INVESTMENT REPORT
2022/2023

Resilience and renewal in Europe

European Investment Bank

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Investment Report 2022/2023: Resilience and renewal in Europe.

About the report
The annual EIB report on investment and investment finance is a product of the EIB Economics Department. The report provides a comprehensive overview of the developments and drivers of investment and investment finance in the European Union. It combines an analysis and understanding of key market trends and developments, with a thematic focus explored in greater depth. This year, the focus is on how Europe is progressing towards a digital and green future amid an energy crisis. The report draws extensively on the results of the annual EIB Investment Survey (EIBIS) and the EIB Municipality Survey, combining 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 to help define its positioning, strategy and policy. The director of the Economics Department, Debora Revoltella, heads a team of 40 economists.

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Executive summary

A series of shocks have battered the European economy. Europe was rebounding strongly from the COVID-19 crisis, but now faces a severe worsening of its terms of trade driven by a surge in energy prices, the cost of which must be shared between European businesses, governments and households. These added pressures risk delaying important investment to address long-term, structural challenges, including the climate transition and digitalisation. Europe's future depends on being able to compete internationally and on leading in innovation, particularly in strategic technologies linked to the climate transition.

As growth slows and budgetary pressures mount, public investment must be protected to reduce economic scarring and to stimulate the private sector. The impact of the energy shock on individual EU members and their capacity to respond vary widely. Support for innovation and the climate transition must therefore be well coordinated to promote a level playing field in the single market, tackle uncertainty about public policies and foster cohesion.

European firms navigated the pandemic better than expected, but they face strong headwinds from energy costs, a lack of skills, tightening financial conditions and uncertainty. High energy prices will provide an enhanced incentive for climate-related investment, but this effect may be outweighed by heightened uncertainty, which is dampening firms' investment. Regulatory obstacles are constraining private and public investment, while a lack of available skills (such as environmental planning and engineering expertise) is hampering investment projects. Addressing technical skills and reducing administrative hurdles is critical for investment, particularly on the local level.

The European economy has been hit by a series of shocks — and is still adjusting

The invasion of Ukraine and the energy crisis compounded existing supply constraints, delivering a severe blow to Europe's terms of trade. In the first half of 2022, nominal energy imports rose from around 1.5% of gross domestic product (GDP) to 3.8%. At the same time, the EU trade surplus in non-energy goods also slumped, reflecting a mix of higher import costs and weaker global demand. The ramifications of higher energy prices therefore go beyond the direct hit to households and businesses. Higher energy prices are fuelling inflation and depressing demand, with the costs borne by Europe's households, businesses and governments.

The ability of European economies to absorb new shocks is complicated by the fiscal legacy of the pandemic. A strong fiscal policy response to the pandemic in 2020 and 2021 shielded households and business from an extensive loss of income. Those measures protected the productive capacity of the economy in a way that enabled it to rebound rapidly once COVID-19 restrictions were lifted. The fiscal support effectively reallocated a large share of net wealth from the public to the private sector (increasing public debt and private savings), and that transfer has not yet been unwound. Governments therefore have less fiscal space to soften the impact of high energy prices on households and firms.

EU members' varying exposure to rising energy costs and levels of public debt risk widening gaps between countries. Disparities in countries' dependency on fossil fuel imports and the energy intensity of production in their economies mean that the energy shock is not being felt uniformly. Meanwhile, higher interest rates caused by a new phase of monetary tightening and investors' increased aversion to risk are complicating issues for countries with high public debt. Spreads between the bond yields of different EU members have widened as a result.

Meanwhile, Europe cannot afford to delay action to address the long-term, structural challenges of climate, digitalisation and innovation

Comparatively low levels of investment in innovation and machinery and equipment risk compromising Europe's ability to compete in the long term. Investment recovered rapidly in 2021 and 2022, rebounding to pre-pandemic levels, but this success belies a persistent weakness in productive investment. When investment in housing is excluded, data show that a gap in productive investment of 1.5 to 2 percentage points of GDP opened between Europe and the United States after the global financial crisis, and still persists. This gap is driven by greater US investment in machinery and equipment and innovation, particularly in information and communication technology equipment (in the service sector) and intellectual property (in the public and defence sectors). Corporate spending on research and development is also low in the European Union relative to international competitors (1.5% of GDP in the European Union in 2020 vs. 2.6% in the United States and Japan).

Data from the EIB Investment Survey (EIBIS) also show that EU firms are less likely to innovate or to adopt new technologies than US firms. The gap actually widened by around 10 percentage points in the 2022 survey, to 19 percentage points. This gap is driven by less frequent investment by EU firms in the adoption of new technologies and practices.

Investments to limit climate change are increasing but are still well below what is needed to meet Europe's target of net-zero emissions by 2050. EU climate investment has rebounded after dipping during the pandemic, but investment needs to step up considerably if Europe is to meet its goals. Investment of €1 trillion a year is needed in the European Union to reduce greenhouse gas emissions 55% by 2030. That is €356 billion more a year than in 2010-2020.

Leadership in green technology will be critical to future competitiveness, but EU prominence in this area is under threat. While Europe is trailing the United States in digital innovation, green technologies have so far stood out as an area where the European Union leads. In patenting green technologies, Europe's main strengths lie in the areas of sustainable mobility, smart grids and wind power, while it is neck and neck with the United States and China on energy storage and, to a lesser extent, solar. To stay competitive, Europe will need to consolidate its position and expand its involvement in more cutting-edge innovation, such as hydrogen technologies. However, the US Inflation Reduction Act, which is expected to provide almost $369 billion for energy and climate change projects, will strengthen the competitive challenge from US firms and has the potential to encourage international firms to move innovative green industries to the United States.

Amid slowing growth and fiscal pressures, public investment must be protected

Sustained public investment is an essential complement to private investment, but it is under threat. Historical data show that public investment is typically more vulnerable than other types of public spending in times of fiscal consolidation. The current phase of monetary tightening, combined with the debt built up during the pandemic, could pressure governments to consolidate their finances by cutting public investment. This would be counterproductive, however. Analysis of the past five decades shows that maintaining or accelerating public investment during crises is associated with less economic scarring in the medium-term, as measured by economic output.

Local government investment (in digital infrastructure, for example) has a strong positive effect on GDP and in spurring private investment. This effect is particularly strong during downturns. Investments

in education, research and development, efficient administration and local infrastructure are the most effective at promoting growth. For example, firms in regions with relatively fast internet services (reflecting better local digital infrastructure) were 7.1% more productive than other firms, an effect that rises to nearly 16% for firms that also invested in becoming more digital in response to the pandemic.

National governments need to protect public investment by making it a priority in national budgets, and the effective implementation of the €723.8 billion Recovery and Resilience Facility (RRF) will help many countries to do that. The facility represents around 1% of EU GDP to be disbursed over four years, or almost one-third of total public investment. However, disbursements for green and digital investments under the Recovery and Resilience Facility are already proving slower than projects in other areas. Tackling technical skills, coordination and planning hurdles for more complex green and digital projects will be key to their successful implementation.

With the current shocks exacerbating risks for social and regional cohesion, addressing local investment barriers is vital

The energy crisis and inflation are disproportionately affecting poorer households and people already disadvantaged by the pandemic. Despite policy support, the financial situation of poorer, younger and less qualified people worsened as a result of the pandemic. These groups are also suffering more from rising prices, given that they spend a bigger share of their income on food and energy, have less savings to fall back on and are generally more vulnerable to the effects of inflation.

Regional cohesion is also at risk, with less developed regions in Eastern Europe more exposed to economic and political stress. One factor is the uncertainty created by the war, which is slightly higher in Eastern Europe, and which acts as a major deterrent to private investment. Less developed regions are also more dependent on energy intensive industries, while regions with higher unemployment are less able to benefit from the labour provided by new refugees and are facing greater pressure on social infrastructure and services. Cohesion regions seem to particularly lack the technical capabilities needed to access funds and increase investment. Tackling these barriers at the municipal or regional level is important.

A lack of funds, lengthy regulatory processes and regulatory uncertainty are the largest barriers to municipal investment and are linked to greater investment gaps, particularly in Central and Eastern Europe. Because 43% of municipal investment is funded by transfers, addressing local skills and regulatory hurdles will be particularly important to the successful implementation of the Recovery and Resilience Facility.

Skill constraints are slowing climate investment by municipalities. When asked about capacity constraints, 69% of municipalities say that a lack of environmental and climate assessment skills is a barrier. Digital skills, engineering and other technical skills, and regulatory understanding are not far behind.

Firms navigated the pandemic better than expected, but they face strong headwinds

Policy support enabled firms to recovery rapidly after the initial COVID-19 crisis. As of mid-2022, 84% of firms expected 2022 sales to be back to pre-pandemic levels, if not higher, according to EIBIS data. Only 16% of firms expected 2022 sales to be below pre-pandemic levels. Most of those (13%) were firms that suffered a year-on-year drop in sales during 2020 or 2021 and still did not expect sales to recover.

Firms are increasingly concerned about energy costs, and a growing share say those costs are impeding investment. A lack of skills and uncertainty are also challenging investment. Energy costs are now the second most frequently cited barrier to planned investment, with 82% of firms citing those costs as an issue (just below skills availability). Uncertainty also edged up to 78% of firms.

Heightened uncertainty is likely to have a particularly strong effect on corporate investment. Given the possibility of delaying investments, firms' worries about uncertainty are a cause for concern. Simulations by the European Investment Bank suggest that corporate investment in 2022 would have been 10% higher (representing around 1.2% of GDP) if uncertainty had remained at its 2021 level, all else being equal.

Finance conditions for smaller businesses also began to deteriorate in 2022, reflecting monetary tightening and investors' increased reluctance to take on risk. In mid-2022, the cost of corporate bank loans began to rise abruptly. Interest rate spreads between more and less risky loans also rose, which is likely to affect firms that are more indebted following the pandemic.

High energy prices alone will not be enough to accelerate green investment by firms

Overall, green investment by firms advanced in 2022, following a dip during the pandemic. 88% of firms reported some form of investment in climate change mitigation, with most taking action on energy efficiency and on minimising waste. 33% of businesses report taking steps to adapt to the effects of climate change.

However, the outlook for corporate investment to tackle climate change is mixed, with uncertainty and administrative barriers weakening investment incentives created by high energy costs. Energy supply disruptions and high prices could push firms to invest in energy efficiency, electrification and small-scale power generation from renewable sources. However, some emergency interventions to maintain the energy supply have also exacerbated uncertainty about public commitment to the green transition. An analysis of the drivers of green investment by firms suggest that uncertainty may outweigh the incentives created by higher energy prices. Firm that perceive energy costs as a major obstacle are 3 percentage points more likely to invest in climate measures, but the effect turns negative when uncertainty is also cited as a constraint. Tackling barriers, such as lengthy licencing processes for small renewable energy installations, is also essential.

European policymakers need to act decisively to encourage critical investment

More specifically, policymakers need to:

Provide clarity and preserve incentives to advance Europe's transformation. The response to the energy shock should lay the foundation for a more efficient and reliable EU energy market, tackling uncertainty and setting out a clear, ambitious path for the green transition.

Take advantage of the catalytic effect of public investment to crowd-in investment by the private sector, drawing on resources such as the Recovery and Resilience Facility to protect public investment from spending cuts and to minimise economic scarring over the longer term.

Use risk-absorbing financial instruments to help shield strategic investment by the private sector. EIB studies show that credit and guarantee instruments for small and medium companies and venture debt for firms with high-growth potential can positively affect investment and innovation, countering market failures affecting smaller firms and higher-risk, innovative investment.

Reduce unnecessary administrative barriers to investment and address technical skills, particularly for firms and municipalities in cohesion regions, and particularly for more complex green and digital objectives.

Enhance support for innovation, which remains crucial at various stages of the climate transition, while preserving the benefits of the European single market. Uncoordinated responses risk undermining economic convergence and a level playing field, just when EU members are dealing with diverging effects and wider ramifications of the pandemic, climate change and the energy shock.

Debora Revoltella
Director, Economics Department
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Introduction

A string of economic shocks has increased pressure on European economies and businesses at a critical point in Europe's transition to a greener and more digital economy. Trends like digitalisation, the green transformation, ageing and growing inequality constitute major hurdles for the EU economy. At the same time, productivity growth in the European Union has been weak for the past 20 years, and productive investment has trailed the United States for the past ten. The challenges posed by the pandemic and the energy crisis further complicated the already difficult situation facing European businesses and policymakers. How Europe deals with these difficulties will determine how successfully its economy navigates the twin transition and exploits the opportunities it presents, while at the same time addressing inequality and ageing.

In the wake of the COVID-19 crisis, firms have been forced to make big choices with lasting consequences. The pandemic exposed vulnerabilities that had accumulated during a period of rapid globalisation, which benefited from low transportation costs. Businesses had built their supply chains to minimise costs, often at the expense of their resilience to major disruptions. To address these vulnerabilities, firms could choose to reduce globalisation and geographically diversify supply chains, which may also be shortened because of the rising cost of transportation. Finally, production networks will also be reshaped by a political push for strategic autonomy, especially in the European Union and the United States. These new developments will create winners and losers, and they may change global growth dynamics. For policymakers at the EU and global levels, the challenge is to tread the narrow path between increasing resilience and preserving the benefits of globalisation.

A severe energy crisis is supressing the post-pandemic economic recovery and threatens to undermine political and social support for the green transition. Soaring energy prices in Europe, especially for natural gas, reduced household incomes and affected the competitiveness of European firms. However, these effects differed across EU members, reflecting the fragmentation of the European energy market. The policy response at the national and European level was quick and commensurate with the size of the shock, but some measures threatened climate action, such as backsliding on fossil fuel subsidies and relying on higher-carbon fuels like coal to replace gas.

The energy crisis created significant uncertainty, yet it could ultimately accelerate the green transition. Elevated uncertainty shaped corporate investment plans in 2022, with consequences in the medium and long term. On one side, high energy prices squeezed corporate profits and households' disposable income. Financial conditions tightened and the economic outlook deteriorated, negatively affecting investment. At the same time, high fuel prices provided incentive to invest in renewable energy, technologies that reduce the use of fossil fuels and innovative solutions to save energy.

To remain competitive, European businesses need to digitalise. While EU firms are rapidly gaining on their US peers in the use of advanced digital technologies, Europe is trailing in digital innovation and remains dependent on critical technologies from third countries. To reap the full benefits of digitalisation, European policymakers should create better conditions for digital technologies and innovation at home.

The twin green and digital transition may be threatened by growing social and geographical inequality. Higher energy and commodity prices hit poorer households particularly hard, as they have less financial resources and more of their income goes to energy and food. Certain regions have been more severely affected, particularly those that rely heavily on fossil fuels. The energy crisis will likely accelerate the green transition, but the transition will have serious negative consequences for social and territorial cohesion.

All these challenges are creating a perfect storm for macroeconomic policy in Europe. Following a surge in inflation, monetary policy entered a phase of dramatic tightening, which was accompanied by widening spreads between the rates of some countries' sovereign bonds. After a period of heavy spending during the pandemic, countries had planned to tighten their budgets as the pandemic wound down.

Large-scale programmes designed to dampen the blow of the energy crisis on people and businesses have undone some of that fiscal consolidation. At the same time, an extraordinary amount of public investment is needed to support the twin transition while ensuring social and territorial cohesion.

The €723.8 billion Recovery and Resilience Facility will likely be central to macroeconomic policy. Government investment is usually the first victim of cutting when countries face concerns about the sustainability of their debt. Historically, when governments consolidated their finances, they also reduced public investment. This is particularly true in times of crisis. This time around, investment was largely spared as the European Union suspended fiscal rules that constrain public spending and as the Recovery and Resilience Facility came into place. Substantial funds remain available under the facility (some 1% of gross domestic product per year until 2026). To benefit from them, governments must accelerate the implementation of negotiated reforms, remove barriers to investment and advance with planned projects.

Coordination at the EU level remains key to enhancing the impact of policies in different countries. EU members' immediate reaction to the energy crisis prioritised speed over intergovernmental coordination. However, over time, it has been possible to craft and deploy a more structured, cohesive and efficient policy response. The European Union played an important role in achieving this by imposing sanctions against Russia, facilitating the movement and labour market integration of Ukrainian refugees, and adopting the REPowerEU plan to reduce EU dependency on Russian energy imports. While the short-term responses to the energy crisis settle in, policies should begin addressing the medium and long-term challenges. The European Union needs a true common energy market — one that is more robust and less prone to fragmentation. A redesigned Stability and Growth Pact, the completion of the common market for services and a fully functioning capital markets union will enhance the European Union's economic resilience and help it adapt to global challenges.

An analysis reveals that Europe is building its resilience and renewing its economy after a long period of crisis. The EIB Investment Report 2022/2023 focuses on the effects of the COVID-19 and energy crises on the major structural challenges facing Europe — digitalisation and climate change — while stressing the importance of maintaining social and territorial cohesion. The first part of the report assesses the macroeconomic and financial environment in the European Union. It discusses trends and developments in overall investment, focusing on government and corporate investment as well as investment in intangible assets and climate action. The second part of the report delves into the challenges of climate change and digitalisation, analysing their effects on different social groups and regions.

The report's findings are underpinned by two proprietary surveys. The annual EIB Investment Survey (EIBIS), conducted for the seventh time in the summer of 2022, adds valuable information about European firms' investment activities and financing, as well as the obstacles they face. It also focuses on the effects of the COVID-19 crisis and the policies that addressed the pandemic. The survey's climate module, which was recently expanded, reveals the effect of climate change on firms' decisions in unique detail. The third wave of the EIB Municipality Survey in 2022 — after surveys in 2017 and 2020 — provides much-needed information about infrastructure investment by local EU governments, and looks closely at investment in climate action and digital infrastructure.

Throughout the report, EU members are generally grouped into three regions: Central and Eastern Europe, Western and Northern Europe, and Southern Europe. Central and Eastern Europe contains countries that have joined the European Union since 2004 and that rely substantially on EU cohesion and structural funds. Southern Europe encompasses Cyprus, Greece, Italy, Malta, Portugal and Spain. The remaining EU countries are grouped into the region Western and Northern Europe. While these regions are based on geographic location, the countries in each group share many economic characteristics, making the regions useful for economic analysis.

PART I

Investment environment in a time of crises

Higher costs mean energy imports are absorbing **3.5%** **more of EU GDP than before the Ukraine war**

The gap in productive investment between **the European Union** and **the United States equals up** to **2%** of GDP

EU firms are **19** **percentage points** less likely **to innovate than US firms**

percentage points

Funds made available by the **Recovery** and **Resilience Facility** amount to **1%** of **EU GDP per year,** around **one-third of government investment**

According to estimates, **the European Union** must invest an extra

€350 billion

a year to achieve its **2030 climate targets**

85% **of firms say a lack of skills is impeding investment**

Energy prices have risen 80%
for EU firms since 2021

69%
of municipalities **lack environmental and climate assessment skills**

Rising uncertainty caused **corporate investment to fall** by an estimated **1.2%**
of GDP

The share of **insolvent firms is set to rise to as much as 7%** **compared to the long-term average of 4%**

Chapter 1

The macroeconomic context

High geopolitical uncertainty caused by Russia's invasion of Ukraine, trade shocks fuelled by spiralling energy prices and persistent supply chain disruptions deteriorated the investment environment in 2022. In 2021, the world economy expanded at its fastest rate in almost 50 years. The suspension of economic activity imposed by the pandemic gave way to a strong rebound once lockdown measures were lifted. Monetary and fiscal policy provided a major boost. However, as inflation spiralled during 2022, central banks started to hike interest rates (sharply compared to the recent past, especially in the United States). Higher policy rates and greater risk increased corporate funding costs. The proportion of firms highlighting a lack of available finance as a major constraint increased, albeit from low levels, particularly in Southern Europe and among small and medium businesses.

During the first six months of the Ukraine conflict, the European Union transferred wealth worth around 3.5% of its gross domestic product (GDP) to oil and gas producers (15% of which went to Russia), through higher prices. A major deterioration in the European Union's terms of trade (the ratio of export and import prices) and the widening in interest rates between Europe and the United States caused the euro to depreciate. While labour markets remained tight in most of the European Union, wage growth did not compensate for the rapid increase in inflation. Consumer confidence fell sharply, particularly in EU members most exposed to higher gas and oil prices.

The current macroeconomic environment makes monetary and fiscal policy coordination difficult. During the pandemic, monetary and fiscal policy measures provided ample support to the economy. Monetary policy, which supported inflation targets, also lowered governments' financing costs. During 2022, monetary policy tightened significantly, raising governments' financing costs just as spending needs expanded in the short term (to combat a decline in real incomes caused by inflation) and in the longer term (to advance the green transition).

EU members progressively coordinated their policy responses to the crises — the Ukraine war and spiralling fuel costs. Over time, countries coordinated their policy responses more closely. The European Union played an important role here by adopting sanctions against Russia, helping Ukrainian refugees to travel and work and adopting a new programme, REPowerEU, to quickly reorient the EU energy market and make it less dependent on imports from Russia. As the short-term responses to the energy shock are implemented, policies should start to focus more on medium to long-term challenges. The EU energy market needs to become more robust and better integrated without distorting the level playing field the single market provides for firms.

Introduction

The war in Ukraine significantly worsened the investment environment in the European Union. High geopolitical uncertainty, deteriorating terms of trade caused by spiralling fuel prices, and persistent supply chain disruptions stopped the recovery in its tracks in 2022. Business confidence fell, bringing the post-pandemic rebound in corporate investment to an end. Meanwhile, EU members are spending heavily to cushion the impact of higher energy prices, even though borrowing costs are rising. The combined pressures could weigh on public investment.

