By providing protection and exclusivity, a patent encourages investment in research and the subsequent innovative work that will put inventions to practical use. By providing temporary exclusive rights to intellectual property, patents give their holders a competitive advantage. Patents can also be licensed or used to help create or finance a spin-off company. Patent-holders, therefore, can derive value from patents even if they are unable to manufacture the product (as is the case of universities, for instance).

A patent filing contains a wealth of technical information that can be useful for follow-up inventions. In addition, the elaborate and well-structured information stored in patent documents facilitates systematic and objective quantitative analyses that can provide insights into technological progress. Indicators based on patent statistics are widely used to assess the inventive and innovative performance of a country or a region. As such, patents reflect a country's inventive activity and its capacity to use and develop knowledge for potential economic gain.

In addition to containing technical details about the innovation in question, patent applications also disclose material on prior inventions, such as any other relevant patents. While patent statistics can be used to measure innovation, statistics on patent citations can be used to assess the spread of knowledge and technology.

Nevertheless, some caveats exist for patent-based indicators. First of all, the propensity to patent varies by technological domain and country. Second, not all innovations are patented (for reasons of secrecy, for example), and not all patented inventions are innovative or even marketable products. Obtaining a patent does not necessarily mean the patented technology is important or has any commercial value. The value of patents varies widely. Last, some patent activity stems from strategic behaviour (such as blocking out or scaring off potential competitors) rather than innovative and valuable R&D efforts.

PATSTAT

The patent data used in this chapter are sourced from PATSTAT (Worldwide PATent STATistical Database). PATSTAT is a patent statistics database held by the European Patent Office (EPO) and developed in cooperation with the World Intellectual Property Organisation (WIPO), the Organisation for Economic Co-operation and Development (OECD) and Eurostat.

PATSTAT was founded in 2006 and concentrates on raw data, leaving it up to licensed users to create indicators. PATSTAT's raw patent data are collected from more than 100 regional and national patent offices worldwide, including the most important and largest offices such as the EPO, the United States Patent and Trademark Office (USPTO), the WIPO, the Japanese Patent Office (JPO) and the Chinese Patent Office (SIPO).

PATSTAT is a relational database: more than 20 related tables contain information on relevant dates (filing, publication, grant, etc.), applicants and inventors, technological domains, references to prior art, etc. The database is updated twice a year, in the spring and autumn. The data sourced for this report were produced in collaboration with the Centre for Research and Development Monitoring (ECOOM) in Belgium.

Investment in climate change mitigation

Climate change mitigation investments are spread across many economic sectors, they have diverse effects on greenhouse gas emissions and the data sources have varying degrees of accuracy and consistency.

The estimates drawn together in this report are organised under the following headings: renewable energy and energy networks, energy efficiency, transport infrastructure, agriculture forestry and land use, and R&D spending on low-carbon technologies.

These categories correspond to the EU taxonomy: low-carbon activities (such as renewables, electric vehicles and afforestation that are compatible with a 2050 net zero carbon economy); transition activities (such as building renovation that contribute to a transition to a zero net emissions economy in 2050 but that are not currently operating at an expected optimal level); and enabling activities (such as smart technologies and R&D that facilitate low-carbon performance, substantial emissions reduction or environmentally sustainable investments).

Renewable energy

The International Energy Agency (IEA) provided estimates of total investment in renewable energy for the regional blocs (European Union, United States and China). These are based on public information and IEA estimates of capacity additions, combined with estimates of investment costs. End-use renewables (such as rooftop solar thermal) are included in renewable generation. The amount is larger for China than for the United States and European Union.

A proportion of investment in networks is assigned to renewable energy. First, network investment is divided between maintenance (replacement of existing lines) and expansion. All expansion is assigned to renewables, as very little non-renewable capacity is being installed.

The remaining investment in maintenance is divided between renewable and non-renewables according to the share of renewable energy in total generation capacity.