The crisis is affecting EU countries very differently. Higher energy and food prices have starved the European Union's post-pandemic recovery. But while the shock itself is common to all countries, some are more heavily affected than others. The degree of the impact depends on several factors: countries' reliance on fossil fuels, the energy intensity of their production and their use of natural gas imported from Russia. Countries' ability to offset the shock also differs. Central banks outside the euro area raised interest rates quickly to return inflation to target levels, countering pressure on their currencies, while the European Central Bank (ECB) chose to tighten policy more gradually. More heavily indebted countries had not been able to increase the fiscal space lost during the pandemic. Some countries imposed extraordinary taxes on energy companies or banks to fund support for households and firms.

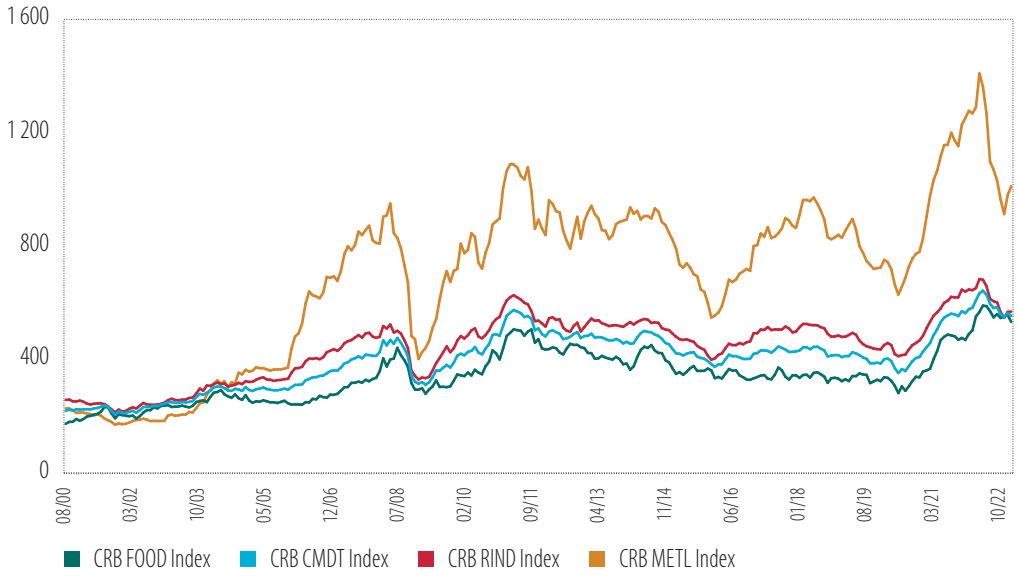
The turbulence in energy prices evokes memories of oil price shocks in the 1970s. At the time, energy production in the United States and Europe relied heavily on oil imports, and the high prices pushed many oil-importing countries into brief recessions and generated persistently higher unemployment. Those shocks, however, also stimulated research into green energies and improved the efficiency of energy use for households and industries. Similar developments can be observed today.

This chapter describes the macroeconomic factors influencing corporate and public investment in the European Union during 2021 and 2022. It starts by describing the EU economy's external environment, and then turns to the domestic economy before reviewing recent major changes in monetary policies (tightening to address inflation) and fiscal policies (more expansionary to counter the effect of higher energy prices on incomes). The chapter also contains four boxes. The first box draws on the latest EIB Investment Survey (EIBIS) to analyse the reaction of European firms to trade disruptions caused by the pandemic and the Ukraine war. The second box analyses the varying degrees to which inflation rose in EU countries. The third box considers whether the oil crisis of the 1970s might foretell how the current crisis could affect the EU economy in the longer term. The fourth and final box compares the US Inflation Reduction Act, which will provide USD 391 billion for spending on energy and climate change, to the European Union's initiatives to increase energy security, accelerate the green transition and develop local supply chains.

A major negative shift in the EU trade balance

The invasion of Ukraine boosted commodity prices, dealing a large trade blow to the EU economy. Russia invaded Ukraine just as commodity prices were rising, spurred by the reopening of the global economy. These prices were stabilising by the end of 2022 (although they were still high in historical terms), as global demand slowed (Figure 1). However, the European Union continues to pay high energy prices, a result of the conflict, sanctions and Russia's retaliation in cutting supplies (primarily natural gas). Moreover, concerns of possible energy shortfalls have created a very volatile environment, with prices spiking at the smallest sign of a possible gap in supply. All of these factors are having a major, but varied, effect on inflation and trade in EU countries.

Figure 1
Prices of selected commodities (1967=100)



Source: *Bloomberg.*
Note: *CRB stands for Commodity Research Bureau. CMDT stands for iShares Commodities Optimized Trust, the most widely used commodity index. RIND is the sub-index including raw industrial commodities. METL is the sub-index of metals.*

A negative trade balance and widening differences in real exchange rates

As energy prices surged, the EU trade balance shifted from a substantial surplus to a deficit. Higher energy prices weighed on the economy and international trade. The European Union's negative trade balance for goods in the mineral fuels, lubricants and related materials[1] category averaged EUR 285 billion per year from 2005 to 2019, fluctuating with changes in oil and energy commodity prices. However, the figure for the first ten months of 2022 massively surpassed this level, exceeding EUR 548 billion, which pushed the European Union into a net trade deficit. The European Union has historically been a net exporter, and aside from seasonal peaks (in January), a trade deficit has not been consistently registered since late 2011 (another time of high energy prices (Figure 2)). By paying more for imported oil and gas than before the war, the European Union effectively transferred wealth worth about 3.5% of its GDP to oil and gas producers (15% of which went to Russia).[2]

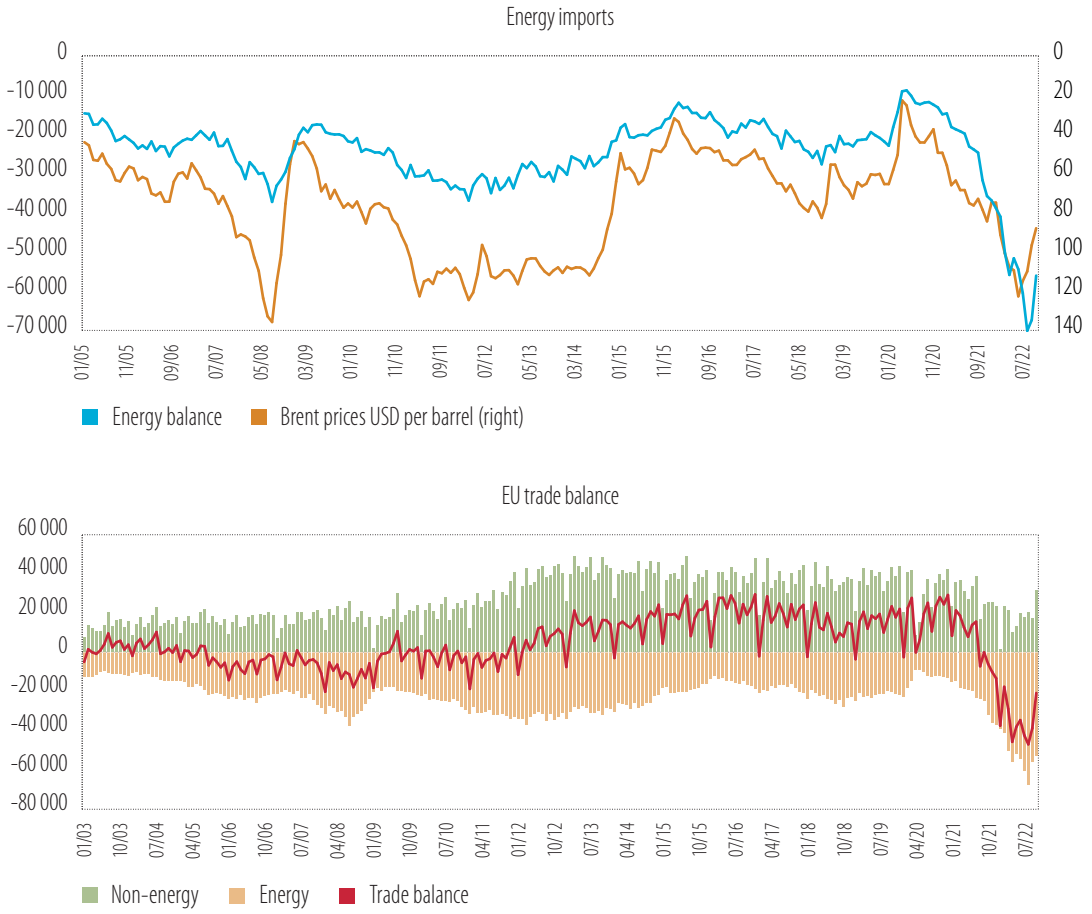
The trade deficit and growing differences between interest rates in the euro area and the United States weakened the euro. With the trade balance shifting from surplus to deficit, (transaction-related) demand for euros diminished. The euro's weakness was further exacerbated by differing monetary policy stances in the United States and the euro area. The US Federal Reserve started to tighten rates sooner and more aggressively than other major central banks. At the same time, a risk-averse environment tends to favour the US dollar, because investors think the US economy adapts and reacts to shocks more quickly. In late

1 Standard International Trade Classification (SITC), rev. 4, Section 3.

2 Computed as the value of imports of petroleum products (SITC 33) and gas (SITC 34) during March-August 2022, from all non-EU countries into the European Union, relative to half of the European Union's GDP for 2021.

August 2022, the euro-US dollar rate fell below parity and stayed there for the first time in 20 years. The euro partly recovered in the autumn. The weak euro[3], which also pulled down currencies in non-euro area EU members[4] (the exceptions being Bulgaria and the Czech Republic), should help EU exports and discourage imports. However, other factors are also at play.

Figure 2
EU trade balance and energy imports (EUR million)



Source: Eurostat.

Deteriorating EU trade comes as external demand slows. Increasing food and energy prices mean that a smaller share of income can be used to buy non-primary goods — traditionally a key area for EU exports. The energy shock is also hitting Europe harder than anywhere else, leading to higher production costs. This competitive disadvantage was only partially offset by the weakness of EU currencies vs. the US dollar (Figure 4).

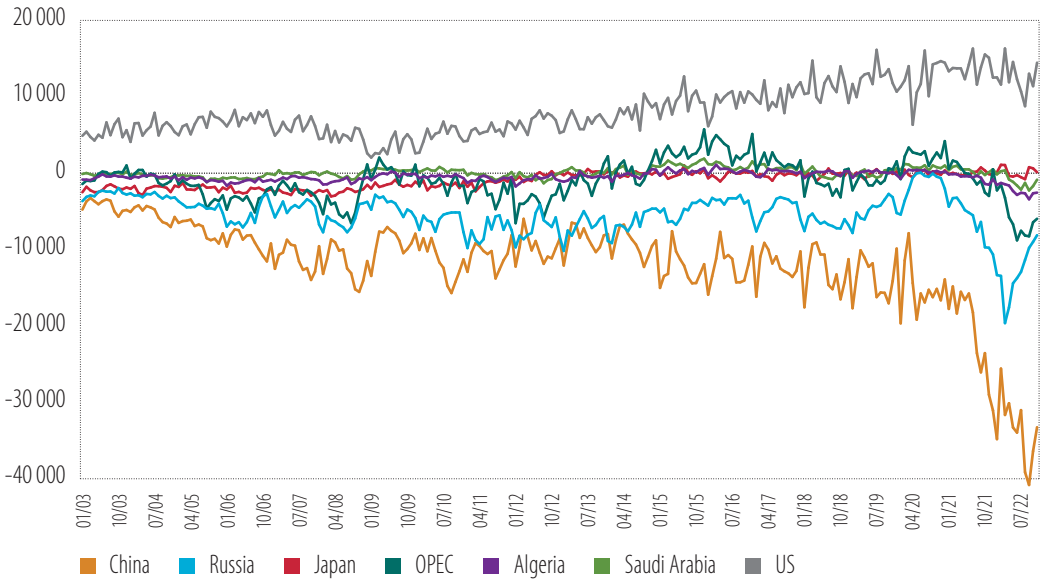
The non-energy-related trade balance also deteriorated significantly (Figure 2). In the first ten months of 2022, the net trade surplus excluding fuels was EUR 150 billion (compared to around EUR 360 billion on average for January to October from 2015 to 2019). It is particularly difficult to pinpoint the cause, as rising prices make it difficult to understand how much import and export volumes are growing. However, in nominal terms, imports are clearly growing more than exports (including in non-energy trade).

3 Figure 4 shows the evolution of the nominal effective exchange rate for the euro and US dollar vs. a broad group of trade partners.

4 The trade balance of non-euro EU countries in Central and Eastern Europe is in line with that of euro area countries. The performance of two non-euro Nordic countries (Sweden and Denmark) was affected less because they rely more on renewable energy.

The worsening of the non-energy trade balance is, surprisingly, mostly because of exponentially large increases in imports from China (Figure 3). The energy shock weighed on the competitiveness of European firms. At the same time, the green transition raised EU demand for Chinese-made products, such as solar panels and electric cars. Imports in the first ten months of 2022 were about EUR 152 billion higher than in the same period of 2021 (while the overall trade balance, including energy, worsened by nearly EUR 480 billion, going from a EUR 80 billion surplus in the first ten months of 2021 to a EUR 398 billion deficit in the same period of 2022). Machinery and transport equipment accounted for the largest portion of this — about 45% (4% of which was for road vehicles). Electrical machinery, equipment and appliances accounted for about 23% (5% of which was telecommunications equipment, 4.5% office machines and automatic data processing, and 3.9% other industrial machinery). Metals (including steel) accounted for around 13%, while chemicals (particularly organic chemicals) made up 21%.

Figure 3
EU trade balance (EUR million)**, by partner country**



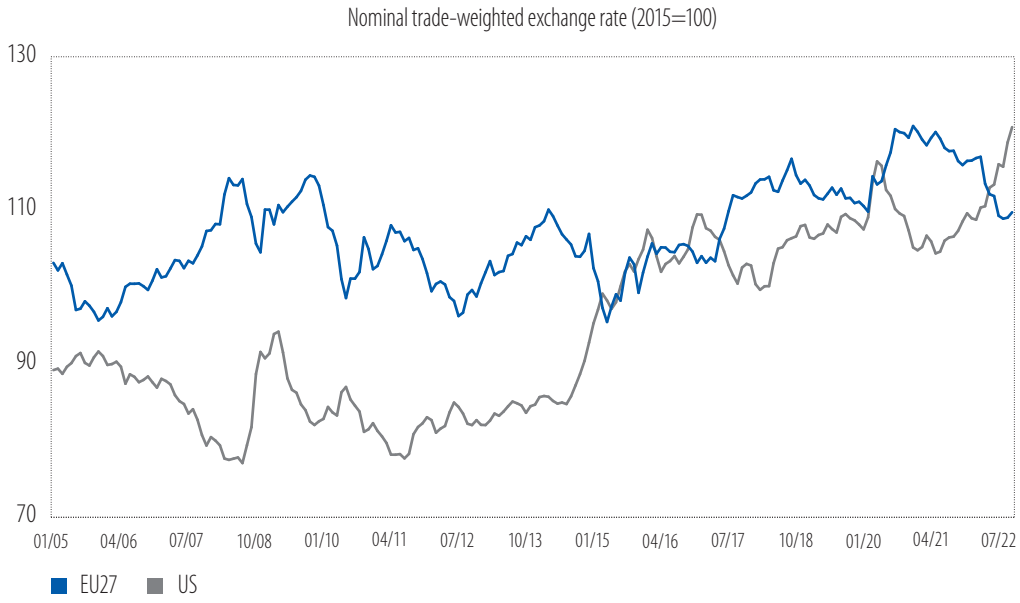
Source: *Eurostat.*

Effective exchange rates among various EU currencies — both nominal and real — are increasingly varied. The dispersion of the nominal trade-weighted exchange rates among the different EU currencies is clear, but a widening spread can also be seen inside the euro area. There, the gap can only be attributed to the different weights used for trading partners. The dispersion of real effective exchange rates (Figure 5) has increased because of the large differences in inflation within the European Union, even in the euro area (see below in Box B). At first glance, the evolution of real effective exchange rates with the main EU partners and data on the trade of goods seem to indicate that pressure on demand is outweighing the effect of depreciation. In other words, the negative impact of higher prices on external demand for goods produced in the European Union is greater than the positive effect of currency depreciation. From January to October 2022, the EU-US non-energy trade balance improved by 28% (or almost EUR 42 billion), but Europe's aggregate non-energy trade balance worsened by more than 48% (EUR 142 billion).

The worsening trade situation coupled with high energy prices is affecting trade balances in various EU countries differently. The impact on data from the national accounts has been computed in real terms and offers a different point of view. The net export contribution to growth declined and turned negative in the course of 2022 (taking 0.04 percentage points off average growth for the European Union as a whole and for the euro area in the first three quarters of 2022). In all countries, export performance is clearly linked to movements in real exchange rates and a country's physical proximity to the Ukraine

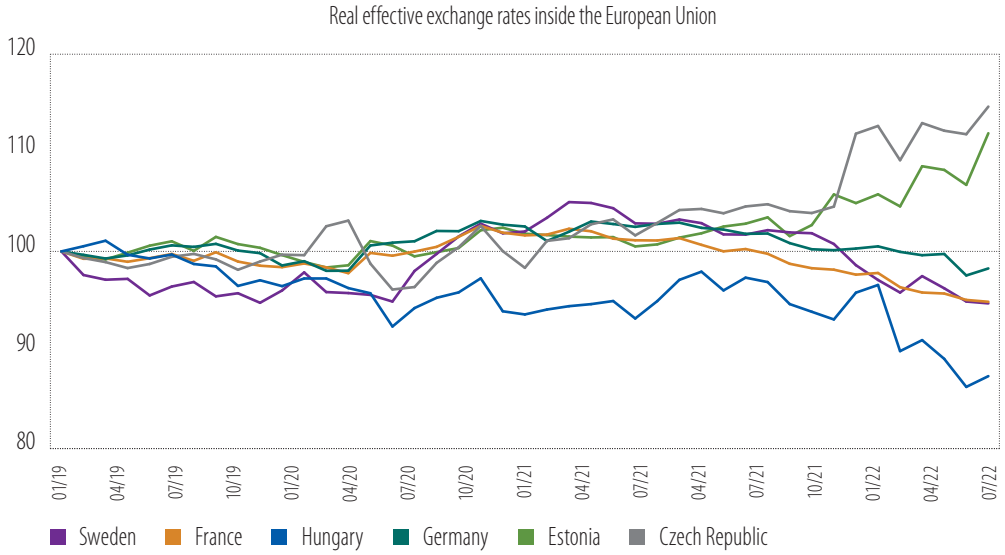
conflict (Figure 7).[5] In six out of 11 countries in Central and Eastern Europe, the contribution of net exports to growth was negative on average in the first three quarters of 2022. Among those in Western and Northern Europe, exports are weighing on growth in four countries, and two of them (Sweden and Finland) are closer to the conflict area. Overall, the standard deviation of the net contribution[6] between EU countries is as high (Figure 6) as it was during the pandemic.

Figure 4
Euro exchange rates



Source: *EC Price and Cost Competitiveness, Refinitiv.*

Figure 5
Real effective exchange rates of European currencies (baseline=100)

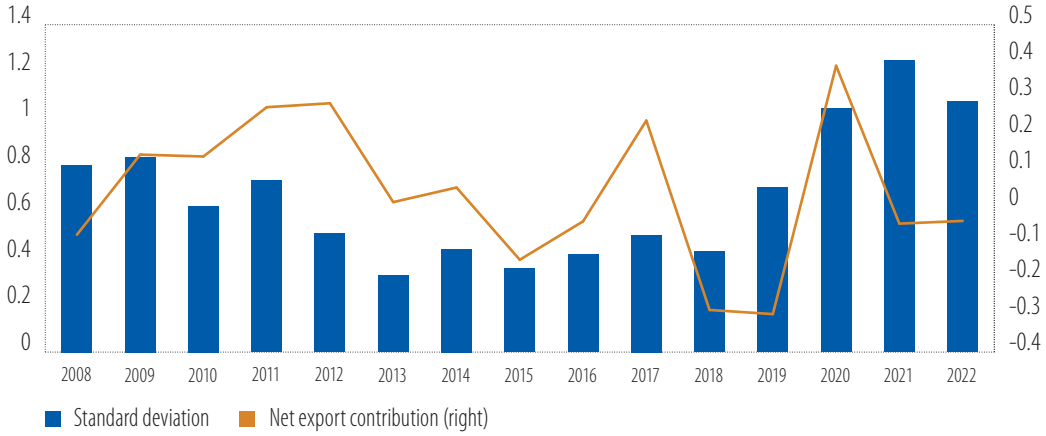


Source: *EC Price and Cost Competitiveness, Refinitiv.*

5 For the effect of the Ukraine war on different EU regions, see Chapter 4.
6 Ireland was excluded from the calculation because of the recent volatility of Irish National Accounts data.

Figure 6

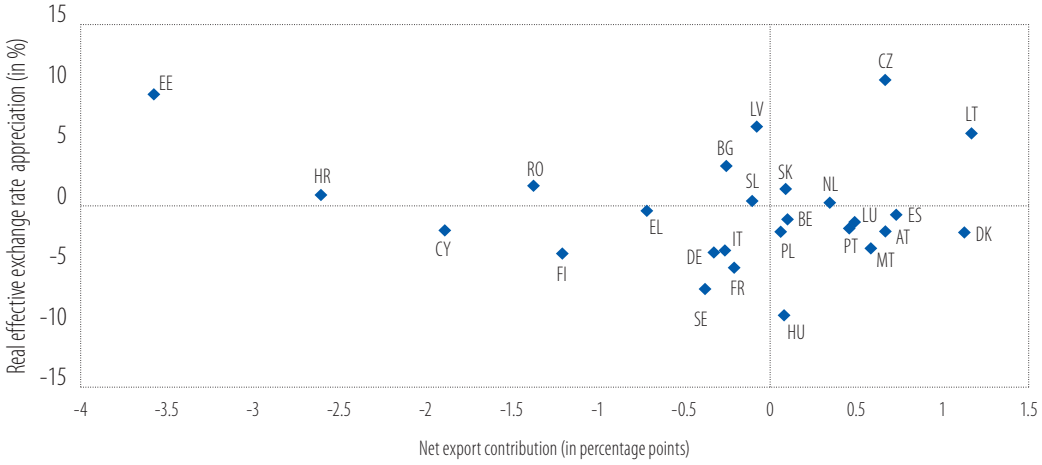
Contribution of net exports to EU GDP growth and the dispersion across EU countries
(left axis: standard deviation; right axis: percentage points)



Source: Eurostat, EIB staff estimates.

Figure 7

Contribution of net exports to EU GDP growth and the change in EU countries' real exchange rates



Source: European Commission, Eurostat, EIB staff estimates.

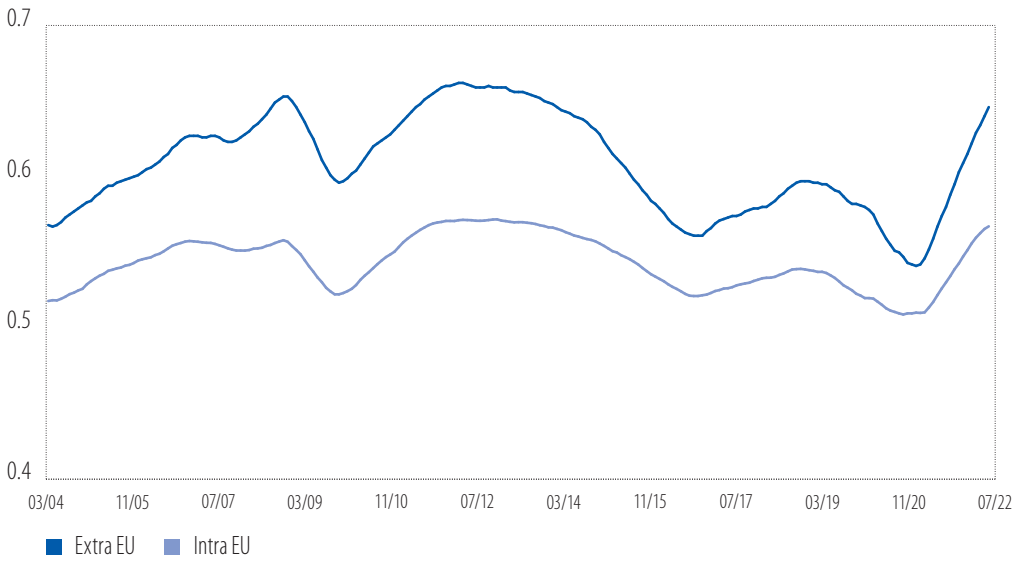
The growing debate on changes to global supply (or value) chains

Trade disruptions have renewed the debate on how to balance resilience with cost when structuring supply chains. Whether global value chains are sufficiently resilient has been a topic of discussion in academia and in policy-oriented groups for some time. The key questions were the costs and benefits of diversifying and shortening supply chains and, more broadly, whether economies would enter a new phase of deglobalisation (Baldwin, 2022; Yellen, 2022).[7] The invasion of Ukraine has given new impetus to this debate. Trade flows and information from the EIBIS suggest that firms are diversifying but not (yet) shortening their supply chains. Box A provides details.

7 On the academic side, Richard Baldwin's posts on VoxEU summarise some of the evidence and the interpretation. Speeches by Janet Yellen (for example, "Remarks by Secretary of the Treasury Janet L. Yellen at LG Sciencepark") or the proposal that the European Union should consider strategic autonomy in specific sectors are examples of the policy implications.

The share of imported intermediate goods in total imports is not declining. If European firms were to rely less on outsourced intermediate goods (particularly from far-away sources), the share of imported intermediate goods in total imports would likely decline. Figure 8 shows this share computed over time for imports from outside and inside the European Union. The share declined from 2013 to 2017, but rebounded in early 2021, bringing the ratio close to its maximum level (in 2012). The higher number likely reflects higher prices. However, it does not provide any explicit evidence that more intermediate goods were coming from inside Europe.

Figure 8
Share of intermediate goods in imports of goods (in %)

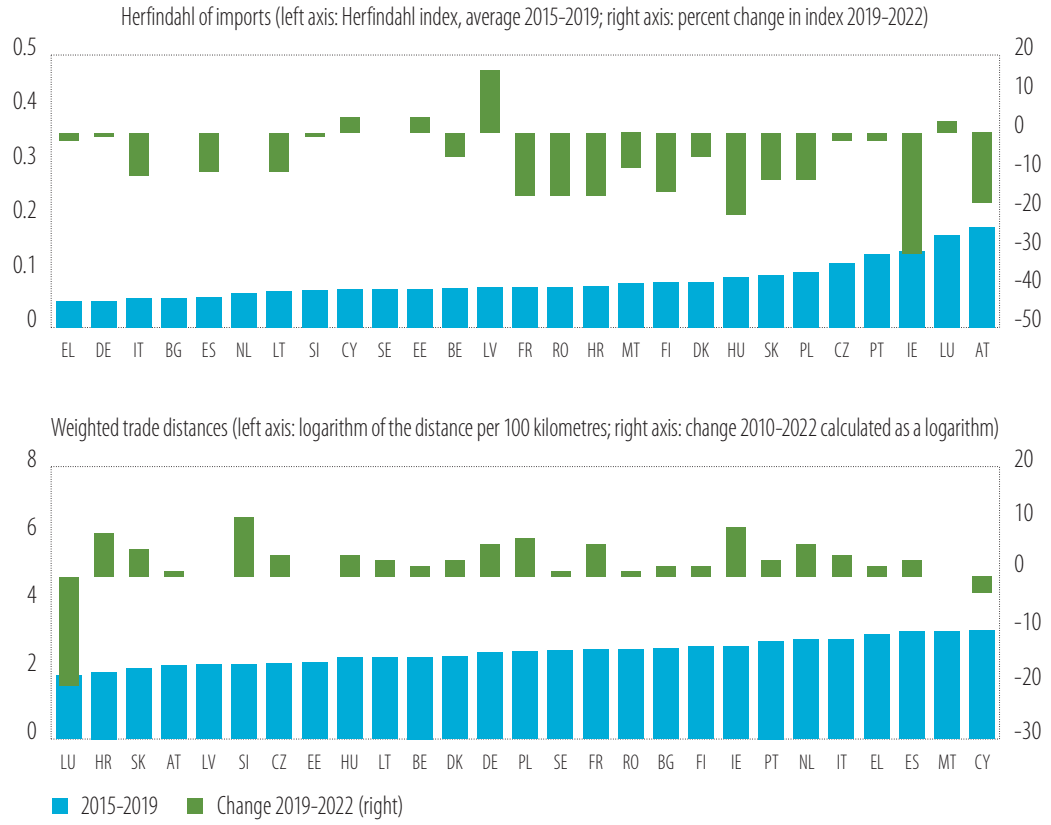


Source: Eurostat.

Figures on imports indicate that they are coming from more diverse sources than previously. Figure 9 (upper panel) shows the Herfindahl index (a widely used measure of concentration) for goods imported between trading partners in recent years. The figure compares results for the first half of 2022 to the same periods from 2015 to 2019. Concentration decreases for the majority of EU countries, with the largest declines seen in countries that had a less diverse sources of imports before the pandemic, which includes Ireland and Austria.

At the same time, the average distance between trading countries is not declining. A decrease in the average distance could be interpreted as companies looking for suppliers closer to home, either within the European Union or in neighbouring countries. Figure 9 (lower panel) shows that except for a handful of countries (notably Luxembourg), the average distance between import partners and EU countries has increased moderately since the pandemic.

Figure 9
Changes in the structure of goods imported to the European Union



Source: *Eurostat, CEPII, EIB staff estimates.*
Note: *The Herfindal index is the sum of the squares of each country's share of EU imports. A lower number suggests imports come from more diversified sources.*

Box A
How firms are dealing with trade disruptions — evidence from the EIBIS

More than 80% of firms report that they experienced some kind of trade disruption. While most EU firms (56%) reported a major disruption, almost one-third (30%) reported only minor problems. The most common disruptions concern global logistics (45%) and the provision of raw materials or services (42%). A smaller share of firms (15%) say trade has been upset by new regulations, customs or tariffs.

The coronavirus pandemic and the war in Ukraine are the main causes of disruption — 58% of firms cite both factors. Almost one-fifth of firms (19%) say only the COVID-19 crisis caused a disruption, while an even smaller share (13%) point to the war in Ukraine as the sole cause.

Table A.1

Response of firms' sales to trade shocks

	(1)		(2)	
	Sales from 2019 to 2020		Sales from 2020 to 2021	
Variables	Decline	Increase	Decline	Increase
Major disruptions				
Logistics/maritime	0.196***	0.171**	0.202**	0.123*
	[0.070]	[0.072]	[0.084]	[0.067]
Material	0.085	-0.008	0.112	0.020
	[0.070]	[0.072]	[0.084]	[0.067]
Customs/Regulation	0.157*	0.046	0.203**	-0.066
	[0.086]	[0.090]	[0.100]	[0.082]
Any financial support during COVID-19	0.972***	0.016	0.324***	0.296***
	[0.056]	[0.056]	[0.066]	[0.052]
Constant	-0.603***	0.060	-0.594**	-0.050
	[0.213]	[0.214]	[0.254]	[0.202]
Observations	10 260	10 260	10 276	10 276
Sector fixed effects	yes	yes	yes	yes
Country fixed effects	yes	yes	yes	yes

Source: *EIBIS 2022.*

Note: *The table presents results from three multinomial logit regressions. The baseline for each regression is "stay the same." Each regression controls for firm size and age categories, trading status, severity of the disruption and type of trade shocks. Sector and country fixed effects are also included. Standard errors are in brackets. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

When the economic consequences of the pandemic hit firms in 2020, the distribution of firm sales changed. In addition to the high share of firms that had significant losses, the share of firms experiencing a large increase in sales was also more elevated than in other years.

The results indicate that firms reporting problems with global logistics and maritime transport were more likely to lose money or enjoy sales growth than other firms. However, firms that reported obstacles concerning trade regulations were more likely to lose money. The results also confirm the conclusion of Harasztosi et al. (2021) that COVID-19 measures supported firms with significant losses. The effect of trade disruption on 2021 sales follows a similar pattern to the previous year, although firms that received government support were also more likely to see sales stabilise.

Almost 60% of EU firms say they will act to deal with international trade disruptions. EIBIS 2022 asked firms to signal whether they were adopting one of two strategies for limiting trade disruption: increasing their number of trade partners to diversify, or focusing more on domestic suppliers and markets. Firms could also say that they had not taken any action. EU firms were slightly more likely to diversify (37%) than look for domestic suppliers and markets (35%).

Firms taking action to reduce the effects of trade disruptions were more likely than other firms to expect higher sales in 2022 than in 2019. Table A.2 shows estimates of the factors determining the probability that sales would increase. The results suggest that firms taking action to diversify their import or export partners were more likely to expect higher sales in 2022 than in 2019. However, this was not the case for firms responding to trade shocks by looking for domestic markets. Those firms' sales were not expected to improve significantly.

Table A.2
Sales expectations in 2022, by the response to trade shocks

	(1)	
	Sales from 2019 to 2022	
Variables	Decline	Increase
Diversification	-0.073	0.131**
	[0.078]	[0.057]
Domestic markets	-0.004	-0.040
	[0.075]	[0.056]
Observations	8 267	8 267
Sector 12 fixed effects	yes	yes
Country fixed effects	yes	yes

Source: *EIBIS 2022.*
Note: *The table presents results from a single multinomial logit regression. The baseline is "stay the same." Regression controls for firm size and age categories, trading status, severity of the disruption and type of trade shocks. Sector and country fixed effects are also included. Standard errors are in brackets. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

The willingness or ability of firms to respond to the trade shock varies considerably. Larger, innovative and digital firms are more likely to react to trade shocks. Regression estimations show that small and medium businesses are about 3-4 percentage points less likely to take action. Innovative firms are about 10 percentage points more likely to react to trade disruptions. At the same time, digitalised firms seem to display a similar level of adaptability, and they are more likely to report diversifying or focusing on domestic markets instead of not taking action. For a more detailed analysis see Brasili and Harasztosi (2022).

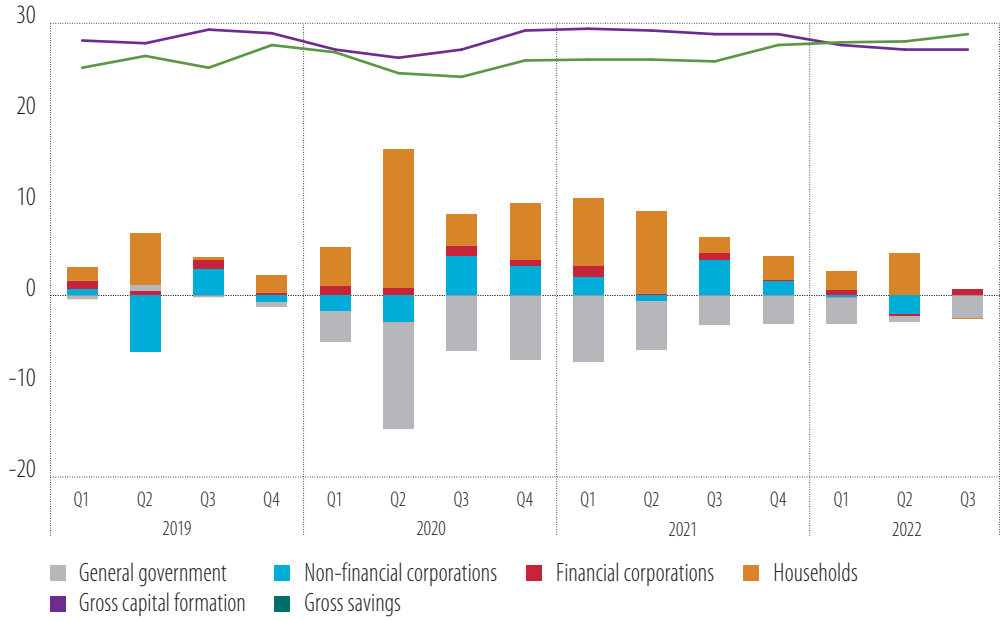
The EIBIS evidence therefore suggests that firms' choices are related to the type of firm and the shock experienced. In general, more digital and innovative firms implement strategies to address disruptions more frequently. Major logistic and transport-related difficulties are also likely to push firms to diversify. Larger and more innovative firms seem to prefer diversifying over focusing on domestic markets. The choice to diversify suppliers seems to be linked to positive sales expectations, suggesting that firms believe this strategy will help returns. Innovative firms and firms that perform well tend to implement diversification strategies, potentially widening the gap between firms that are leaders and laggards.

Falling real incomes depressed growth in the European Union, with major differences between countries

The EU economy had surpassed its pre-pandemic level of output when energy prices surged and trade began unravelling. Fiscal policy, which had provided unprecedented levels of support during the pandemic, was gradually wound down and governments were planning to consolidate their finances. Monetary policy was still very expansionary, with interest rates around zero in all EU countries and stimulus, such as central bank asset purchases, continuing in the euro area. Rates charged for riskier investments were low and overall financial conditions were relatively loose. Household savings built up during the COVID-19 crisis were supporting consumer demand. Construction activity was booming as low interest rates stimulated demand for residential real estate. Labour markets tightened as services started to recover despite a new pandemic wave. Job vacancy rates exceeded their pre-pandemic levels, reflecting the economic upswing and, perhaps, greater friction in matching firms with labour.

Fiscal policy unwound its exceptionally expansionary stance while households consumed heavily. Net savings in various institutional sectors had gradually moved towards normal levels by mid-2022. Deficits, which had swelled when governments supported the economy during the pandemic, shrank to almost zero (Figure 10). Households consumed more, after having received government support and primarily because they had limited opportunities to do so during lockdowns and other pandemic measures. Non-financial firms had sharply reduced investment during the pandemic, but they now picked up the pace (including expanding inventories) and saved less. On balance, a small savings shortfall emerged and was financed by investments from abroad.

Figure 10
EU savings and investments (% GDP)**, by sector**



Source: *Eurostat.*
Note: *The bars show the net financial balance for each institutional sector.*

Two unforeseen events brought the recovery to a halt during the first half of 2022: the inability of supply to keep up with demand and the war in Ukraine. Confronted with supply chain bottlenecks, the strong rebound in demand following the pandemic pushed up inflation. Bottlenecks developed and remained not only because demand pivoted from services to goods, but also because pandemic-related restrictions constrained imports from China. As demand for services recovered, labour shortages emerged in areas such as tourism and hospitality, which had been hit particularly hard by the pandemic.

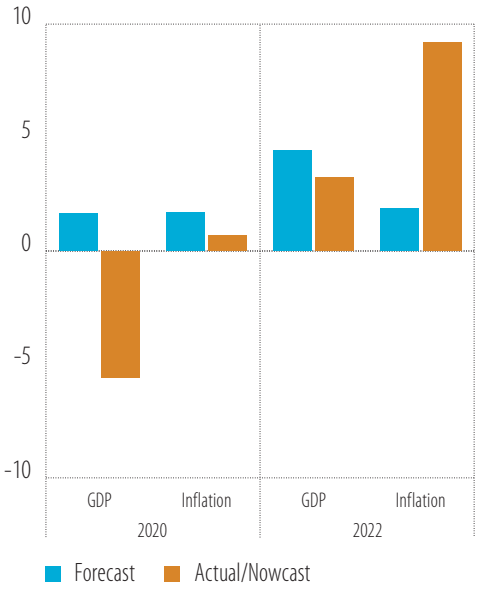
The war in Ukraine highlighted the European Union's dependence on energy imports from Russia and the vulnerability of supply chains more generally. The war affected the EU economy mainly because it relied heavily on fuel imports from Russia. The European Union imports 90% of its natural gas, and 45% came from Russia. Russia also accounted for around 25% of the European Union's oil imports and 45% of its coal imports. In addition, the war inhibited EU imports from Ukraine that, despite their small value, included some key supplies, particularly in the automobile industry (Boston, 2022). Supply chain disruptions were exacerbated as companies built up inventories, shifting from just-in-time to just-in-case inventory management.

Inflation rose and slowed GDP growth. Concerns about energy security caused oil and gas prices to explode, quickly feeding through to other products and services. Food prices were pushed up as imports of Ukrainian grain plummeted and fertilisers (the production of which uses large quantities of natural gas) became more expensive. In the third quarter of 2022, annual consumer price inflation exceeded 10%

in the European Union for the first time since records began in 2000. People and firms began expecting higher prices to continue. Consumer inflation expectations over the next 12 and 36 months increased in line with official forecasts (ECB, 2023). Consumer confidence plummeted further than it had during the pandemic. Households reined in their spending on food, energy and discretionary items to match their lower real income. Industrial production stagnated, and fewer energy-intensive goods were made. The growth of real GDP slowed.

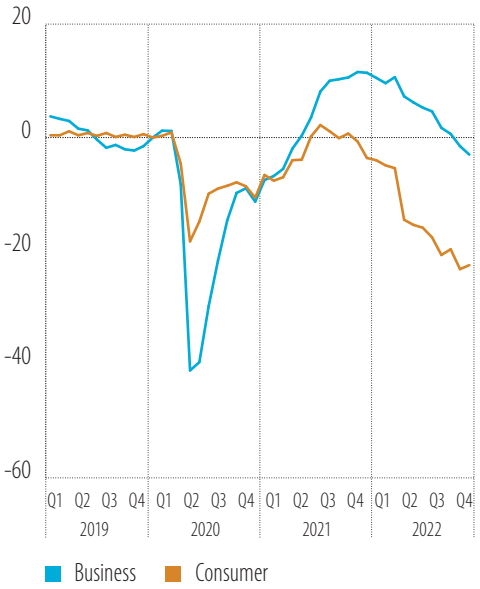
By the autumn, the blow the Ukraine war dealt to real GDP appeared much less violent than that of the pandemic (Figure 11). However, steep declines in business and particularly in consumer confidence pointed to a recession and a protracted recovery (Figure 12), even though confidence recovered a little during the winter when energy prices rose less than feared.

Figure 11
Forecast and actual GDP and inflation (in %, year-on-year)



Source: *IMF, EIB staff estimates.*
Note: *Forecasts for 2020 are from the Autumn 2019 forecast of the International Monetary Fund (IMF). The forecast for 2022 is from the IMF's Autumn 2021 forecast; the nowcast is from the IMF's Autumn 2022 forecast.*

Figure 12
Consumer and business confidence (index)**, changes relative to December 2019**



Source: *European Commission.*
Note: *For business confidence, the European Commission's sector weights are applied to industry, services, construction and retail.*

The combination of rising inflation and slowing growth created new challenges for fiscal and monetary policy. The pandemic initially led to a steep fall in demand and inflation consequently fell short of central bank targets. Years of stable growth had also given some EU countries more fiscal flexibility. As a result, fiscal and monetary policy were able to act in tandem and provide sizeable impulses to economic growth. By early 2022, governments' fiscal space had shrunk and inflation was already growing well above central bank targets. As the energy crisis erupted, fiscal policy provided strong stimulus measures worth several percentage points of GDP to shield households and business from high energy costs. In contrast, central banks were confronted with the risk that inflation expectations might rise substantially above target. Instead of providing additional stimulus, they accelerated the normalisation of their policy stances (see below).

Although all EU countries saw inflation soar and economic growth slow, the shocks affected each nation differently. The impact was greater for countries whose production was more energy intensive

(such as many Central and Eastern European countries); whose energy consumption relied more on gas and oil (such as the Benelux countries of Belgium, Luxembourg and the Netherlands); which imported a greater share of fossil fuels from Russia and Ukraine (such as Germany); whose households consumed more food and energy (generally countries with GDP per capita below the EU average); whose fiscal situation left governments with less resources to provide support; and whose monetary policy was more constrained by widespread inflation and the risk of capital outflows (such as Hungary and the Czech Republic). Broadly speaking, the impact was strongest in Central and Eastern Europe (see Chapter 4).