Energy efficiency

The IEA provides estimates of investment in energy efficiency for the United States, China and the European Union from 2014 to 2020. In broad terms, the methodology for calculating these estimates looks at the additional cost of an energy-efficient alternative over and above the less efficient alternative that serves a similar purpose. In the automotive sector, for example, many manufacturers make eco models that are more expensive than the regular model. The cost difference, under the IEA methodology, is assigned to energy efficiency investment. The IEA describes the methodology in detail in its Energy Efficiency Investment Report.

Transport infrastructure

The OECD International Transport Forum (ITF) collects data annually from its member countries, covering investment, maintenance spending and capital value of transport infrastructure. Data are collected from transport ministries, statistical offices and other institutions designated as official data sources.

The lack of common definitions and practices to measure transport infrastructure spending hinders comparisons between countries. While the survey covers all sources of financing, a number of countries exclude private spending. Coverage of urban spending also varies between countries. Indicators such as the share of GDP needed for investment in transport infrastructure depend on a number of factors, such as the quality and age of existing infrastructure, maturity of the transport system, geography of the country and transport intensity of its productive sector. Caution is therefore required when comparing investment data between countries. However, data for individual countries and country groups are consistent over time and useful for identifying underlying trends in levels of spending. Definitions and methods are addressed in a companion report (International Transport Forum (ITF), 2013).

For the United States, the data sources have changed. The 1992-2003 data are from the US Department of Transportation (Bureau of Transportation Statistics, 2005). The 2004-2015 data are from Railroad Facts,

published by the Association of American Railroads.⁵ Since 2004, the data have covered only Class 1 Railroads. Class 1 Railroad capital expenditure accounts for roughly 94% of total railroad capital expenditure.

Forestry

Eurostat data for gross fixed capital formation in forestry up to 2018 are available for the European Union. Data are extrapolated to 2020 assuming a constant ratio to total GFCF. For the United States, data are available from the Bureau of Economic Analysis up to 2020. No data are available for China.

Research and development

The latest research results on the status, forecasts and R&D investment figures for low-carbon technologies are sourced from JRC-SETIS (Joint Research Centre Strategic Energy Technologies (SET-Plan) Information System). Government R&D figures are sourced from the IEA, International Monetary Fund, OECD and various government agencies. Corporate R&D is sourced from the Joint Research Centre of the European Commission for key quoted companies in all clean energy sectors according to Energy Union priorities. The data were made available in current prices in billions of euros rounded to the nearest hundred thousand.

Inflation and exchange rates

Data are presented in real 2019 EUR million. Source data are on different bases and the following procedures were used to convert them to real 2019 EUR million.

- IEA investment data

IEA investment data are in real 2019 USD billion. These were converted to real 2019 euros by applying the average 2019 exchange rate (from Eurostat). Where necessary, the data are further converted to current EUR million using the GDP deflator for the European Union. The GDP deflator is derived from the Eurostat data by rebasing to 2019=100. This rebasing preserves the implied inflation rates year by year.

For the real data in euros, these procedures preserve the growth rates in the IEA data.

- OECD data and Eurostat data on forestry and transport

These data are in current prices in euros and are converted to real 2019 euros using the applicable GDP deflators. The country-by-country deflators are derived from the Eurostat data and rebased to 2019=100 as described above. Use of the country-specific deflators takes account of differences in inflation in different countries. This is the best procedure for making country comparisons. However, note that the method does not necessarily maintain additivity — the sum of the deflated countries does not equal the deflated total.

⁵ See capital expenditure table on <https://www.aar.org/>.