Inflation in different EU members varied widely, reflecting their exposure to energy and food prices, and the energy contracts already in place. In September 2022, annual consumer price inflation in the European Union ranged from 6.2% in France to 24.1% in Estonia. Box B investigates these differences and their policy implications. Differences in wealth explain part of this dynamic, as households in poorer member countries tend to spend a higher share of their income on food and energy. Another factor is differing policies. For example, not all countries have capped or are planning to cap electricity and gas prices. Also, the type of energy covered, the levels of consumption and prices at which these caps enter into force, and the duration of these policies all vary. The speed at which such measures are lifted will affect when inflation rears its head.

Spiralling energy prices evoke memories of the 1970 oil crisis. At the time, energy production in the United States and Europe relied heavily on oil imports, and rapidly rising prices pushed many oil-importing countries into brief recessions and generated persistently higher unemployment. High prices for fossil fuels, however, also stimulated research into green energies and increased energy efficiency for households and industry (Box C). Similar developments can be observed today.

Box B

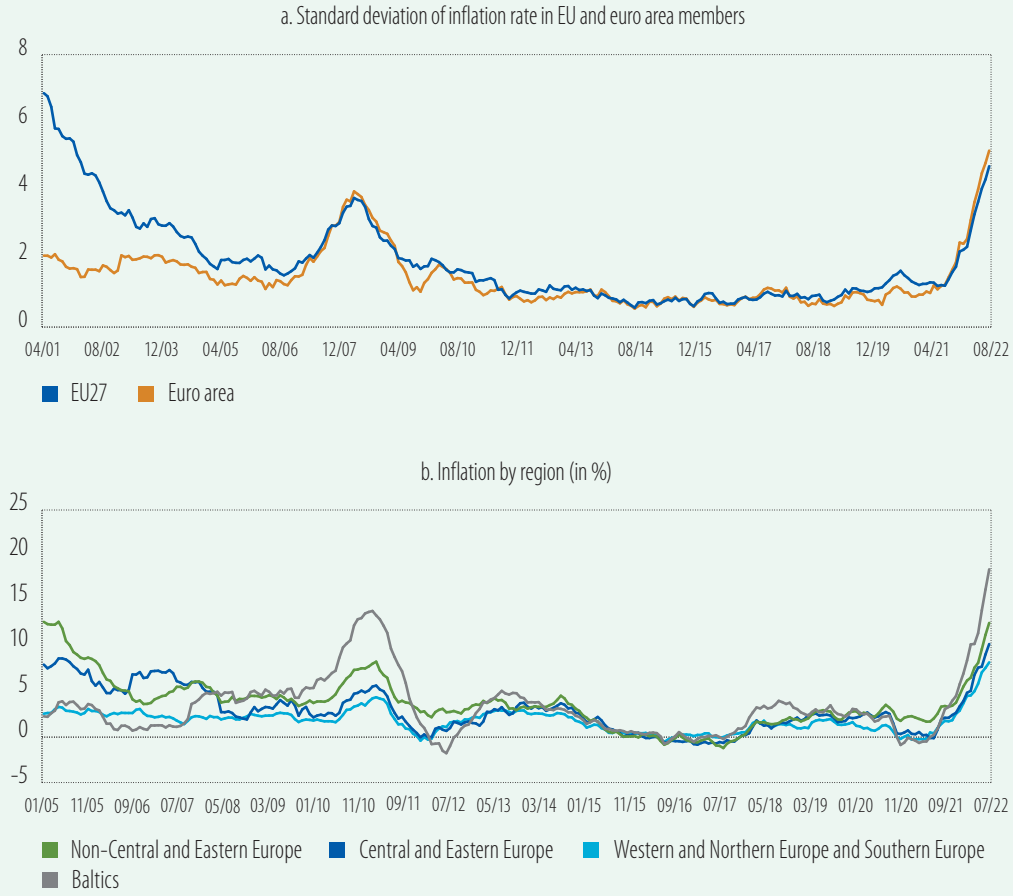
Inflation in the European Union: Features, origins and consequences

Inflation is not only high, but it also varies widely between countries, with headline inflation in September 2022 ranging from 6.2% in France to 24.1% in Estonia. The standard deviation of inflation among the European Union's 27 member countries is at record levels and is also very high for the smaller euro area. The bottom panel of Figure B.1 clearly shows that inflation has not been so dispersed since commodity prices spiked before the global financial crisis of 2009.

The impact of the war and the energy shock on inflation in different EU countries depends on certain characteristics, the two most relevant being geographical proximity to Ukraine and the existence of a national currency. The top panel of Figure B.1 uses simple (unweighted) averages of monthly inflation rates by country group. Inflation is incredibly high in the Baltics (close to 23% annually) and notably high in Central and Eastern European countries not using the euro (around 16%). It is less marked in Central and Eastern European countries with the euro and around 10% for Western and Northern European countries (including countries still using a national currency) and Southern European countries.

The ways countries calculate inflation influence the dispersion, namely the different weights applied and different methods used to track prices. Focusing on the energy and the food, beverages and tobacco categories, the two tables below show differences in weights (Table B.1, left panel) and in price evolution (Table B.1, right panel). The Harmonised Index of Consumer Prices (HICP) system uses different weights for each country to reflect the varying role of each item in the national consumption basket.

Figure B.1
Inflation dispersion in Europe



Source: *EIB staff estimates based on Eurostat data.*

Table B.1
Weights and price changes for energy and food

	Weights (in 1000) in the CPI basket	
	Energy	Food
Baltics	149.5	291.8
Western and Northern Europe	102.8	198.6
Southern Europe	95.6	237.0
Non-euro Central and Eastern Europe	126.9	300.9
Euro Central and Eastern Europe	141.5	258.1

	Year-on-year change as of August 2022 (in %)	
	Energy	Food
Baltics	77.7	21.5
Western and Northern Europe	42.4	10.1
Southern Europe	32.9	10.0
Non-euro Central and Eastern Europe	30.6	18.1
Euro Central and Eastern Europe	28.0	15.1

Source: *Eurostat.*
Note: *CPI stands for the consumer price index.*

For the weights, it is possible to perform a counterfactual exercise in which actual price changes are applied to the HICP euro weighting scheme. In this case, dispersion would only be 4.1 (compared to 4.9), while the difference between the more and less inflationary country groups would be 10.3 (instead of 12.6).

It is difficult to gather reliable information on the evolution of prices. This element depends not only on the structure of different markets, but also on the measurement methods. A blog published by Eesti Pank (the Estonian central bank)[8] in July 2022 points out that the actual measure of energy prices in the consumer price index released by the statistical office can overestimate the real prices paid by customers. Without this overestimation, inflation might have been closer to 20% instead of the 24% recorded in July 2022. Statistics Netherlands[9] also provides evidence that the observation method currently used can overestimate actual energy price increases, because the method only uses data from newly signed contracts.

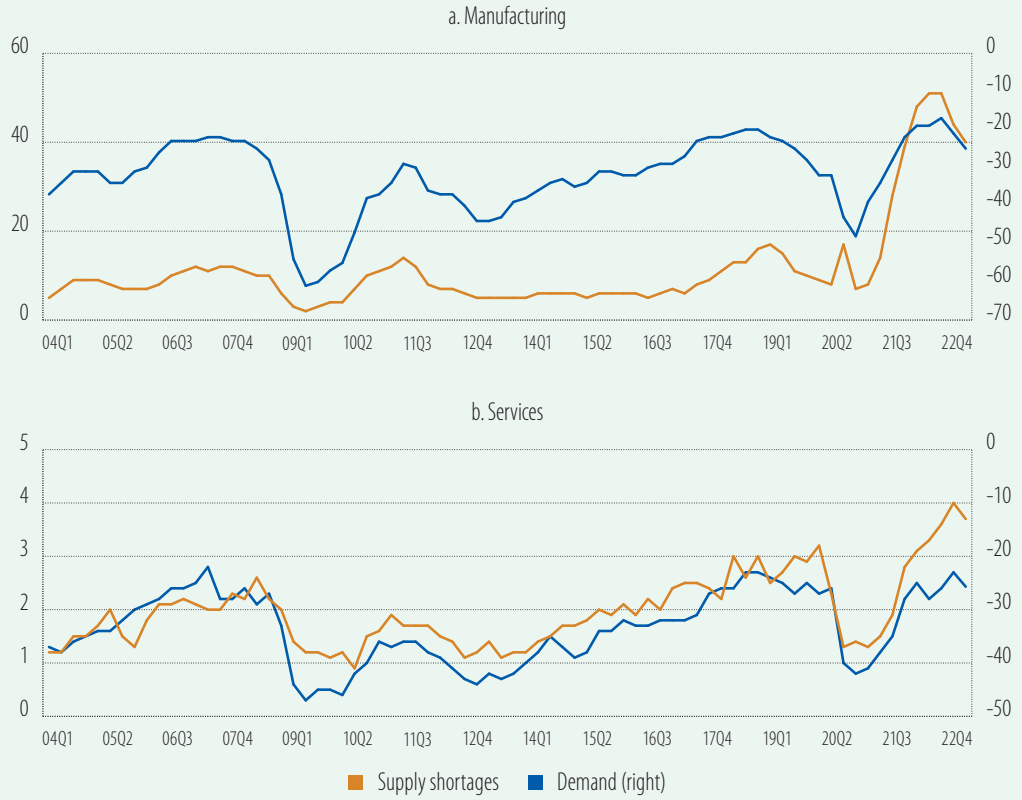
Inflation dispersion creates problems in a well-integrated economic area, and even more in a currency union. Assuming that measurement issues are not the problem, significant price dispersion creates two major issues. In the short run, it makes it more difficult to craft one-size-fits-all approaches to monetary and fiscal policy. For monetary policy, the appropriate increase in policy interest rates is obviously different if the inflation rate is above 20% or below 10%, regardless of inflation's origins (for how much is derived from supply and demand, see below). Fiscal policies also change depending on the level of inflation. Another, longer-term issue is how wide differences in prices affect competitiveness. Wide variations in domestic prices will eventually weigh on a country's performance.

Understanding the inflation's origin is key to predicting how prices evolve and the most appropriate policy responses. Research in the United States (Shapiro 2022) assumes that a demand shock moves prices and quantities in the same direction, while a supply shock forces prices up and quantities down. Examining over 100 product categories, the research finds that more than half of the US inflation rate stemmed from supply bottlenecks, such as disruptions related to the pandemic and the war in Ukraine. In contrast, demand factors explain only one-third of recent inflation, despite playing a big role in the spring of 2021.

The European Commission performed parallel analysis of inflation's origins in the European Union. The analysis (Pasimeni 2022) was based on survey data, since the European Commission Business Survey includes questions on the main obstacles hindering production. Respondents could choose between demand and supply factors, and these were used as explanatory variables in a regression with the producer price index as a dependent variable. The conclusion was that in Europe, supply factors seem to be responsible for at least 80% of producer price inflation. Figure B.2 shows the evolution of the two survey indicators used in the analysis. For the manufacturing sector, supply issues were a major factor in the first quarter of 2022 and their importance is now slowly declining, though they remain at record levels (the long-term average indicator was 8 for 2004-2019, is currently 40 and peaked at 51.1). The same dynamic also applies to demand, although current figures for demand's impact are high but remain below other peaks. The situation in the service sector is similar, with less supply pressure. The main policy implication is clear. Removing supply obstacles, by promoting and accelerating the transition to renewable energy, could help lower inflation.

8 Kaspar Oja: Eesti elektri hinnatõus on seletamatult suur | Blogi | Eesti Pank.
9 Towards a new method of calculating energy prices (cbs.nl) CBS Netherlands.

Figure B.2
Share of firms (in %) **reporting supply shortages or demand as an obstacle to production**



Source: *EIB staff estimates based on European Commission survey data.*

Box C
The 1970s oil shock: Impact, policy responses and structural changes

At the start of the 1970s, energy production in the United States and Europe relied heavily on oil imports. Over the preceding two decades, many countries had scaled up their use of crude oil to meet increasing energy needs. On the eve of the first oil shock, dependence on crude oil was particularly high in Europe. Italy sourced almost its entire energy supply from imported oil, with similarly high figures in France (75%), the United Kingdom (50%) and Germany (40%). The United States was less dependent: It only imported 27% of the crude oil used to produce energy, while oil itself generated just over one-third of the total energy produced (International Energy Agency (IEA), 2019).

The oil shocks of 1973 and 1979 transferred substantial wealth to oil-exporting countries. In 1973, oil prices tripled following export embargoes by Arab oil-producing countries.[10] They continued to rise gradually in US dollar terms until they again more than doubled in 1979, when Iranian oil production temporarily fell in the aftermath of the Iranian revolution. Many oil-importing economies entered recessions in 1974-1975 and 1980-1981. The two oil shocks transferred around 2% of gross national product from Organisation for Economic Co-operation and Development (OECD) countries to Organization of the Petroleum Exporting Countries (OPEC) members (Llewellyn, 1983).

10 West Texas Intermediate (WTI), in current US dollars.

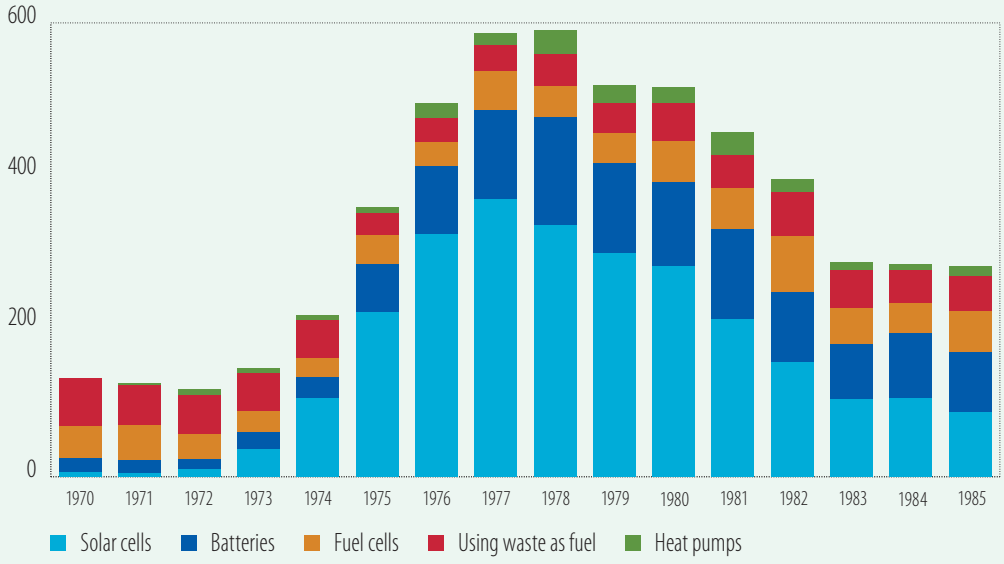
Policymakers responded very differently to the two shocks. In 1973, policymakers in the large oil-importing economies were mainly concerned about offsetting the negative impact higher oil prices were having on demand. Fiscal policy was generally mildly expansionary and monetary policy accommodative. A notable exception was Germany, where the Bundesbank tightened policy rapidly. As a result, inflation rose by less in Germany than in other large oil-importing countries, increasing from 5.5% in 1972 to 7% in 1974 (compared with a rise from 4.5% to 13.2% for Group of Seven (G7) countries). In 1979, concerns about persistent inflation and growing fiscal deficits generated a very different response. Monetary policy was tightened aggressively. Average real interest rates in the G7 nations from 1980 to 1982 were 2.4%, vs. -2.3% from 1973 to 1975 (Black, 1985). Discretionary changes to fiscal policy, such as spending freezes and increases in taxes and social security contributions, amounted to 1.5% of GDP from 1979 to 1982, reducing but not fully offsetting the impact of automatic stabilisers, such as changes in tax revenue and spending (Llewellyn, 1983). As a result, inflation fell back. Unemployment, however, continued to increase, rising from 4.9% in 1973 to a peak of 9.7% in 1982 in the United States, and from 0.8% in 1973 to a peak of 6.1% in 1983 in Germany.

The oil shocks drove a search for alternative energy sources to increase energy security. US coal demand grew by an average of 2.3% per year in the 20 years following the first oil shock, vs. only 0.9% per year for total energy and no growth for oil and gas. Italy halved the share of crude oil in its energy production, relying more on natural gas. France scaled up its nuclear energy programme. By 1990, the share of nuclear energy in its total energy supply had reached 36%, up from just 2% in 1973. The United Kingdom developed its own oil reserves in the North Sea and by 1990, its net exports of crude amounted to 16% of the energy it generated from oil.

High energy prices stimulated research into green energies. The number of patent applications for green energy generation and storage in the United States increased sharply following the first oil shock (Figure C.1). After the second oil shock, patenting activity in these technologies receded, potentially because of changing policy priorities, combined with declining oil prices. Another reason may have been declining returns on innovation at the time (Popp, 2002).

Figure C.1

Patent applications for green energy solutions (by number)**, in the United States**

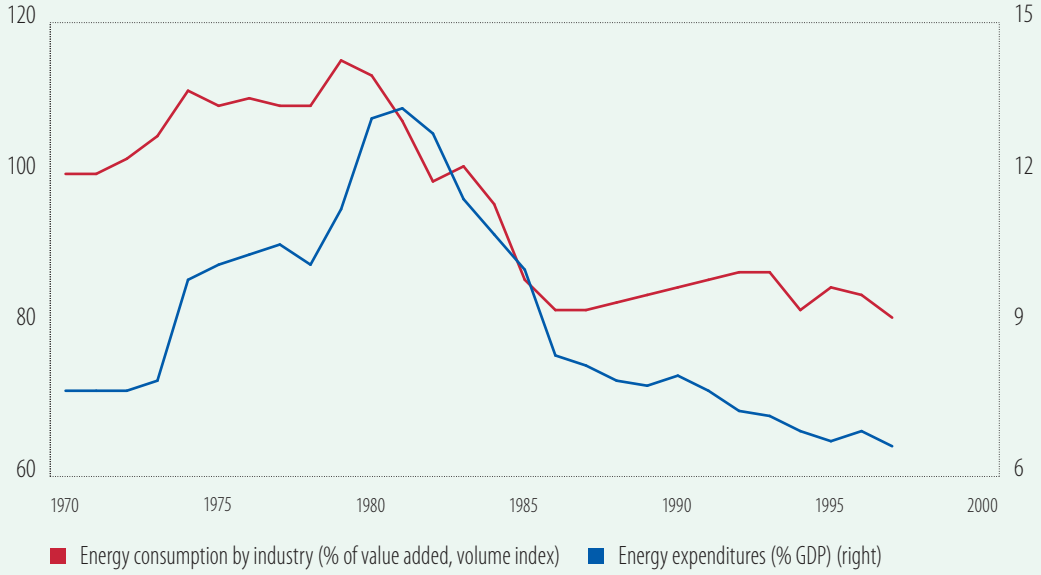


Source: *Popp (2002).*
Note: *Privately held patents are attributed to the year of application. Battery patents are for storing solar energy.*

Households and industries used energy more efficiently. Technologies such as computer-aided design and manufacturing, numerically controlled machines and information networks reduced the energy needs of production (Alpanda and Peralta-Alva, 2010). The amount of energy US business used to add economic value declined by about one-third in the decade following the first oil shock (Figure C.2). Technological improvements in heating, lighting and cooling systems led to a decline in energy use, despite a rise in the building space that required heating and cooling (Rosenfeld, 1990).

Figure C.2

Energy expenditures and use by businesses (left axis: an index; right axis: % GDP), **in the United States**



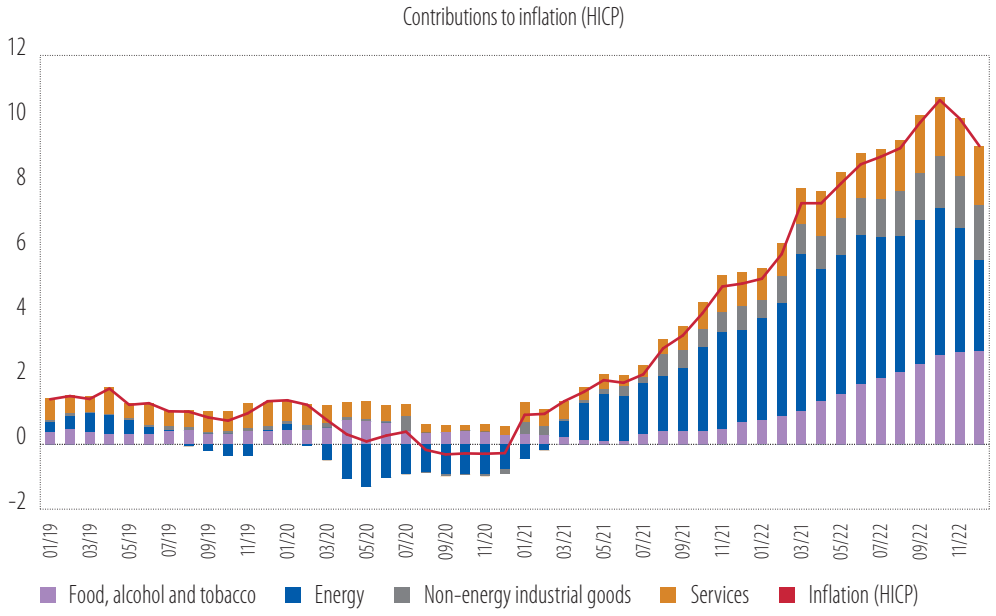
Source: *Energy Information Administration (EIA) and Bureau of Economic Analysis (BEA).*
Note: *The index measures the total energy consumed by industry relative to the quantity of industrial value added (1970=100).*

Tighter monetary policy and greater risk aversion are pushing up corporate funding costs

By the end of 2021, central banks across the European Union started to withdraw some of the extraordinary stimulus provided during the pandemic. Amid a robust recovery, in December 2021 the ECB announced that it would stop increasing its Pandemic Emergency Purchase Programme (PEPP) in March 2022. Under PEPP and the Public Sector Purchase Programme (PSPP), the ECB bought bonds worth equivalent to euro area countries' entire government bond issuance from 2020 to 2021 (Figure 19). Elsewhere, central banks in EU members not using the euro had started to raise interest rates. For example, Hungary increased its rates from a low of 0.6% to 2.4%, the Czech Republic from 0.25% to 3.75%, and Poland from 0.1% to 1.75%.