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Glossary of terms and acronyms

3-D printing	Also known as additive manufacturing. Variety of processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together (such as liquid molecules or powder grains being fused together), typically layer by layer.
ABS	Asset-backed security.
Active innovators	Firms that invest in R&D (R&D-to-sales ratio higher than 0.1%).
Adaptation	Addresses the risks posed by climate change rather than the underlying causes.
Adopting firms	Firms that have no substantial R&D (R&D-to-sales ratio lower than 0.1%) but have introduced or developed new products, processes or services, according to the EIB Investment Survey (EIBIS).
Adult learning	The participation of adults in lifelong learning. Usually refers to learning activities after the end of initial education and is a central component of the European Union's lifelong learning policy. The main indicator to measure adult learning is the rate of participation in education and training, which covers formal and non-formal education and training.
Advanced	Firms that have invested in advanced digital technologies but have not taken action to become more digital as a response to COVID-19.
AFME	Association for Financial Markets in Europe.
AMECO	The annual macroeconomic database of the European Commission's Directorate-General for Economic and Financial Affairs.
APP	Asset Purchase Programme. ECB purchase programmes under which private and public sector securities are purchased to address the risks of an excessively prolonged period of low inflation.
AI	Artificial intelligence. A system's ability to correctly interpret external data, to learn from such data, and to use such learning to achieve specific goals and tasks through flexible adaptation.
AOM	Add-on module of the European Investment Bank Investment Survey.
Augmented or virtual reality	Presentation of information integrated with real-world objects, using a head-mounted display.
Automation	Substitution of work activities undertaken by human labour with work performed by machines with the aim of increased quality and quantity of output at lower costs.

Backward citation	Citations referring to previous patents upon which the current invention (described in the patent application) is based.
Baltics	Estonia, Latvia and Lithuania.
Basic	Firms that have not yet implemented any advanced digital technology in their business but have taken action to become more digital as a response to COVID-19.
Benelux	Belgium, the Netherlands and Luxembourg.
Beta-convergence	Refers to a process in which poor regions grow faster than rich regions and therefore catch up with them.
Big data	Extremely large data sets that may be analysed computationally to reveal patterns, trends and associations, especially relating to human behaviour and interactions.
Biotech	Biotechnology, often abbreviated to biotech, is the manipulation of living organisms or their components to produce useful and usually commercial products.
BIS	Bank for International Settlements (Basel, Switzerland).
Blending	Tools to help investors blend financing with additional sources. Blending can include a grant element or guarantees.
Blockchain	A growing list of records (blocks) that are linked using cryptography.
BLS	Bank Lending Survey. ECB survey carried out four times a year, which provides information on bank lending conditions in the euro area.
bn	Billion (1 000 million).
BNEF	Bloomberg New Energy Finance.
Border carbon adjustment	A trade measure intended to level the playing field between domestic producers facing costly climate-change measures and foreign producers facing very few.
Both	Firms that have implemented advanced digital technologies in their business and that have also invested further in digitalisation as a response to COVID-19.
Brown sectors	Sectors that are operating in pollution-producing industries such as oil, gas and coal mining industries. The classification takes into account the EIB's climate risk assessment framework that allocates sectors at NACE 4 digit level into five transition risk profiles (1 representing the low risk sectors and 5 the high risk sectors). Brown sectors include sectors with the highest (5) transition risk scores.