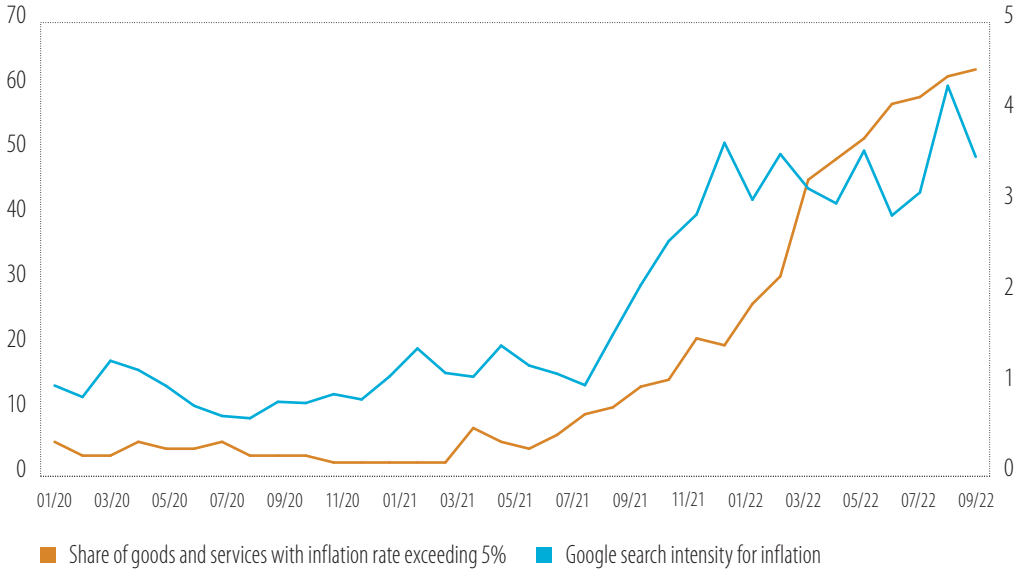
The war in Ukraine darkened the outlook for growth while pushing inflation far above central banks' targets. Initially, rising prices were confined to energy and food (Figure 13). Because those increases were considered to be temporary, they were initially overlooked by monetary policy. But rising prices proved persistent and broadened to other components of the consumer price index basket. Internet searches for "inflation" rose steeply, suggesting that households and firms were incorporating higher inflation into their price and wage demands (Figure 14).

Figure 13
Contributions to annual EU inflation (in percent)



Source: *Eurostat, authors' calculations.*
Note: *HICP stands for Harmonised Indices of Consumer Prices.*

Figure 14
Attention to inflation (left axis: an index) **and share of goods with high inflation** (in %)

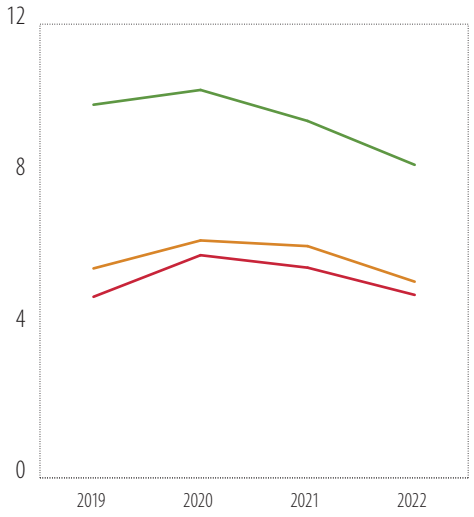


Source: *Eurostat, Google.*
Note: *Share of CPI basket items based on 4-digit items. Google search intensity is based on GDP-weighted indices of the 11 EU members with the largest GDP. The frequency with which Google users search for inflation is taken as a measure of their attention to inflation. Data was last updated in October 2022.*

Concerns grew that wages would start to spiral, unhinging inflation expectations. The picture was ambiguous. Strong labour markets were likely to support higher wages. In fact, wages and salaries had started to grow faster, particularly in EU countries in the east, but they did not keep pace with inflation.

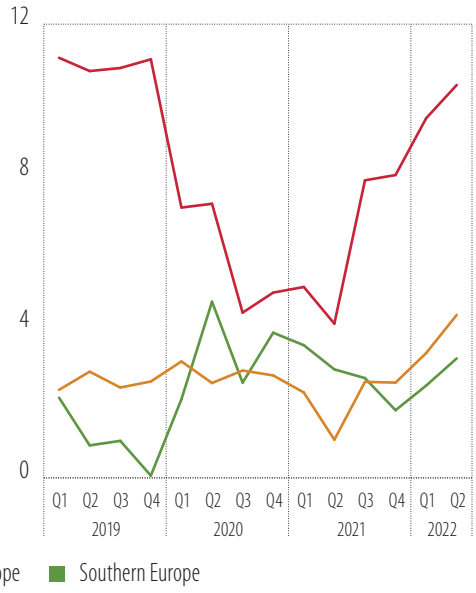
Reliable data had a six-month lag, making it difficult to see the inflation picture clearly (Figure 16). There were also regional discrepancies, with much higher unemployment in Southern Europe than in the rest of the European Union (Figure 15). Longer-term inflation expectations remained generally close to central banks' targets. In the euro area, expectations for 2022 and 2023 had gradually risen but those from 2024 onwards remained close to 2% (Figure 17).

Figure 15
EU unemployment (% of labour force)



Source: *Eurostat, EIB staff calculations.*
Note: *Regional aggregates are simple averages across countries. 2022 reflects the average of the first ten months of the year.*

Figure 16
Growth of wages and salaries (in %, year-on-year)**, by EU region**



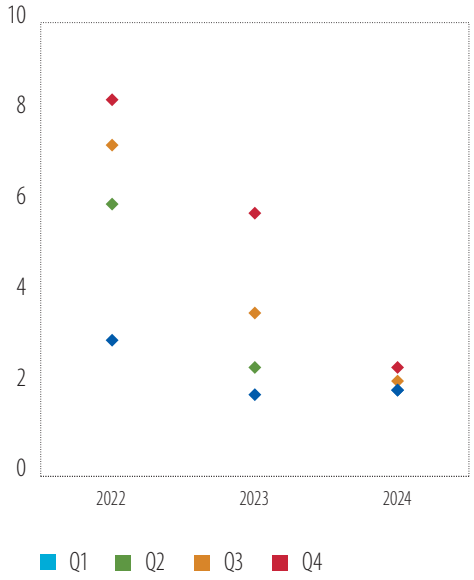
Source: *Eurostat, EIB staff calculations.*
Note: *Regional aggregates are simple averages across countries.*

An intense debate ensued on how much monetary policy could and should do to contain inflation without plunging the European economy into recession. If inflation was mainly caused by demand exceeding supply (for example by households unwinding savings accumulated during the pandemic), tighter monetary policy could rebalance the economy. If, instead, the main cause of inflation was a rise in the cost of inputs, or supplies, monetary policy could do little to hinder its transmission through the economy. Instead, supply obstacles would need to be removed, such as by building renewable energy production capacity to meet energy demands. The demand and supply pressures were affecting various EU members differently (see Box B above).

Central banks responded by tightening monetary policy rapidly despite concerns about growth. EU central banks in Central and Eastern Europe, which is largely outside the euro area, accelerated tightening. In 2022, the Hungarian central bank increased interest rates by over 10 percentage points, the Polish central bank by 5 percentage points, and the Czech National Bank by 3.25 percentage points. These hikes also supported non-euro area countries' exchange rates, which had started to come under pressure as the global investment climate turned more risk averse. The ECB ended net asset purchases (including those in the PSPP) as of July 2022, and it started to raise its policy rate in the same month. Given how difficult it was to predict inflation, the ECB also abandoned forward guidance, which had been useful when interest rates were close to zero.[11]

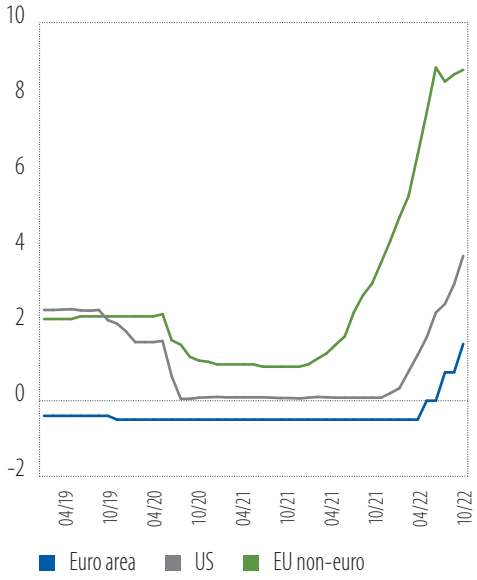
11 The ECB started to provide forward guidance about its policy actions in July 2013, when its Governing Council said it expected interest rates to remain low for an extended period. This quasi-commitment to low rates was meant to stimulate the recovery in the medium and longer term.

Figure 17
Forecasts for 2022-2024 euro area inflation by professional forecasters at different times in 2022 (in %)**, by survey quarter**



Source: *ECB.*
Note: *The chart shows the mean forecasts for annual inflation for 2022, 2023, and 2024 from the Survey of Professional Forecasters conducted in the first quarter of 2022 and the fourth quarter of 2022.*

Figure 18
Central bank policy rates (in %)



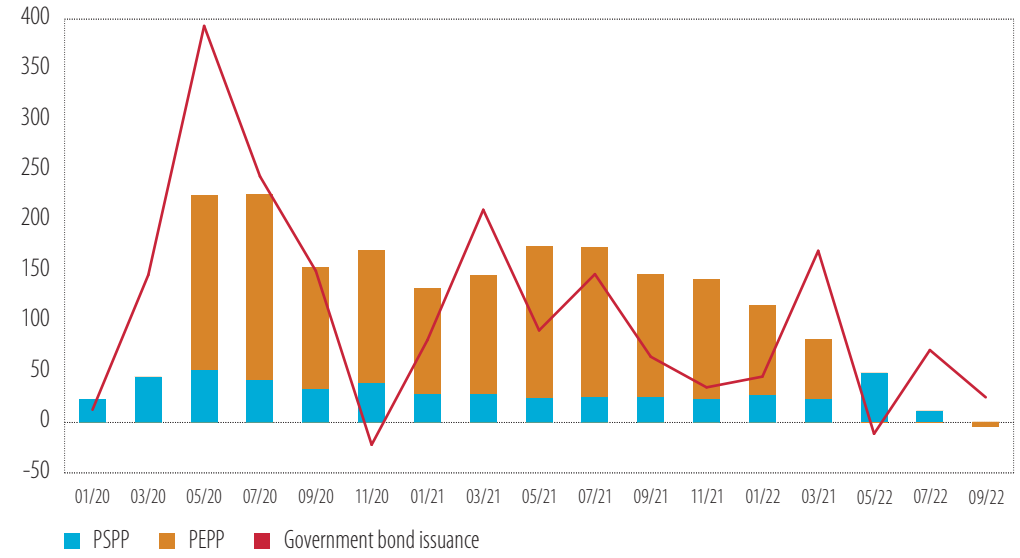
Source: *National central banks.*
Note: *For EU countries outside the euro area, rates were calculated using the simple average of policy rates in Poland, the Czech Republic, Hungary and Romania.*

Sovereign funding costs rose rapidly amid much volatility. Yields on longer-term euro area sovereign bonds fluctuated during 2022, caught between concerns about rising inflation and slowing growth. The yield on 10-year German sovereign bonds rose from -0.1% at the end of December 2021 to 1.6% by mid-June, fell back to 0.8% by the start of August, and increased again to 2.5% in late December. Part of the increase may also have been caused by the ECB's renewed focus on keeping inflation expectations in check and its apparent willingness to accept that the euro area economy might have to enter a recession to bring inflation down. While sovereign bond yields remained low in historical terms, the speed at which they increased generated volatility in some financial markets.[12]

The spreads between the sovereign bonds of EU countries with higher and lower debt widened, prompting the ECB to announce a new asset purchase programme. Sovereign bond yields widened more for highly indebted euro area member countries. For example, spreads of Italian over German 10-year sovereign bonds increased from around 130 basis points at the start of the year to 240 basis points in mid-October (Figure 20). Aiming to avoid an increase in longer-term sovereign yield spreads, the ECB began a new bond purchase programme, the Transmission Protection Instrument. Under this programme, the ECB can purchase securities issued in jurisdictions experiencing a deterioration in financial conditions not warranted by country-specific fundamentals. The fundamentals considered include compliance with the EU fiscal framework, fiscal sustainability and soundness of macroeconomic policies. Purchases are unlimited but should not alter the ECB's overall monetary policy stance.

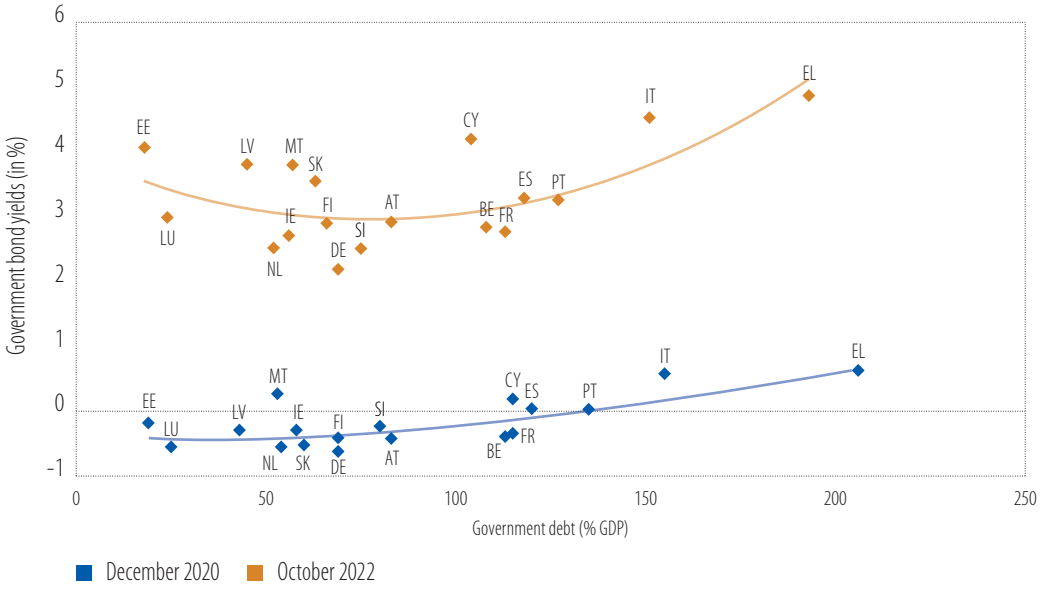
12 One such episode occurred in the United Kingdom, where the Bank of England intervened to halt a steady decline in the price of gilts.

Figure 19
Value of bonds issued by euro area governments and of bonds purchased by the ECB
(EUR billion)



Source: *EIB staff estimates based on Eurostat, ECB.*
Note: *ECB's net purchases of bonds issued by euro area residents under the PSPP and the PEPP from January 2020 until July 2022 and the market value of net bonds issued by euro area governments during the same time. A small fraction of the PEPP contains corporate bonds. There is a break in the series of government bond issuance in January 2021.*

Figure 20
Government debt and government bond yields



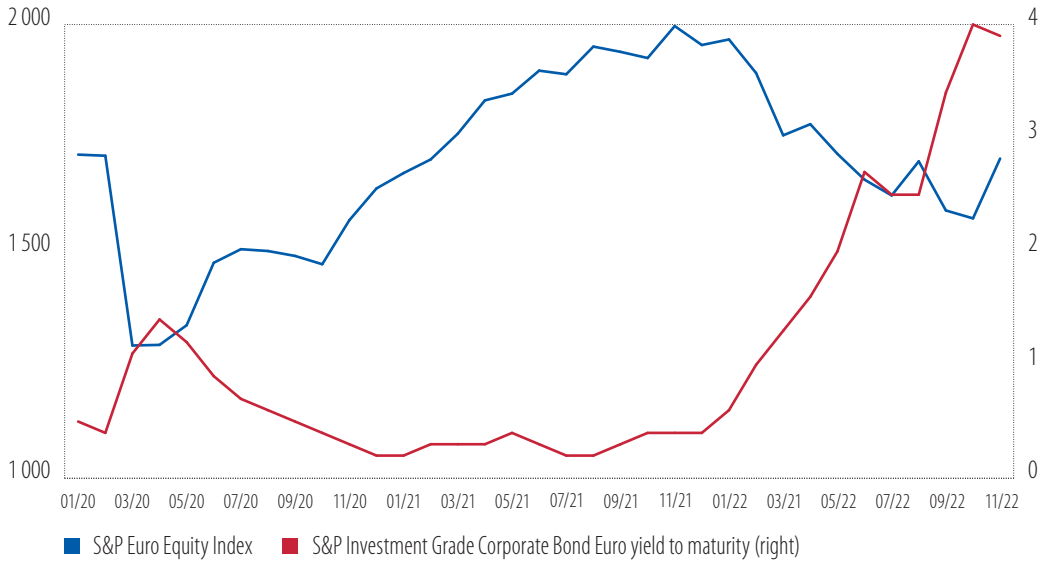
Source: *EIB staff estimates based on Eurostat, ECB.*
Note: *The chart uses 2021 government debt for yields in October 2022. The dashed line represents a second-order polynomial trend.*

Tighter monetary policy and higher risk spreads weighed on corporate refinancing. The proportion of firms that highlighted the lack of available finance as a major constraint increased, particularly in Southern Europe and among small and medium companies (EIB, 2022). The cost of bank lending to corporates,

most of which is at variable rates, followed the ECB's policy rate. Banks tightened their lending standards while firms increased their demand for loans to fund working capital and inventories (ECB, 2022). Yields on fixed-rate corporate bonds rose rapidly (Figure 21), especially for firms in Southern Europe, where spreads over German bonds widened the most. Non-financial firms reduced their net issuance of longer-term bonds, primarily those at fixed rates (Figure 22). Higher interest rates and wider risk spreads also reduced share prices and dampened the equity issuance. For example, the Euro Stoxx 50 declined by about 20% over the first nine months of 2022, with technology firms losing the most value. Net share issuance by companies picked up again when the equity market appeared to bottom out.

Figure 21

Euro area share prices (left axis: index) **and corporate bond yields** (right axis: in %)



Source: *Standard & Poor's.*

Figure 22

Net issuance of securities by non-financial corporations in the euro area (EUR billion)

Source: *ECB.*

Towards the end of the year, central banks slowed or halted their tightening of monetary policy and risk spreads narrowed. Oil and gas prices had receded from their mid-summer peak, reflecting high storage levels and reduced demand due to warmer weather, less demand from energy-intensive industries, energy savings and slower economic growth in the European Union and elsewhere. Annual consumer price inflation appeared to stop rising. Cuts to gas supplies — and lasting damage to industry — had become less likely. Central banks argued that previous interest rate increases needed time to work their way through into the economy.

Fiscal policy between short- and long-term challenges

More than two years after the coronavirus pandemic began, the environment created by the war in Ukraine, the energy crisis and monetary policy tightening threatens to exacerbate differences in the fiscal health of EU countries. Three immediate factors are at play. The first is the increase in interest rates, which influences fiscal performance by absorbing public resources to a different degree depending on a country's debt levels. The second is the different pressures in countries to offset high energy prices with support (which depends on geographical, household and corporate exposure). The third is the non-uniform need for structural revamps as a country progresses more quickly towards the climate transition and energy security. Better fiscal policy coordination among countries and at the EU level is needed to stop these divergent forces from becoming too strong.

At the start of 2022, the main challenge for European fiscal policy seemed to be unwinding the post-pandemic expansionary measures and gradually returning to normal. However, the geopolitical crisis triggered by the Russian invasion of Ukraine changed everything. The initial reaction was to keep the general escape clause[13] of the EU economic governance framework active, and to acknowledge the mounting uncertainty surrounding the economic outlook and need for intervention. As during the COVID-19 crisis, two levels of policy intervention were applied. At a national level, fiscal policy provided discretionary transfers to ease the impact of higher energy prices on households and businesses. At an EU level, the focus was on policies to structurally improve energy security and break dependency on Russia, accelerating the transition away from fossil fuels (such as the introduction of REPowerEU). In the United States, the Inflation Reduction Act pushed in the same direction (Box D). The European Union also continued to play a pivotal role in safeguarding public investment (via the implementation of the Recovery and Resilience Facility).

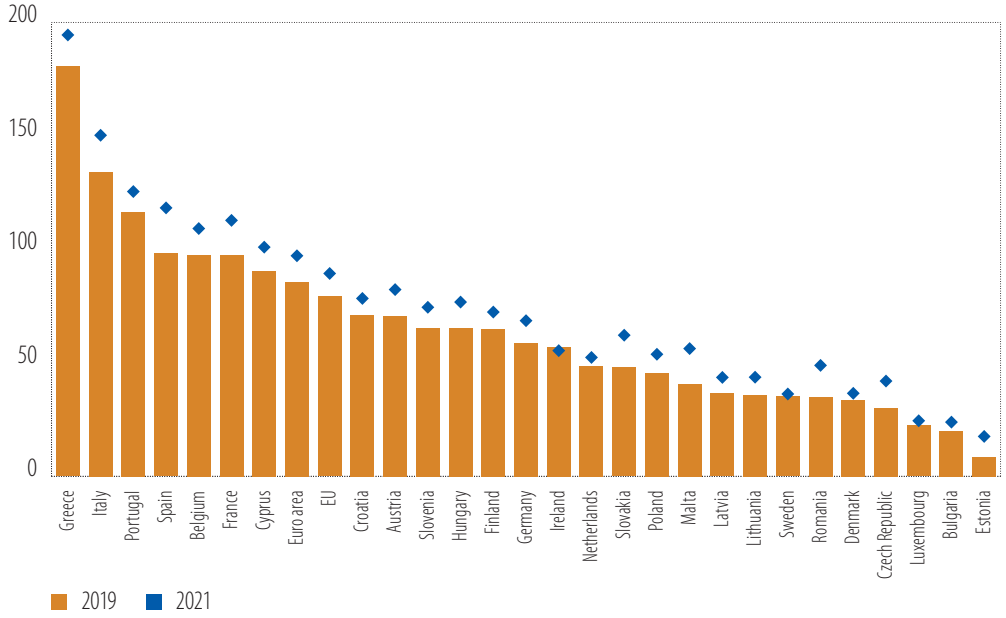
The COVID-19 crisis left the European Union with higher public debt. Owing to the pandemic-related expansionary fiscal stance and lower growth, by the end of 2021 the general government debt for the EU27 had increased by almost EUR 2 trillion, rising to an overall debt-to-EU GDP ratio of 89.4% from 79.2% at the end of 2019. In this period, general government debt increased by an average of 10.2% in EU members and by 11.4% of GDP in euro area countries (Figure 23). In seven EU countries (all in the euro area and representing 44% of the European Union's GDP), the public debt-to-GDP ratio was above 100%.

In May 2022, the European Commission and the Council of the European Union recommended gradually making fiscal policy less expansionary than during the pandemic. The Council of the European Union and the euro area finance ministers[14] recommended that Member States be ready to react to the evolving economic situation (with the high level of uncertainty caused by the energy crisis) and confirmed the move from a supportive fiscal stance in 2022 to a neutral one in 2023. The European Commission's European Semester Spring Package (issued on 22 May 2022) stated that fiscal policy should ease the impact of high energy prices on vulnerable households "being mindful of the measures' potential impact on inflation." The European Commission also recommended that EU members use the Recovery and Resilience Facility to support their recovery to preserve nationally financed investment.

13 The general escape clause allows for a coordinated and orderly temporary deviation from the normal requirements for all EU members in a situation of generalised crisis caused by a severe economic downturn of the euro area or the European Union as a whole.

14 Eurogroup, 23 May 2022 Main Results.

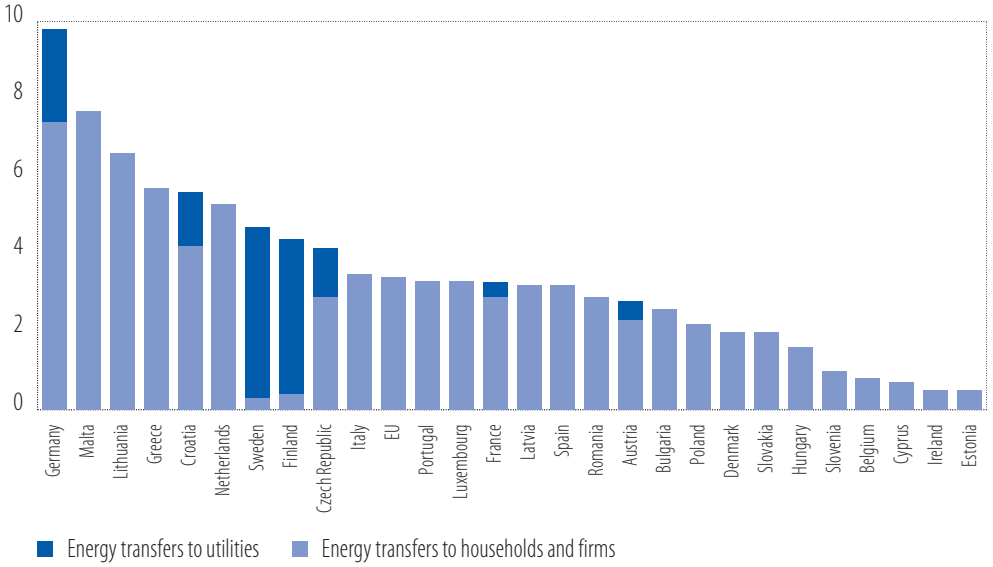
Figure 23
General government gross debt in the European Union (% GDP), **2021 vs. 2019**



Source: *European Commission.*

However, gas and electricity prices on European markets continued to rise throughout the spring, reaching record levels. EU members rolled out various energy-related subsidies to alleviate the negative impact of the higher energy prices and overall cost of living on firms' and households' disposable income, and they provided extraordinary funding to energy-sector public utilities. From September 2021 to October 2022, total allocations for the transfers were estimated to be about EUR 756 billion (3.9% of EU GDP), 76% of which was provided through direct subsidies to consumers and firms and 24% as bailout funds to public utilities (Figure 24).

Figure 24
Value of fiscal transfers related to high energy prices (% GDP), **September 2021 to October 2022**



Source: *Bruegel and EIB staff estimates.*

In October 2022, the European Council reached a milestone agreement on how to address high gas prices in European Union, thus alleviating the pressure on national governments. While negotiation and fine-tuning are still ongoing, the European Council held in Brussels on 20-21 October 2022 reached a broad agreement for new emergency measures to address high gas prices in the European Union and to ensure a secure supply of energy. This will be done through: (i) joint liquid natural gas purchasing to negotiate better prices (by pooling demand for at least 15% of EU member country gas storage needs during 2023); (ii) a mandate to the European Commission to create a temporary mechanism to limit gas prices and volatility on the main European Title Transfer Facility (TTF); (iii) a solidarity mechanism between EU members ensuring that any country facing an energy emergency will receive gas from others in exchange for fair compensation (up to EUR 40 billion in transfers drawn from unused EU cohesion funds); and (iv) continuous efforts to reduce gas demand at national level.

The impact of higher inflation and lower growth on government balances is unclear. According to the European Commission's autumn forecast (from November), EU GDP growth was expected to be 3.3% in 2022 and 0.3% in 2023 (3.2% and 0.3% for the euro area). Figures for EU gross public debt are projected to be 86% in 2022 and 84.9% in 2023, while the deficit is expected to be -3.4% in 2022 (down from -4.6% in 2021) and -3.6% in 2023. The structural primary balance is projected to move from -2.5% in 2021 to -2.0% in 2022 and -1.5% in 2023. The change in the structural primary balance is considered to be the best single indicator of how the fiscal stance is changing. The numbers confirm the gradual reduction in the expansionary stance. However, it is important to note that the number was positive before the pandemic, averaging 1.2% from 2014 to 2019.

The European Commission proposal for a revised fiscal framework points to enhanced coordination on debt reduction plans. The proposal presented to the Council by the European Commission in early November acknowledges that some of the automatic mechanisms — particularly a rule that implies government debt to GDP should fall below 60% in 20 years — are now unworkable (given the debt levels reached) and difficult to implement. In the spring, each EU member should present a plan merging the current stability and convergence programmes and national reform programmes. Countries with high debt (particularly those with debt over 90%) should find an agreement with the European Commission on tailor-made four-year (maximum seven-year) debt reduction plans. Non-compliant countries will enter into the standard procedure for dealing with excessive deficit. Committing to specific reforms and investments may grant EU countries additional time regarding their debt reduction (with a stronger guidance from the European Commission). The new framework also aims to simplify the definition of the reduction path (for debt and deficit) using a simple and single fiscal indicator (net primary expenditures[15], defined for each EU member by the European Commission on the basis of the debt sustainability analysis). It also points to increased national participation on defining reforms and policies. The European Commission has acknowledged that the proposal takes inspiration on implementation and monitoring from the governance of the Recovery and Resilience Facility.

In the overall assessment of 2023 budget plans[16] (in euro area countries only), the European Commission confirmed the debt guidelines issued during the summer. These guidelines stated that EU members with high debt levels should limit the growth of primary current expenditure below potential GDP growth, while those with low or medium debt should move towards a neutral fiscal stance. It was also reiterated that any further measures to tackle the energy crisis should specifically target vulnerable households and exposed firms. The European Commission highlighted the role of the Recovery and Resilience Facility in protecting public investment proposed in EU members' plans.

Looking ahead, national and EU-wide fiscal policy challenges remain. Higher public debt and lower economic growth, against a global backdrop of high inflation and rising interest rates, give governments and policymakers less room for manoeuvre. With the ECB ending quantitative easing and tightening monetary policy, European governments are confronted with higher borrowing costs on top of increased

15 As suggested repeatedly by the European Fiscal Board in its Annual Reports.
16 European Commission (2022).

debt levels following the pandemic, limiting their capacity to borrow. At the same time, the ECB has introduced the Transmission Protection Instrument (TPI) as a tool to prevent market turbulence that is unrelated to macroeconomic fundamentals. That turbulence can hinder the normal transmission mechanisms of monetary policy. However, the TPI is principally intended to tackle crises. The weight of interest rate expenditure on government spending will unavoidably return to levels not seen in recent years, absorbing substantial resources from the most indebted countries. For example, the yield for Italy's average debt maturity (seven years) rose from 0.42% in June 2021 to 4% in October 2022. At the current level of debt (147.2%) and after higher interest rates are taken into account for debt payments, interest expenditures will absorb close to 6% of GDP compared to 3.4% in 2019. As the difference between interest rates and economic growth once again becomes a key component in assessing debt sustainability[17], European countries will face the challenge of carefully calibrating spending programmes and keeping gross financing needs in check for years to come.

Box D

How the US Inflation Reduction Act could alter the international trade of green products

The Inflation Reduction Act aims to support households and businesses, stimulating employment and investment, and reducing deficits amid rampant inflation. Central to the vast USD 369 billion public spending plan are clean energy provisions intended to cut energy bills, remove barriers to clean energy deployment and build resilience. The act entered into force on 16 August 2022.

Preliminary assessment suggests that the spending plan could trigger over USD 1.5 trillion of new investments in clean manufacturing within ten years. An initial wave of USD 28 billion of investments were expected to be announced following the bill's signature, directly boosting the deployment of electric vehicles, batteries and solar energy manufacturing. A Clean Energy and Sustainability Accelerator, an independent finance entity, will support state and local financing for clean energy investments, pushing the uptake of zero-emission technologies. Production tax credits will encourage the domestic development of more secure and sustainable supply chains, embedding critical minerals that should be extracted, processed and recycled in North America.

This landmark legislation marks a turning point for climate action in the United States. But given the sheer size of subsidies involved, some fear the bill could cause market distortions that pull operations or manufacturing back to the United States. That reshoring could impede the industrial competitiveness of key US trading partners, including in the European Union, eventually undermining their own decarbonisation efforts.

The European Union is also repositioning industrial supply chains to meet its domestic needs for green-tech solutions, with public provisions to catalyse research and foster innovation. A firmed-up REPowerEU action plan — originally put in place to alleviate the immediate impact of the energy crisis — is expected to result in the wider adoption of cheaper clean energy by small and medium companies and industries (von der Leyen, 2022). A key example of the European Union's strategic reorientation is the newly established European Solar Photovoltaic Industry Alliance, following the European Battery Alliance programme founded in 2017 and the European Clean Hydrogen Alliance in 2020, reducing the reliance on imported products vital to Europe's green transition.

The bloc has also announced new trade partnerships to secure the supply of green hydrogen and to offset the deficit of critical materials in the long term. The progressive implementation of the European Union's Carbon Border Adjustment Mechanism — an integral part of the Fit for 55 package effective from 2023 — is intended to harmonise the carbon footprint of goods circulating in the European Union, but it may entail higher tariffs for European consumers.

17 The IMF Fiscal Monitor projection for Italy's rate-growth differential is -1.1% for 2022 to 2027. It was -1.8% in the 2021 October Fiscal Monitor. For France, the differential is -2.3% (it was -3.0% in 2021).

Without some degree of policy and trade rule harmonisation among regional partners, isolated initiatives may result in wider gaps in domestic production costs and inconsistent sustainability standards, which will slow down the green transition globally. Conversely, strengthened cooperation and more transparent support schemes could create a virtuous circle that encourages industrial transformation, stimulates the exchange of green products and delivers a cost-effective and timely transition on both sides of the Atlantic.

In line with the Inflation Reduction Act, the European Commission recently announced its proposals for a Green Deal Industrial Plan to boost the competitiveness of European industries and accelerate the transition to climate neutrality. The plan revolves around four pillars: the regulatory environment pillar, a funding pillar articulated around a newly-created European Sovereignty Fund to raise capital for businesses as well as skills and trade pillars.

Conclusion and policy implications

The ongoing crisis is affecting EU members to very different extents. The upward pressure on energy and food prices exacerbated by the Ukraine war starved the European Union's post-pandemic recovery. But while the shock itself is common to all countries, some EU members are more profoundly affected than others, reflecting their dependency on fossil fuels, the energy intensity of their production and their reliance on gas imported from Russia. Countries' ability to offset the shock also differs. Non-euro area central banks felt the need to raise interest rates quickly to counter pressure on their exchange rates, while the ECB chose to tighten policy more gradually. More heavily indebted countries find their spending constrained after the pandemic, limiting the support they can provide to households and firms.

Better policy coordination would strengthen the European Union. The uneven effect of the crisis highlights the need for coordinating national policies to prevent the rising prices from driving a permanent wedge between the different economies. As it did during the pandemic, the European Union has played an important role in the energy crisis by adopting sanctions against Russia, helping Ukrainian refugees to travel and work and adopting a new programme (REPowerEU) to address the energy crisis.

Europe's energy supply would be more secure if energy purchases were coordinated and network infrastructure improved. For example, coordinating purchasing could help push down prices for energy previously imported from Russia, and improved gas and electricity distribution networks could help countries to avoid rationing energy. These investments will not be implemented overnight, but some might still arrive in time. Energy prices remain volatile and might react quickly to signs of supply shortages. Those shortages might be more acute during the winter of 2023-2024, when gas storage is less full than at the start of winter 2022-2023.

Support for businesses should be targeted, focused on energy efficiency and coordinated to minimise distortions to the single market. National energy prices differed even before the energy shock. However, the increase in wholesale gas prices could easily dwarf the price differences that existed between EU members before the war. Differing price caps across the European Union could give a competitive advantage to firms in countries with lower caps. The single market could be distorted. Moreover, measures to protect business should not weaken incentives for companies to diversify their energy mix, invest in energy efficiency or invest in renewables.

Fiscal policies will need to be coordinated, not least to protect public investment. The European Union's decision to prolong the escape clause of the Stability and Growth Pact provided countries with flexibility to offset the impact of higher energy costs on households and firms. The key question remains how to prevent some countries from 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 investment, but in the past public investments have often fallen victim to fiscal consolidation. Several options exist to protect public investment, such as taking account of the positive effect of investment expenditures on growth when assessing countries' debt sustainability, while ensuring that the European Union meets its longer-term fiscal goals. Measures to hold in check increases in sovereign interest rate spreads — such as the ECB's new asset purchase programme, the TPI — will be more effective if Europe's fiscal framework remains sound and credible.

Overall, the crisis is a challenge as much as it is an opportunity for Europe. The opportunity is that almost all investments tackling the energy crisis will also drive the green transition. The challenge is threefold. First, inflation needs to be tamed. Second, public investment needs to be protected even as countries stare down budget deficits caused by higher military spending and measures to shield households and firms from the energy price shock. And third, investment in the green and digital transitions need to be implemented effectively.

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Chapter 2

Investment in Europe

Since 2020, Europe has seen its economy's capacity to invest, transform and adapt hampered by a string of negative developments. Trends like digitalisation, the green transition, ageing and growing inequality constitute major challenges for the European economy. To address them, Europe will have to become more innovative, flexible and resilient — a feat that will require continuous effort. Furthermore, for the past ten years, Europe's national economies have shown a gap in productive investment of 1.5 to 2 percentage points of gross domestic product (GDP) relative to the United States. The pandemic, the energy crisis and now the deteriorating outlook have endangered Europe's ability to address investment needs in the public and private sectors. Focusing on policies that encourage productive investment is therefore crucial.

In many countries, the Recovery and Resilience Facility (RRF), Europe's EUR 723.8 billion investment plan, will play a key in role in sustaining transformative public investment even as concerns about fiscal health mount. Government investment is usually the first victim of budget cuts when countries face concerns about the sustainability of their debt. During the pandemic, however, Europe's decision to suspend fiscal rules and put in place the Recovery and Resilience Facility gave a major boost to government investment. Substantial funds remain available — some 1% of EU GDP per year until 2026. To benefit, governments will have to accelerate promised reforms, remove barriers to investment and move forward on planned projects.

Private investment is faced with high levels of uncertainty, tightening financial conditions and decelerating economic growth. The pandemic spurred corporate investment in digitalisation. The energy shock, in turn, might provide incentives for firms to invest in energy efficiency and renewable energy sources, giving impetus to the green transition. In the first half of 2022 aggregate investment held up well, underpinned by robust investment in buildings and structures. However, high uncertainty and a deteriorating economic outlook could depress investment. Against this backdrop, policy measures to incentivise investment are important, including measures to reduce barriers and financial instruments that help share risks.

Introduction

Fifteen years after the global financial crisis, European investment is again being battered by a series of major adverse developments. Coming hot on the heels of the pandemic, the energy crisis signals an important structural shift for the European economy. Given its intensity, the energy crisis has the potential to weaken investment substantially, just as the global financial crisis did. But crises often bring opportunities, and the current challenge could incentivise major changes and breakthrough investments.

Good policy has a role to play in encouraging investment. The right policies will not only prevent an investment downturn, they could actually turn this crisis into an opportunity, speeding up the green and digital transition.

To achieve the transition, major investment is required to enhance resilience, reduce fossil fuel dependence and accelerate digitalisation. But Europe needs more than investment in tangible fixed assets. It also needs innovation and new skills. However, elevated uncertainty and slowing economies put this investment in peril.

This chapter outlines recent investment developments and examines what is needed to transform the EU economy. The first section gives an overview of investment dynamics and investment in different asset types. It shows that high levels of uncertainty are dragging down investment. The section contains a box on the gap in productive investment between the European Union and the United States and another on how funds from the Recovery and Resilience Facility are being deployed. Section two outlines recent trends in government investment. It contains two boxes discussing the importance of government investment in times of crisis. The third section looks at corporate investment through the lens of the EIB Investment Survey (EIBIS). It discusses the investment outlook, along with the short- and longer-term effects of the COVID-19 crisis on corporate investment. Section four focuses on recent trends in investment in intangible assets and innovation, and it contains a box on the effects of the pandemic on investment in intangible capital. The fifth section outlines recent developments in investment in climate change mitigation and adaptation. It includes a box on barriers to climate-action investment.

Following a strong rebound from the pandemic, investment still faces challenges

Investment in buildings and structures underpinned overall EU investment

Investment recovered relatively quickly from the pandemic shock. Real gross fixed capital formation (GFCF) in the European Union exceeded pre-pandemic levels at the end of 2021 and kept increasing in the first half of 2022.[1] By the end of the third quarter of 2022, the aggregate investment rate, defined as the ratio of investment to GDP, was about a percentage point above its historical average and slightly exceeded its pre-pandemic level. In the third quarter, the investment rate in the European Union was actually slightly above that in the United States, a situation that had not been seen since 2013 (Figure 1a). Investment rates among countries are also converging within the European Union. Very high investment in Southern Europe since early 2021 has pushed the investment rate back up to its long-term average, and the region is rapidly closing the gap with the rest of the European Union (Figure 1b).