Bureau van Dijk's Orbis database	Database of private and listed company information from around the world that includes, among others, companies' financial accounts, ownership structures and details of mergers and acquisitions activity.
Business angel	An individual who provides capital for startups, usually in exchange for convertible debt or ownership equity.
Capital cost	A cost deriving from, or forming part of, capital expenditure on a project.
Carbon intensity	The ratio of greenhouse gas emissions divided by activity, such as greenhouse gas emissions/GDP.
Cautious reducers	Firms that have invested in tackling climate change risks but have no plans to continue these investments in the future. This group also accounts for firms that have set climate targets but have not yet invested in climate measures and do not have plans to do so.
Climate change adaptation	Describes measures to deal with the impact of changing weather patterns or extreme weather events.
Climate change mitigation	Mitigation addresses the underlying causes of climate change.
CCUS	Carbon capture, utilisation and storage is a group of technologies that can remove almost 100% of the carbon dioxide from large-scale point sources of carbon such as energy-intensive industries (such as steel, cement and refining) and fossil fuel power.
Cedefop	European Centre for the Development of Vocational Training.
Central and Eastern Europe	Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.
Circular economy	A systemic approach to economic development designed to benefit businesses, society and the environment. In contrast to the 'take-make-waste' linear model, a circular economy is regenerative by design and aims to gradually uncouple growth from the consumption of finite resources.
Cognitive technologies	Natural language processing, data mining and pattern recognition. Relevant for automation, machine learning and information technology, such as big data analytics or artificial intelligence.
Cohesion regions	Regions are grouped based on the 2021-2027 cohesion policy. Transition regions and less developed regions, together referred to as cohesion priority regions, have more extensive possibilities for co-financing. More developed regions, also referred to as non-cohesion (priority) regions, have more limited possibilities for co-financing.
Depreciation	A reduction in the value of an asset over time, due in particular to wear and tear; a decrease in the value of a currency relative to other currencies.

Developers	Firms that have substantial R&D (R&D-to-sales ratio equal to or higher than 0.1%) but have not introduced or developed new products, processes or services, according to the EIB Investment Survey (EIBIS).
Digital	Firms that have implemented at least one of the four digital technologies in recent years (see "Digitalisation").
Digitalisation	The adoption of one of four advanced digital technologies in the manufacturing and services sectors respectively. The technologies include 3-D printing, advanced robotics, internet of things, and big data in the manufacturing sector and digitalisation of internal routines, web-based applications for marketing and sales, digital products or services offered over the internet and big data in the services sector.
Disposable income	The amount of money that can be spent after current personal taxes. Refers to income from wages and salaries, self-employed income, income from unincorporated enterprises, social benefits, etc., after taking into account net interest and dividends received and the payment of taxes and social contributions.
Drones	Powered, unmanned aerial vehicles that can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non-lethal payload.
EBA	European Banking Authority.
ECB	European Central Bank.
EE	Energy efficiency.
EIB	European Investment Bank.
EIBIS	European Investment Bank Investment Survey.
EFB	European Fiscal Board.
EGF	European Guarantee Fund.
EIF	European Investment Fund.
EIOPA	European Insurance and Occupational Pensions Authority.
Energy efficiency gap	The difference between the cost-minimising level of energy efficiency and the level of energy efficiency actually achieved.
Energy intensity	Energy consumption divided by activity, such as energy/GDP.
Energy audit	An assessment of the energy needs and efficiency of a building or buildings.

Entrepreneurship	The process of designing, launching and running a new business.
EPEC	European PPP Expertise Centre.
EPO	European Patent Office
ESG bonds	Bonds issued for the financing of companies/activities fulfilling environmental, social and/or governance standards.
ESM	European Stability Mechanism.
ESMA	European Securities and Markets Authority.
ESRB	European Systemic Risk Board.
ETS	EU Emissions Trading System.
EU-LFS	EU Labour Force Survey.
Euro 7 emissions standards	European emissions standards for all petrol and diesel cars, vans, lorries and buses.
European Green Deal	Set of policy initiatives by the European Commission with the overarching aim of making the European Union climate neutral in 2050.
European Union	The 27 Member States of the European Union (taken as a whole when used for data comparison with other groups).
External finance	In the EIB Investment Survey, this consists of: bank loans excluding subsidised bank loans, overdrafts and other credit lines; other terms of bank finance including overdrafts and other credit lines; newly issued bonds; newly issued equity (including quoted or unquoted shares); leasing or hire purchase; factoring/invoice discounting; loans from family/friends/business partner; grants (financial support or subsidies from regional or national government); and funding provided by the public sector.
FCI	Financing Condition Index. An index indicative of tensions in financial markets. The index is extracted from a FAVAR model. It synthesises a large set of information contained in time series related to financial developments, uncertainty and asset pricing.
FDI	Foreign direct investment.