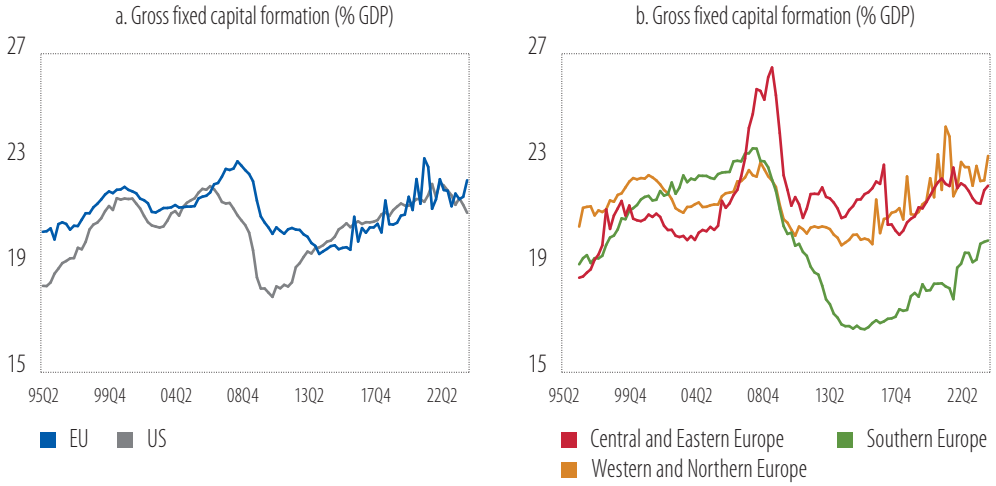
While Europe has kept up with the United States in the rate of investment, a closer look reveals big differences in productive investment across the Atlantic. Total investment in an economy consists of spending on assets that are not engaged in the production of economic output, like residential buildings,

1 Gross fixed capital formation and investment are used interchangeably in this chapter.

and those directly used for production, like equipment, intangible business capital, infrastructure or commercial real estate. While residential buildings are indispensable, it is investment in productive assets that enhances an economy's potential for medium- and long-term growth. Removing investment in residential buildings from the aggregate investment rate reveals a gap of two percentage points of GDP between the United States and the European Union (Figure 2a). This gap appeared after the end of the global financial crisis and has persisted since then. After removing other buildings and structures used in production, what remains are essentially machinery, equipment and intellectual property products. Looking at these kinds of investments, the gap widens to a staggering 3.8 percentage points of GDP (Figure 2b). This gap threatens to weigh on Europe's productivity and further increase the distance with the United States.[2]

Figure 1

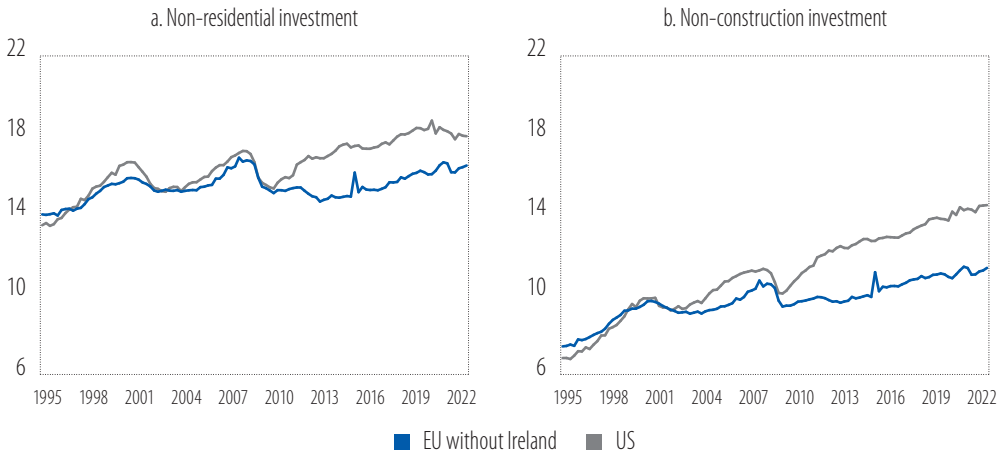
Investment rates are near a 27-year high in the European Union and the United States



Source: *Eurostat and Organisation for Economic Co-operation and Development (OECD) national accounts statistics.*

Figure 2

Rates of productive investment in the European Union have diverged from those in the United States since the global financial crisis



Source: *Eurostat and OECD national accounts statistics.*
Note: *Non-construction investment includes investment in machinery, equipment and weapon systems, intellectual property products and cultivated biological assets.*

2 The ways productivity growth benefits from investment in equipment and intangible capital, which is embodied in many intellectual property products, have been widely documented in academic literature (Brynjolfsson et al., 2002, Corrado et al. 2009, Corrado et al., 2016, Gordon and Sayed, 2020, van Ark et al., 2009).

Box A

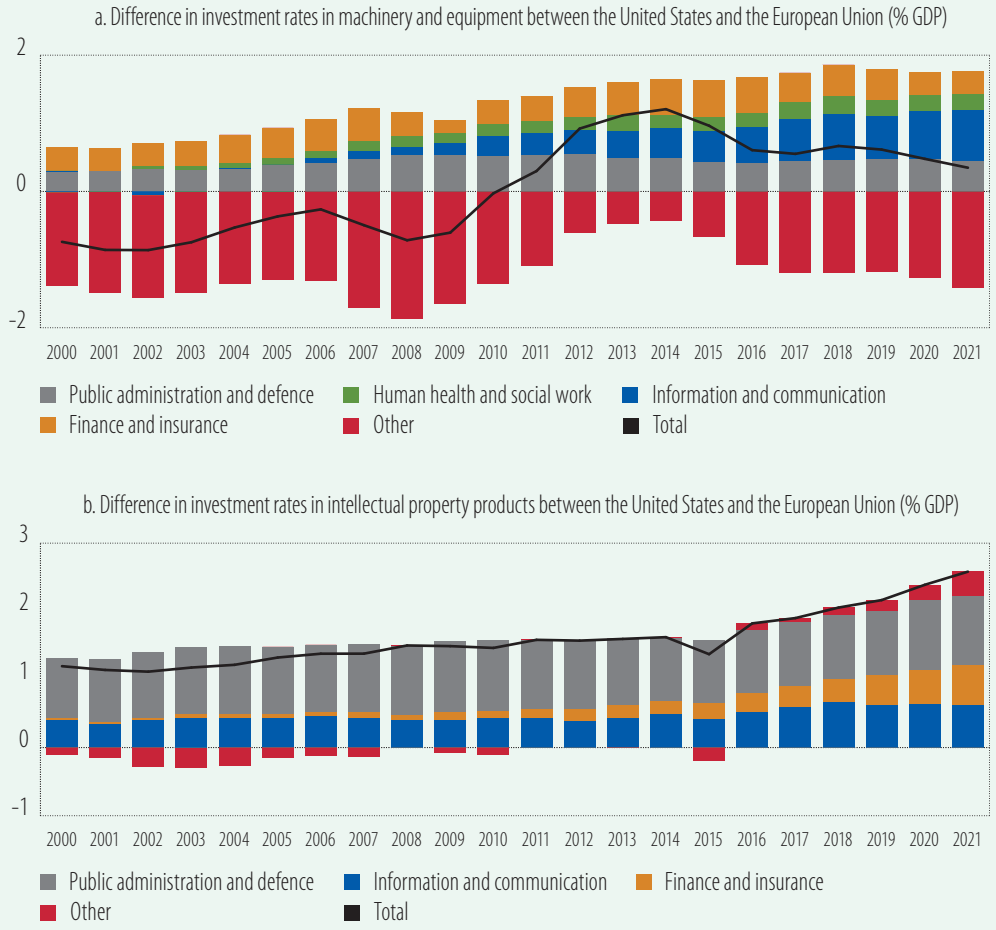
The EU-US gap in productive investment

The gap in productive, or non-residential, investment rates between the European Union and the United States widened at the end of the recession following the global financial crisis. It has gradually increased and has remained above 1.5 percentage points of GDP, underpinned by higher investment in equipment and in intellectual property products in the United States than in the European Union.

The higher investment in machinery and equipment in the United States is accounted for by rising investment in the information and communication sector and the health and social work sector. As discussed in EIB (2020), the investment surge in these sectors is due to higher investment in information and communication technology equipment. The relative increase of this investment in the United States has been very persistent, and had a cyclical component, as EU firms' investment stalled in the aftermath of the global financial crisis and the subsequent sovereign debt crisis (Figure A.1a).

Figure A.1

A sectoral breakdown of the gap in productive investment between the United States and the European Union

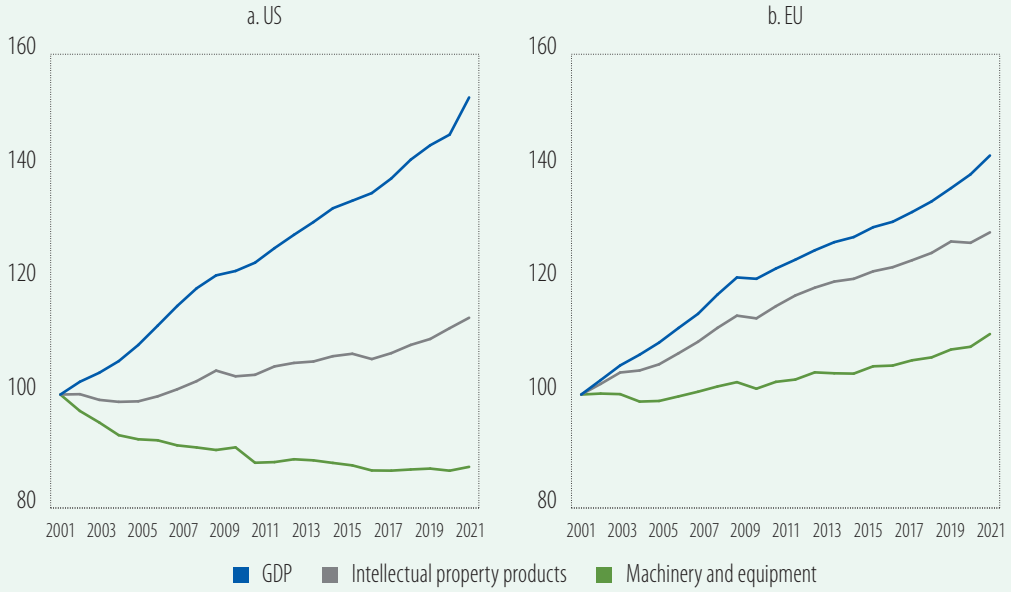


Source: *OECD national accounts.*
Notes: *US GDP and GFCF are measured in US dollars in 2015 chain-linked volumes. EU GDP and GFCF are measured in euros in 2015 chain-linked volumes. The EU aggregate does not include Ireland.*

The gap in investment in intellectual property products has existed at least since 2000. It is sizable and is mainly due to higher investment in public administration and defence and in information and communication. Since the early 2000s, it has gradually widened due to higher investment in the United States in finance and insurance, and in other sectors (Figure A.1b).

In calculating the investment gap, it is important to take the ratio of real gross fixed capital formation and real GDP. While taking the ratio of the nominal variables is temptingly simple, the result would not be informative because the prices of goods normally purchased for investment have evolved very differently from overall prices, making an intertemporal comparison impossible. A country comparison of nominal ratios would be of no great use either, as investment and overall prices evolve differently across countries (Figure A.2).

Figure A.2
Price deflators for GDP, machinery and equipment and intellectual property products (an index, 2000=100)



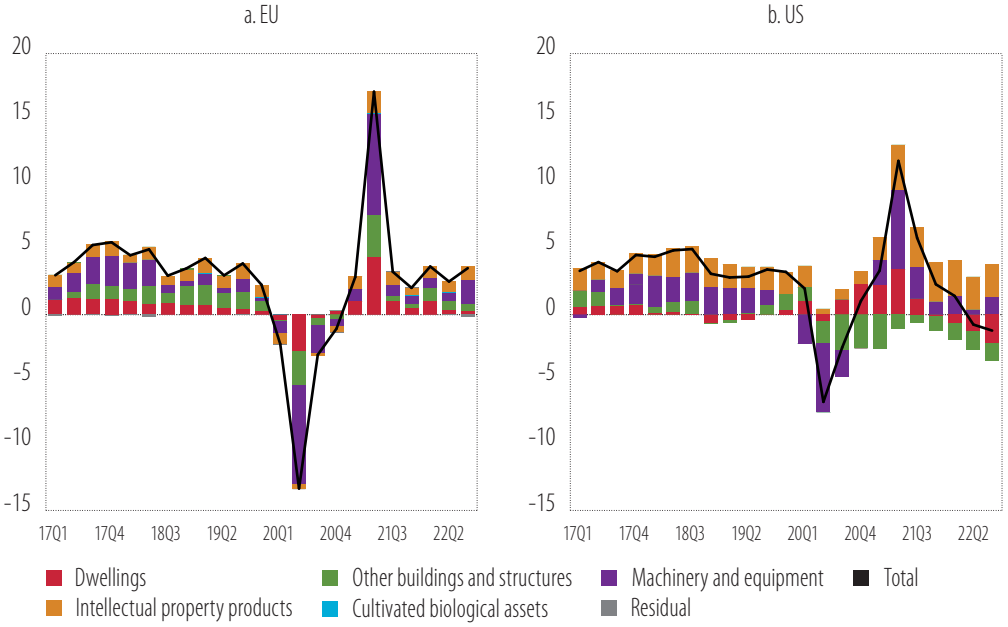
Source: *OECD national accounts.*

Using real quantities is crucial, but it is also important to bear in mind that price deflators, which take into account inflation, are imperfect. The further away an observation is from the base year, the less precise the estimate of the gap will be. For this reason, the value of the gap in any given year is only indicative, and it should not be viewed as an exact estimate. That said, the errors are small. Also, the gap has been cumulating over a long period of time, 12 years, and has turned into a serious challenge for Europe, which needs to tackle underlying impediments to investment.

Investment in machinery and equipment in the European Union exceeded its pre-pandemic level in the third quarter of 2022 (Figure 3). The rise helped total aggregate investment bounce back to its pre-pandemic level, accounting for just over a quarter of the increase. For its part, investment in dwellings and other buildings and structures contributed some 35% to the overall recovery in investment. Spending on intellectual property added 42% to the overall increase in investment from the fourth quarter of 2019 to the third quarter of 2022.

In the United States, the composition of the investment rebound was very different. Spending on intellectual property accounted for 100% of the investment recovery from the fourth quarter of 2019 to the third quarter of 2022, while investment in machinery and equipment made up about three-quarters of the total investment recovery. However, investment in other buildings and structures, which has been declining since early 2020, declined sharply and wiped out about half of the positive contributions made by the other two asset classes. Investment in buildings and structures has dropped to the level in 1994.

Figure 3
Gross fixed capital formation in the United States and the European Union (% change from the previous year)**, by asset type**



Source: Eurostat and OECD national accounts statistics.

The recovery in the European Union was driven by strong investment in Southern Europe (Figure 4). In the European Union, real investment in the third quarter of 2022 was nearly 4% higher than in the fourth quarter of 2019. Countries in Southern Europe contributed the most to this increase (2.2 percentage points, or 55%). Countries in Western and Northern Europe contributed another 1.3 percentage points, while countries in Central and Eastern Europe added only 0.5 percentage points. Southern Europe's growth spurt of 9.9% from the fourth quarter of 2019 to the third quarter of 2022 came mostly from Italy and Spain, and, to a lesser extent, from Greece.[3] Investment in machinery and equipment accounted for much of this growth (4.3 percentage points, or 43%). Investment in other buildings and structures added 2.5 percentage points, and dwellings an additional 2 percentage points. Investment in intellectual property products, most of which originated in Spain, contributed 1.1 percentage points.

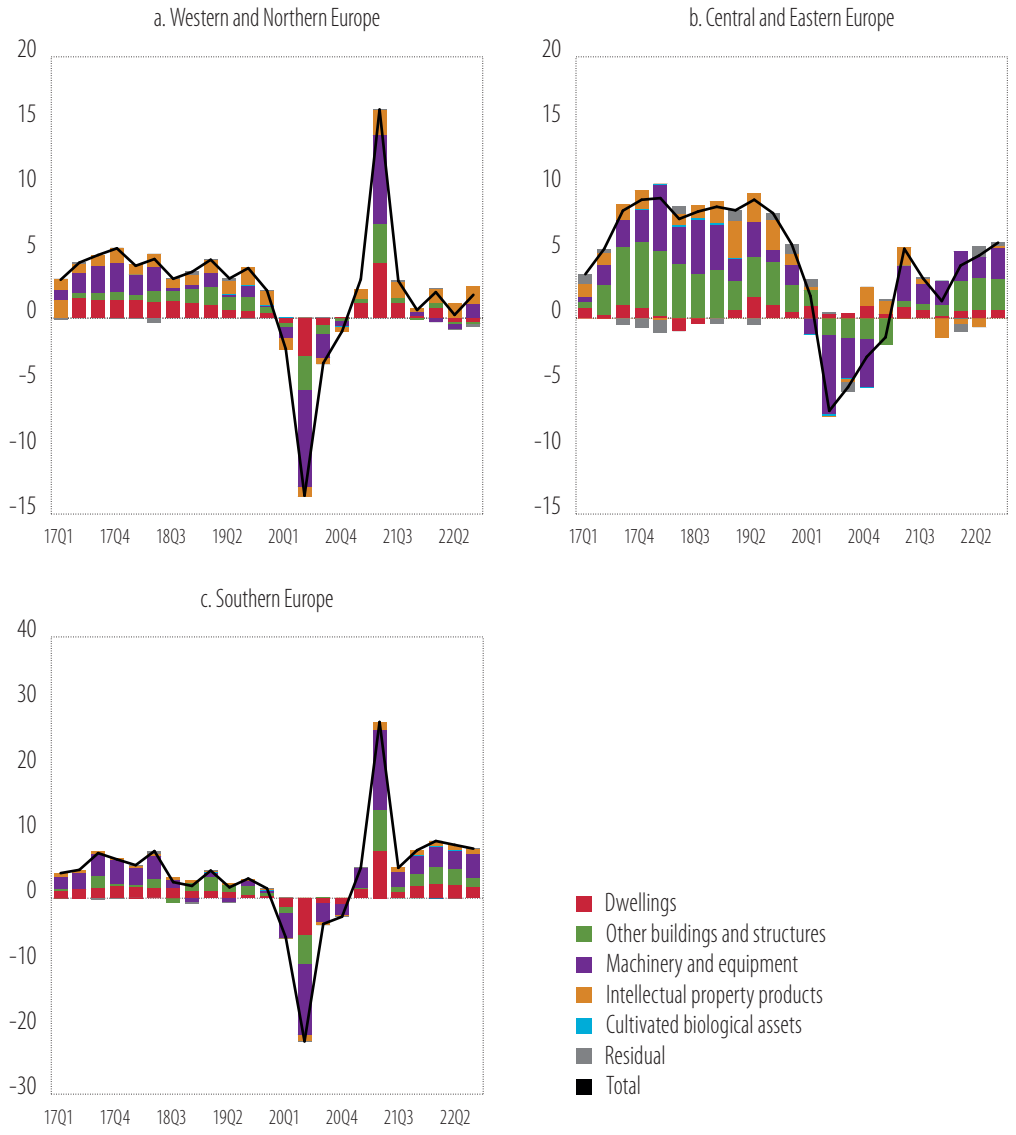
High energy prices have increased input costs — substantially so in some countries and industries — causing the investment outlook to deteriorate.[4] Large shocks to input costs (such as the ongoing rise in energy prices) put considerable pressure on companies' profit margins. Firms that cannot pass a significant part of the increase on to their customers are seeing their cash flows reduced, in some cases substantially, which affects their ability to service debt, finance investment and retain net worth. Companies

3 Incentives to invest in energy efficiency in Italy substantially boosted investment in buildings and structures, and in equipment. In Spain, the rise came from equipment investment from the private and the public sectors. The private sector faced relatively favourable financing conditions, while the government increased spending on digitalisation investment to cope with the challenges posed by reduced mobility and limits on personal contact during the pandemic.

4 See Chapter 6 of the Investment Report for more details on price increases across countries and industries, and the repercussions of those higher energy prices for European economies.

that so far have been able to increase prices may still be affected in the near future if the economy slows down, as recent forecasts suggest. Chapters 3 and 6 of this report provide further detail on the effects of these price increases on firms' balance sheets and the likely consequences for their investment decisions.

Figure 4
Contribution to total investment (% change from the previous year)**, by asset type**



Source: *Eurostat national accounts statistics.*

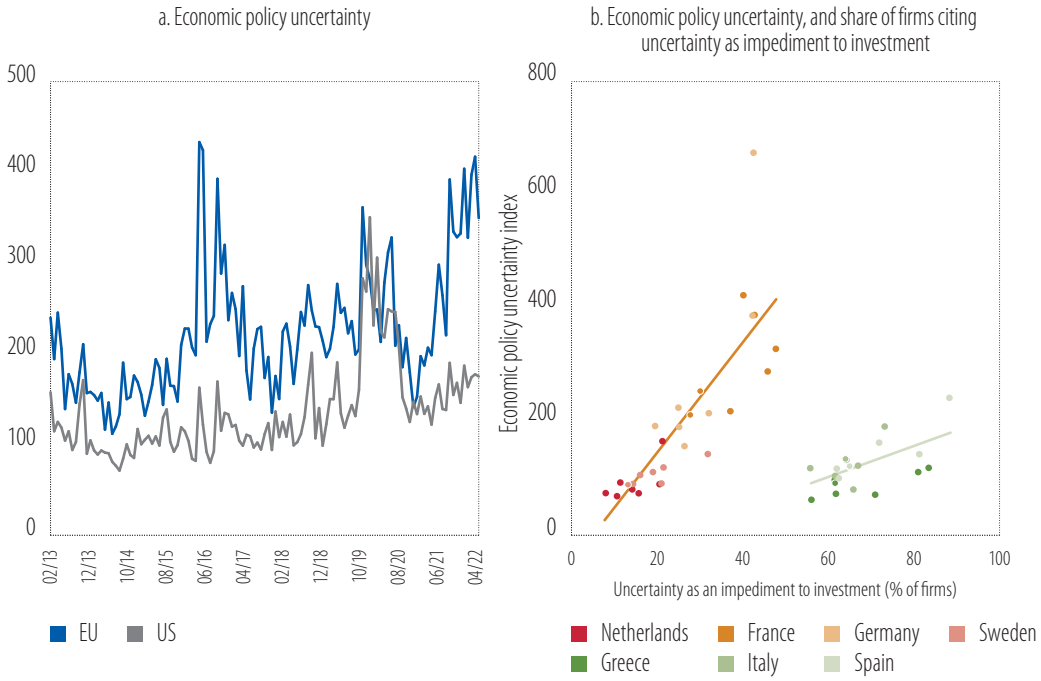
High energy prices, deteriorating economic prospects and elevated uncertainty are testing investment's resilience

High inflation is eroding real incomes, which in turn is putting pressure on aggregate demand. Increasing energy prices fed directly into higher inflation in the second half of 2021. Second-round effects pushed inflation even higher. More than a year of accelerating inflation has started to affect real incomes (see Chapter 1). As household savings are depleted and their real value reduced by inflation, demand will falter.

These pressures, combined with expectations of a worsening economy, will likely prompt firms to revise investment plans downwards.

Uncertainty increased substantially in 2022 (Figure 5). The persistence of the energy price shock, the threat of energy rationing and a likely economic slowdown all aggravated uncertainty. The EIBIS also shows a major increase in firms' uncertainty, following a decline in 2021. These fears are closely linked to energy costs, with firms in more energy-intensive industries likelier to cite uncertainty as an obstacle to investment.