Finance constrained	In the EIB Investment Survey (EIBIS), a firm is considered finance constrained if it was : (i) rejected when seeking any external financing for an investment; (ii) quantity constrained (dissatisfied with the terms and the amount received in the last request for external financing); (iii) price constrained (the firm did not apply because it thought the conditions of external financing would be too expensive); or (iv) discouraged from seeking any external financing (the firm did not apply because it thought the application would be turned down).
Forward citation	Citations or references to the patent in question.
Forward-looking explorers	Firms that are investing in tackling climate change risks and have plans to continue such investments in the next three years, as well as firms that fulfil these three criteria: they have invested in climate, have plans to continue to do so in the future and have set climate targets.
FSB	Financial Stability Board.
Furlough scheme	A job retention scheme that directly subsidises hours not worked in jobs that are temporarily suspended.
GDP	Gross domestic product. The total value of goods produced and services provided in a country during one year.
GFCF	Gross fixed capital formation. The net increase in physical assets (investment minus disposals) within the measurement period. It does not account for the consumption (depreciation) of fixed capital, and also does not include land purchases. It is a component of the expenditure approach to calculating GDP.
Global financial crisis	Refers to the worldwide financial crisis of 2007-2008.
High growth enterprises	Enterprises that have an average annual growth rate of turnover greater than 10% per year over a minimum of three years and at least ten employees at the beginning of the growth period.
High-tech knowledge-intensive services	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting; telecommunications; computer programming, consultancy and related activities; information services; scientific research and development (NACE codes 59 to 63 and 72).
High-technology manufacturing sectors	Pharmaceutical products and preparations; computer, electronic and optical products (NACE codes 21 and 26).
Human capital	The knowledge, skills, competencies and other attributes embodied in individuals or groups of individuals acquired during their life and used to produce goods, services or ideas in market circumstances.
ICT	Information and communications technology.

IEA	International Energy Agency.
IFRS 9	Expected Credit Loss (ECL) approach. International Financial Reporting Standard 9 introduces a new impairment model based on expected credit losses, resulting in the recognition of a loss allowance before the credit loss is incurred.
ILO	International Labour Organization.
IMF	International Monetary Fund.
Incremental innovators	Firms that have substantial R&D (R&D-to-sales ratio equal to or higher than 0.1%) and have introduced or developed products, processes or services that are new to the company, according to the EIB Investment Survey (EIBIS).
Information asymmetry	A situation in which one party to an economic transaction (usually the seller) possesses greater material knowledge than the other party (usually the buyer); also called asymmetric information.
Infrastructure	Infrastructure as defined for the EIB Infrastructure Database includes the following sectors for its macro-analysis: transport, utilities, health, education and communication. Infrastructure in the EIB Municipalities Survey captures social, urban transport, digital, water and waste utilities, climate change mitigation and climate change adaptation.
Infrastructure sector	Based on the NACE classification of economic activities, firms in groups D and E (utilities), group H (transportation and storage) and group J (information and communication).
Institutional sectors	The general government, corporations and households are the three institutional sectors in this report.
Intangible investment	In the EIB Investment Survey (EIBIS), intangible investment consists of investment in: research and development (including the acquisition of intellectual property); software, data, IT networks and website activities; training of employees; and organisation and business process improvements (including restructuring and streamlining).
Intellectual property products	In the European System of Accounts, intellectual property products are defined as fixed assets that consist of the results of research and development, mineral exploration and evaluation, computer software and databases, entertainment, literary or artistic originals and other intellectual property products, as defined below, intended to be used for more than one year.
Internal combustion engine	Engines powered by burning fossil fuels, such as oil or petrol.
Internal finance	In the EIB Investment Survey (EIBIS), internal finance consists of internal funds or retained earnings (such as cash, profits).

IPCC	Intergovernmental Panel on Climate Change.
IRENA	International Renewable Energy Agency.
IRR	Internal rate of return.
ISCED	International Standard Classification of Education. A statistical framework for organising information on education.
ISCO	International Standard Classification of Occupations.
Knowledge-intensive market services	Water transport; air transport; legal and accounting activities; activities of head offices, management consultancy; architectural and engineering, technical testing and analysis; advertising and market research; other professional, scientific and technical activities; employment activities; security and investigation activities (NACE codes 50, 51, 69, 70, 71, 73, 74, 78, 80).
Large companies	Firms with at least 250 employees.
Latency	The time it takes for data to be transferred between its original source and its destination, measured in milliseconds.
Leading innovators	Firms that have substantial R&D (R&D-to-sales ratio equal to or higher than 0.1%) and have introduced or developed products, processes or services that are new to the country or to the global market, according to the EIB Investment Survey (EIBIS).
Less developed regions	EU NUTS 2 regions with GDP per capita below 75% of the EU27 average.
Lifelong learning	Encompasses all learning activities undertaken throughout life with the aim of improving knowledge, skills and competences, within personal, civic, social or employment-related perspectives. The intention or aim to learn is the critical point that distinguishes these activities from non-learning activities, such as cultural or sporting activities.
Low-carbon economy	An economy based on low-carbon power sources (not based on fossil fuels).
Low-carbon sectors	Firms operating in already low-carbon industries such renewables, electricity grids and railways. The classification takes into account the EIB's climate risk assessment framework that allocates sectors at NACE 4 digit level into five transition risk profiles (1 representing the low risk sectors and 5 the high risk sectors). Low-carbon sectors include sectors with the lowest (1) transition risk scores.
Low-technology manufacturing sectors	Sectors with NACE codes 1–18 and 31–32.
Manufacturing	Based on NACE classification of economic activities, firms in group C (manufacturing).

Market income	Income from labour and capital plus private transfers.
Mark-up	The ratio of the cost of a good or service to its selling price, expressed as a percentage of the cost.
More developed regions	EU NUTS 2 regions with GDP per capita above 100% of the EU27 average.
MW	Megawatt.
MWh	Megawatt hour.
NACE	“Nomenclature statistique des activités économiques dans la Communauté européenne”: Statistical Classification of Economic Activities in the European Community, the industry standard classification system used in the European Union.
Neither	Firms that have not invested in advanced digital technologies or in becoming digital as a response to COVID-19.
NGFS	Network on Greening the Financial System.
No innovation	Firms that have no substantial R&D (R&D-to-sales ratio lower than 0.1%) and have not introduced or developed new products, processes or services, according to the EIB Investment Survey (EIBIS).
Non-digital	Firms that have not yet implemented any of four advanced digital technologies considered in recent years or have not heard of them (see “Digitalisation”). The technologies include 3-D printing, advanced robotics, internet of things, and big data in the manufacturing sector, and digitalisation of internal routines, web-based applications for marketing and sales, provision of digital products or services over the internet, and big data in the services sector.
Non-PPP projects	Projects carried out by project companies (SPVs) that are not public-private partnerships.
NUTS	“Nomenclature des unités territoriales statistiques” (Nomenclature of territorial units for statistics.) A hierarchical system for dividing up the economic territory of the European Union.
OECD	Organisation for Economic Co-operation and Development.
Output gap	The amount by which the actual output of an economy falls short of its potential output.

Patent	Documents issued by an authorised agency, granting the exclusive right to the applicant to produce or to use a specific new device, apparatus or process for a limited period. The protection conferred by a patent gives its owner the right to exclude others from making, using, selling, offering for sale or importing the patent invention for the term of the patent, which is usually 20 years from the filing date, and in the country or countries concerned by the protection.
PATSTAT	EPO Worldwide Patent Statistical Database. Contains bibliographical data relating to more than 100 million patent documents from leading industrialised and developing countries.
PCT	Patent Cooperation Treaty. Provides a unified procedure for filing patent applications to protect inventions in each of its contracting states.
PELTRO	Pandemic emergency longer-term refinancing operations. Longer-term refinancing operations that have provided an effective backstop after the expiry of the bridge longer-term refinancing operations (LTROs) conducted since March 2020. The operations provide longer-term funding to counterparties with decreasing tenors, starting with a tenor of 16 months in the first operation and ending with a tenor of eight months in the last operation.
PEPP	The ECB's pandemic emergency purchase programme (PEPP) is a non-standard monetary policy measure initiated in March 2020 in reaction to the COVID-19 outbreak. It is a temporary asset purchase programme of private and public sector securities.
Perceived gap	Firms' perceived investment gap computed on their responses to the question.
Percentile	Each of the 100 equal groups into which a population or other data can be divided according to the distribution of values of a particular variable.
Physical risks	Typically defined as risks arising from the physical effects of climate change and environmental degradation. They can be categorised either as acute (if they arise from climate and weather-related events and acute destruction of the environment), or chronic (if they arise from progressive shifts in climate and weather patterns or a gradual loss of ecosystem services).
PIAAC	Programme for the International Assessment of Adult Competencies is a programme of assessment and analysis of adult skills. The survey measures adults' proficiency in key information-processing skills — literacy, numeracy and problem-solving — and gathers information and data on how adults use their skills at home, at work and in the wider community. The survey is conducted in over 40 countries and measures cognitive and workplace skills.

Planners	Firms that have not yet invested in tackling climate change risks, but have plans to do so in the next three years, irrespective of whether they set climate targets or not.
Platform technologies	Technologies that connect customers with businesses or customers with other customers.
Potential GDP	See Potential output.
Potential output	Potential output refers to the highest level of real gross domestic product that can be sustained over the long term with the available resources and labour efficiency. Potential output depends on the capital stock, the potential labour force (which depends on demographic factors and on participation rates) and the level of labour efficiency.
PPP	Refers either to: i) public-private partnership; or ii) purchasing power parity.
PPS	Purchasing power standards. An artificial currency unit. Theoretically, one PPS can buy the same amount of goods and services in each country. However, price differences across borders mean that different amounts of national currency units are needed for the same goods and services depending on the country. PPS are derived by dividing any economic aggregate of a country in national currency by its respective purchasing power parities.
Procyclical	A positive correlation between the value of a good, a service or an economic indicator and the overall state of the economy, growing when the economy grows and declining when the economy declines.
Production processes	Processes related to actual production, for example machinery and equipment.
PSP	The ECB's public sector purchase programme, under which the ECB purchases bonds issues by governments, international organisations, multilateral development banks, and recognised agencies. It is one of the ECB's asset purchase programmes.
PV	Photovoltaics
R&D	Research and development.
Recovery plan for Europe	The NextGenerationEU fund is a European Union economic recovery package to support member states adversely impacted by the COVID-19 pandemic.
Recovery and Resilience Facility	A large grant and loan facility offered by the European Union to its member states. Part of the recovery plan for Europe.
RES	Renewable energy source.

Robot	Defined in the IFR database as “automatically controlled, re-programmable and multipurpose machine.”
RTA	The relative technological advantage or specialisation index captures the share of patents in a technology field as a share of a country’s total patents, weighted by the same share in the European Union overall.
S&P 500	Standard and Poor’s Index of 500 of the largest stocks that trade on the New York Stock Exchange and Nasdaq.
SAFE	Survey on Access to Finance for Enterprises. A survey on the access to finance of small and medium-sized enterprises conducted by the ECB and the European Commission.
Scarring	Longer-term negative effects on the economy, in particular relating to an economic crisis.
Securitisation	The conversion of an asset, especially a loan, into marketable securities, typically for the purpose of raising cash by selling it to other investors.
Services	Based on the NACE classification of economic activities, firms in group G (wholesale and retail trade) and group I (accommodation and food services activities).
Short-term explorers	Firms that have set climate targets and have invested in the past. They are perceived to be short-term thinkers because they do not have further plans to continue investing in climate measures in the future.
Sigma-convergence	Occurs if the dispersion of income per capita across a group of countries or regions decreases over time.
Slack	The discrepancy between the volume of work desired by workers and the actual volume of available work. It describes the unmet demand for paid labour in the population.
Smart grids	Electricity supply networks that use digital communications technology to detect and react to local changes in usage.
Smart infrastructure	Results from the augmentation of physical infrastructure with digital capacity.
SMEs	Small and medium-sized enterprises. Firms with fewer than 250 employees.
SMEsec	SME securitisation: Transactions backed by SME loans, leases and other products.
Social infrastructure	In the EIB Municipalities Survey comprises healthcare, care for the elderly, childcare, education and training, as well as social and affordable housing.

Southern Europe	Cyprus, Greece, Italy, Malta, Portugal and Spain.
Sovereign debt crisis	Also known as the European sovereign debt crisis. A multiyear debt crisis that took place in the European Union from 2009.
SPV	Special purpose vehicle. A subsidiary company with an asset/liability structure and legal status that makes its obligations secure, even if the parent company goes bankrupt.
SSM	Single Supervisory Mechanism.
Startup	A young firm with high growth ambitions.
Sunk cost	A cost that has already been incurred and cannot be recovered.
SURE	The European instrument for temporary Support to mitigate Unemployment Risks in an Emergency.
Tangible investment	Investment in, for example, land, business buildings and infrastructure or machinery and equipment, as defined in the EIB Investment Survey (EIBIS).
TCFD	Task Force on Climate-related Financial Disclosures.
TFP	Total factor productivity. The efficiency in combining production factors to create added value.
TLTROs	The targeted longer-term refinancing operations are Eurosystem operations that provide financing to credit institutions. By offering banks long-term funding at attractive conditions they preserve favourable borrowing conditions for banks and stimulate bank lending to the real economy.
Transition regions	EU NUTS 2 regions with GDP per capita of 75%-100% of the EU27 average.
Transition risks	Risks that arise from the potential for loss resulting from a shift towards a lower-carbon economy, driven by policy, regulations, low-carbon technology advancement, consumer sentiment and preferences, and liability risks, impacting the value of certain assets.
Transitioning sectors	Firms operating in sectors that contribute to a transition to a zero net emissions economy in 2050 but that are not currently operating at an expected optimal level, such as the consumer goods and retail and automotive sectors. The classification takes into account the EIB's climate risk assessment framework that allocates sectors at NACE 4 digit level into five transition risk profiles (1 representing the low risk sectors and 5 the high risk sectors). Transition sectors concern sectors with transition risk scores ranging from two to four.

Transport infrastructure	In the EIB Municipalities Survey comprises footpaths and cycling lanes, intra-urban public, inter-urban and urban-rural transport connectivity, and charging stations for electric vehicles.
UK	United Kingdom.
UNCTAD	United Nations Conference on Trade and Development.
UNESCO	United Nations Educational, Scientific and Cultural Organization.
UNFCCC	United Nations Framework Convention on Climate Change.
US	USA — the United States of America.
VAT	Value added tax.
VC	Venture capital. A type of private equity focused on start-up companies with high growth potential.
Wait-and-see observers	Firms that have not invested in climate to tackle climate change risks, do not have any plans to do so in the future and have not set climate targets.
Western and Northern Europe	Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, the Netherlands and Sweden.

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**European
Investment
Bank**

The EU bank

European Investment Bank
98 -100, boulevard Konrad Adenauer
L-2950 Luxembourg
+352 4379-1
www.eib.org – info@eib.org

-  twitter.com/EIB
-  facebook.com/EuropeanInvestmentBank
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