Figure 5
Uncertainty among businesses and consumers is on the rise



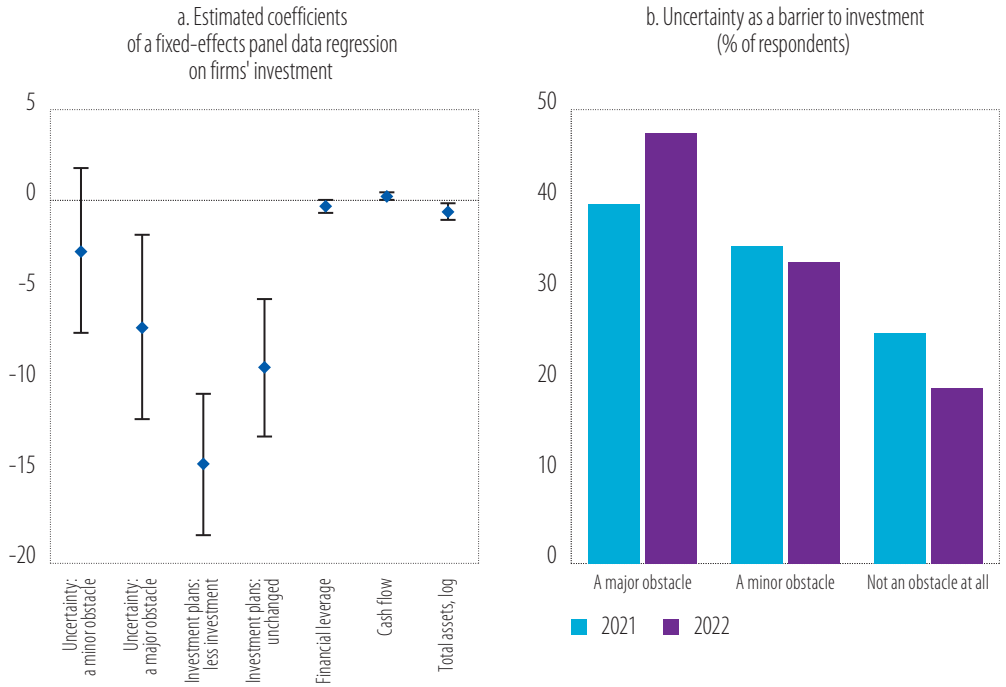
Source: EIBIS 2016-2022, the Economic Policy Uncertainty Index and EIB staff estimates.

The irreversible nature of investments means that uncertainty can weigh heavily on companies' plans. As uncertainty about the future grows, companies look for higher expected returns on investments to compensate for increasing risks. Thus, rising uncertainty could render a project undesirable even if its expected return remains the same. The effect of uncertainty on investments can be substantial, particularly in the short run, if a project is not now-or-never (that is, if firms are able to delay it). By postponing an investment with an uncertain outcome, firms can avoid the risk of making costly mistakes, and instead delay the investment until the economic environment stabilises.

Elevated uncertainty will have a negative effect on investment. Numerous academic studies find that uncertainty substantially affects aggregate investment (Baker, Bloom and Davis, 2016; Bloom, 2014; Bunn et al, 2021). Research by the EIB's Kolev and Randall (2023) uses a merged EIBIS-Orbis dataset, which adds firms' financial information from Bureau van Dijk's Orbis database to firms' answers in EIBIS, to gauge uncertainty's effect on corporate investment in 2022. The authors estimate standard investment models with financial factors (see for example Kalemli-Ozcan, Laeven and Moreno, 2022), adding a variable from the EIBIS to measure uncertainty.

In addition to perceptions of uncertainty, the investment rate — the ratio of net investment to fixed assets in the previous year — is a function of a firm's stated financial plans at the beginning of the year in which the investment is made, the firm's expectations about demand, business prospects in its sector and its size.[5] The ratios of financial debt and cash flow to total assets are also included in the set of explanatory variables. As investment plans and demand are stated in the beginning of the year, we saturate our model with country-sector and country-year dummies to account for developments later in the year.

Figure 6
The negative effects of elevated uncertainty on investment are likely to be substantial



Source: *Kolev and Randall (2023).*
Notes: *Panel-data regression using the EIBIS-Orbis dataset of net investment rate (fixed assets) on uncertainty perceptions (see question below Figure 6b), stated investment plans (more investment relative to previous year, keep about the same or less investment), firm-level controls, country-sector and country-year fixed effects. The figure above plots coefficient estimates and 95% confidence intervals based on standard errors, clustered at the firm level.*

Source: *EIBIS 2021-2022.*
Notes: *Firms are weighted by value added.*
Question: *Thinking about your investment activities, to what extent is uncertainty an obstacle? Is it a major obstacle, a minor obstacle or not an obstacle at all?*

Uncertainty has a significant negative effect on investment (Figure 6a). Holding other factors constant, a firm that perceives uncertainty as a major obstacle to investment will have an investment rate 7.5 percentage points lower than a firm that does not. Using the estimated equation, we calculate the difference between the predicted investment rate for 2022 and a counterfactual prediction, where uncertainty perceptions of each firm are held at their 2021 levels (Figure 6b). We find that, other factors held constant, higher uncertainty in 2022 may have reduced the investment rate by about 1.2 percentage points of GDP, or half of the gap in productive investment between the European Union and the United States (Figure 2a).

5 Our sample is an unbalanced panel dataset covering 2016 to 2022.

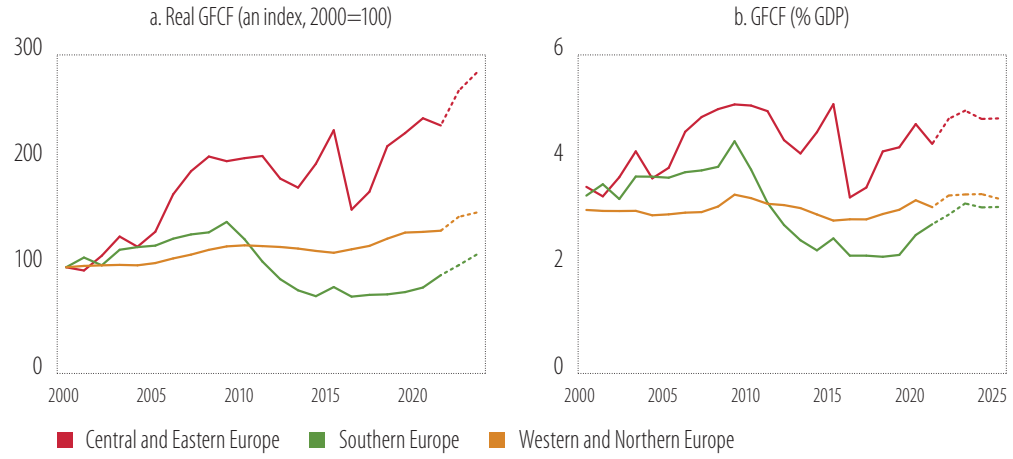
The pandemic response boosted government investment

Growth was robust throughout the COVID-19 crisis

Real government investment increased in the European Union in 2021. In the first half of 2022, government investment continued to grow in nominal terms, but it stagnated in real terms because of high inflation. Compared to 2020 levels, real government investment rose about 3% in the European Union in 2021. The overall increase was largely driven by a strong, 14% increase in investment in Southern Europe (Figure 7a). In Central and Eastern Europe, however, real government investment declined by about 3% during 2021, a drop that was widespread across the region, except for Estonia and Slovenia.[6] Sustained growth in government investment in the European Union bolstered the economy in the short term, and this impact is likely to last in the medium and long term, as discussed in Box D.

Government investment rates — the ratio of government investment to GDP — stabilised across the European Union in 2021 (Figure 7b). As economies were recovering from a decline in output during the pandemic, the increases in real investment were not proportionate to increases in GDP. Investment growth in Southern Europe outpaced GDP growth, allowing the investment rate there to continue the upward trajectory that began after the pandemic. In Central and Eastern Europe and Western and Northern Europe, however, investment rates dropped sharply from their 2020 levels.

Figure 7
General government gross fixed capital formation



Source: *Eurostat national accounts, national stability programmes, EIB staff estimates.*
Notes: *Values for 2022 onwards, indicated by dashed lines, are based on countries' stability and convergence plans.*

In the medium term, growth in general government investment will continue, with a strong boost from the Recovery and Resilience Facility (Box B). Accounting for the investments outlined in national stability and convergence plans, real government investment in the European Union is expected to increase by almost 20% by 2023 compared to 2020. These strong predictions belie past experiences of public belt tightening, when governments found it more politically feasible to prioritise current spending and transfers at the expense of investment. This time around, however, ample resources available from the Recovery and Resilience Facility provide an opportunity to sustain planned investment.[7] Countries must, however, prove that they can implement their national investment plans while meeting the facility's conditions.

6 This decline cannot be considered a setback for the region, as it follows an enormous increase in 2020 that raised overall investment. Compared to 2019, before the pandemic, real government investment in Central and Eastern Europe had risen 9% by 2021. Furthermore, the investment rate as a share of GDP remains above the historical 20-year average.

7 Available funds from the Recovery and Resilience Facility are equal to about 1% of EU GDP per year until 2026, which represents one-third of average annual government investment in the European Union.

Box B

The Recovery and Resilience Facility continues to stabilise and protect public investment

The Recovery and Resilience Facility's resources are being disbursed to Member States until 2026 to support investment and structural reforms. One-fifth (EUR 136.6 billion) of the total envelope (EUR 724 billion) has already been disbursed (Table B.1) to nine different countries.

About one-third of the total package consists of pre-financing made available to Member States upon approval of their investment plans. The remainder is conditional on countries hitting reform targets (such as streamlined administrative approval processes) and on investment milestones (such as having started the procurement processes for a project). Over the next four years, EUR 590 billion (amounting to around 4% of EU GDP in 2021) will be disbursed at an average rate of around 1% of GDP per year across all countries (but substantially more for some). In other words, with public investment accounting for 3.2% of GDP, the facility will provide resources for one-third of total public investment. Not all facility expenditures will go to investment, but the comparison illustrates the impact. So far, so good, but going forward governments' ability to execute their investment programmes and disburse the resources available will be tested.

Table B.1

Recovery and Resilience Facility disbursements as of October 2022

				% GDP (in 2021)	
	Grants	Loans	Total	Grants	Total
Recovery and Resilience Facility total (EUR billion)	338	385.8	723.8	2.3	5.0
Disbursed (EUR billion)	91.39	45.16	136.55	0.6%	0.9%
(as a share of total)	27%	12%	19%		
Pre-financing (EUR billion)	36.6	19.9	56.5		
Disbursement (EUR billion) (after assessments)	54.7	25.4	80.1		

Source: EIB staff estimates using the European Commission's scoreboard data for the Recovery and Resilience Facility.

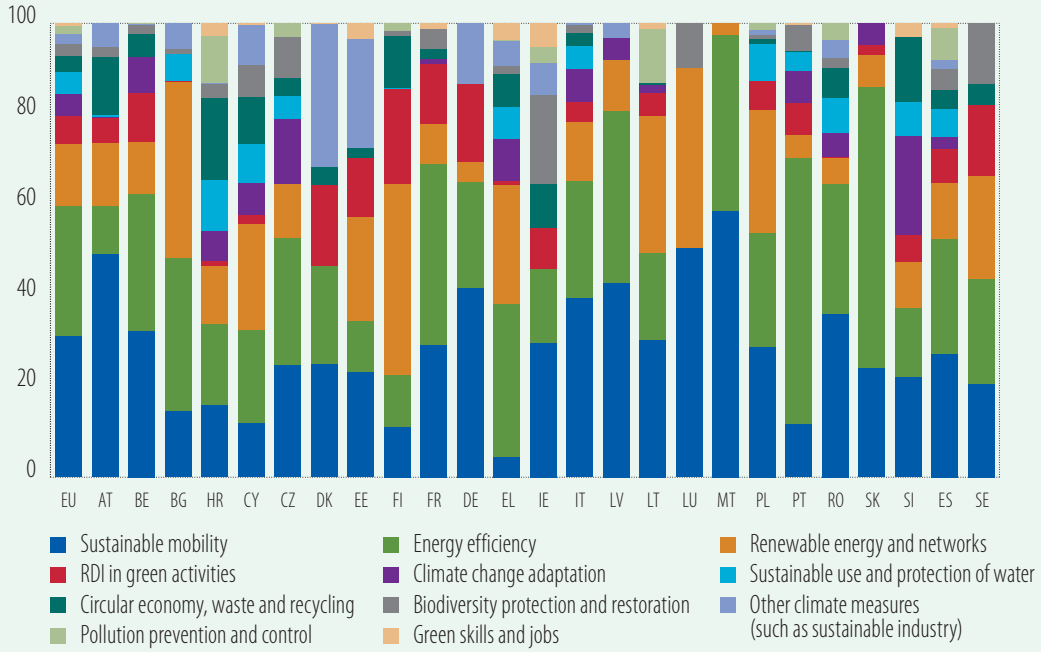
The ongoing implementation of the facility shows that the European Union is committed to preserving public investment in key areas, even in times of challenging fiscal developments. The facility provides important support for the recovery by mitigating the economic and social impact of the pandemic. It also makes societies more sustainable and resilient by pursuing long-term policy objectives like the green and digital transition. Member States have EUR 338 billion in grants and EUR 386 billion in loans at their disposal to help implement ambitious reforms and investments. The aim is to spend at least 37% of the funds on the green transition, 20% on digital transformation and the rest on the other four pillars[8] by 2026, at which point the European Commission will assess the progress made towards milestones and targets.

When looking at the sub-components of the green transition, the largest investments are for renewable energy, energy efficiency and sustainable mobility (Figure B.1). Since measures in these categories are crucial to meeting the European Union's target to reduce carbon emissions 55% by 2030, compared to 1990 levels, it is very important to keep investments rolling. The significant energy investment planned should help bring in the private sector. A wide swathe of investments are planned in energy networks and infrastructure, such as energy storage, district heating networks, electricity interconnectors and smart grids. Investments are also planned across the hydrogen value chain, from production to transport, storage and end-use in hard-to-electrify industrial sectors and transport modes.

8 The other four pillars are smart, sustainable and inclusive growth; social and territorial cohesion; health and economic, social and institutional resilience; policies for the next generation.

Figure B.1

Recovery and Resilience Facility expenditure supporting the green transition (% of total)**, by policy area**



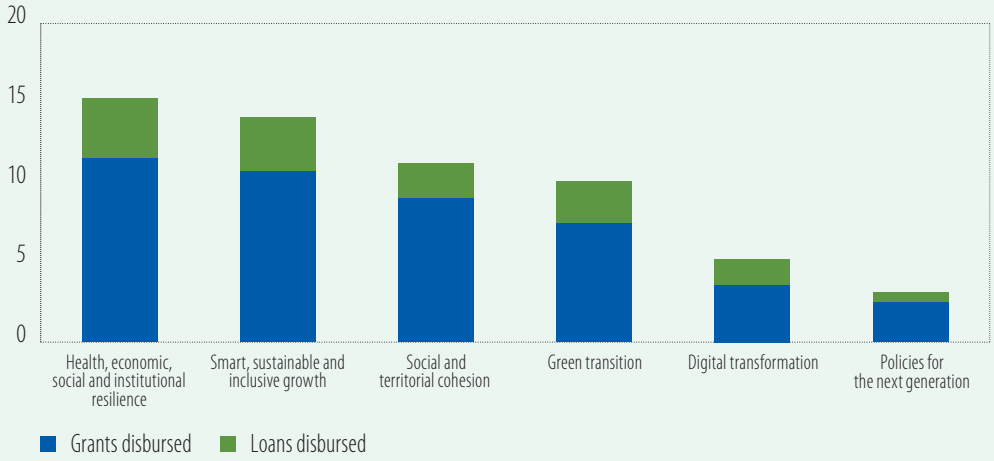
Source: European Commission and EIB staff estimates.

Countries in Western and Northern Europe and Southern Europe will benefit from a higher share of Recovery and Resilience Facility allocations relative to funding they already receive under the European Union's cohesion policies, while the opposite is true for Central and Eastern Europe.[9] Since the facility's overall objective is to improve "the resilience, crisis preparedness, adjustment capacity and growth potential of the Member States," funding approvals take into account the economic fallout of the pandemic, pre-crisis unemployment levels and GDP per capita.

Begun in 2021, the facility has been implemented at different speeds in different countries. By October 2022, nine countries had received disbursements linked to the achievement of milestones and targets. Overall, 26% of the facility's grants and 22% of its loans allocated have been disbursed. Spain is the first country to have received a second payment. However, 14% of the facility's grants and 60% of loans have not yet been allocated to Member States.[10] Although the estimated share of the facility spent on climate is around 40% and digital expenditure is around 26%, climate only accounts for 17% of disbursements and digital around 9% so far. The green transition and digital transformation are only the fourth- and fifth-largest categories of expenditure (Figure B.2). Reasons for the relative lag in these investments might be spiralling costs, a shortage of skilled staff and supply chain constraints. Implementation risks are also growing as fiscal budgets become strained by the economic downturn and the need to fund transfers aimed at dampening the impact of high energy prices on households and firms.

9 See CEPS RRF Monitor: RRF Figures (rrfmonitor-ceps.eu).
10 See Recovery and Resilience Scoreboard (europa.eu).

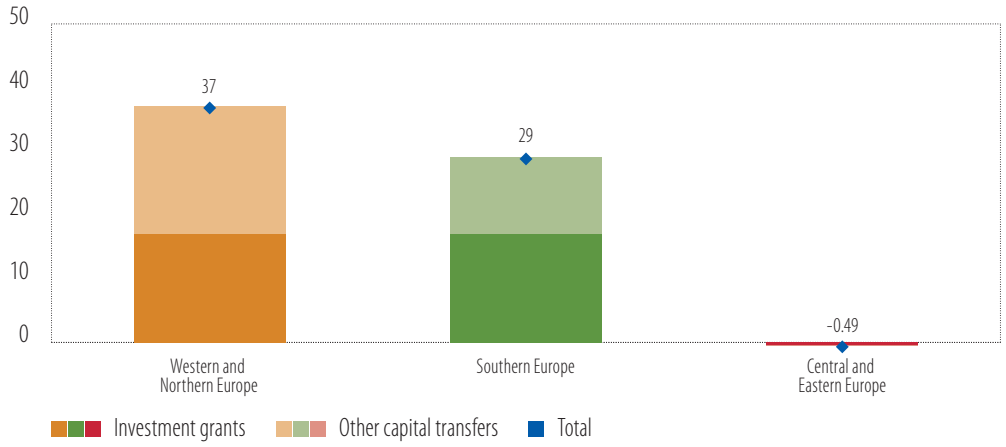
Figure B.2
Disbursed grants and loans funded by the Recovery and Resilience Facility (EUR billion)**, by EU policy objective**



Source: *European Commission.*

Capital transfers by general governments in the European Union increased further in 2021 (Figure 8). Expenditures on capital transfers in 2021 increased less than in 2020, and they did not change in Central and Eastern Europe. The composition of the change from 2020 to 2021 proved to be relatively balanced between investment grants and other capital transfers (Figure 8). For Central and Eastern Europe, there was little to no change in levels relative to 2020, suggesting that the observable drop in capital transfers relative to GDP was primarily driven by the increase in GDP. Capital transfers in the European Union decreased slightly in the first half of 2022 compared with the first half of 2021. That drop was entirely driven by a decline in Southern Europe, and it is attributable to the high base established in 2021. The high level was created by pandemic-related fiscal stimulus that relied substantially on government capital transfers.

Figure 8
General government capital transfers (% change from 2020)



Source: *Eurostat national accounts, national stability and convergence plans, EIB staff estimates.*

Box C

Investment in times of crisis

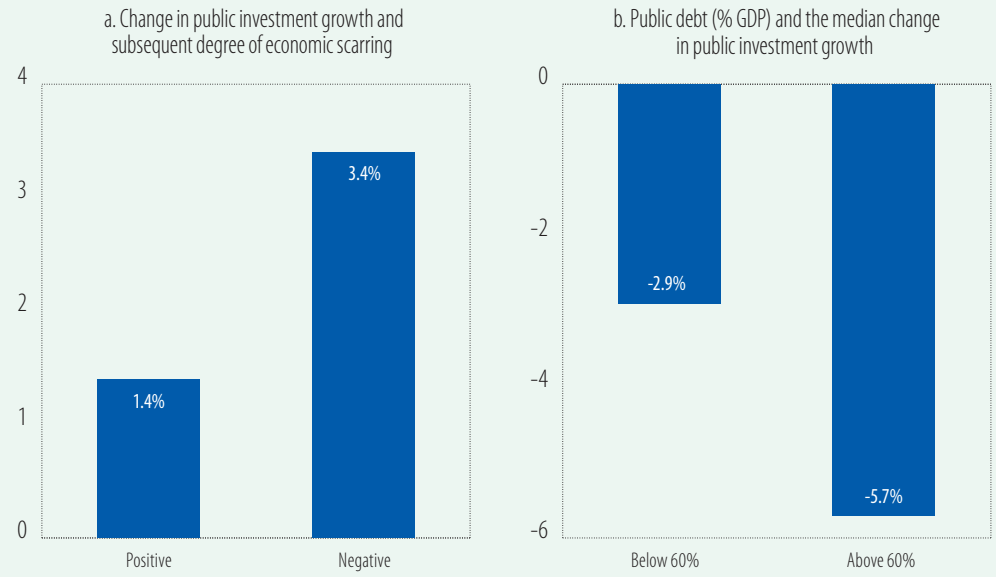
This box shows evidence that investment, particularly by governments, helps moderate the scarring effects of economic crises. There is a broad consensus that fiscal policy multipliers are positive in the short term, and that the size of the multiplier depends on a country's position in the economic cycle and the monetary policy stance. However, the positive effect on output is not particularly persistent, and even turns negative in the medium term. The notable exception are multipliers of government investment, which explains the focus on investment's role in limiting economic scarring during major downturns.

Looking at the anatomy of major economic downturns, economies contract during downturns and rebound in the years that follow. However, the average rebound does not overshoot the economic growth rates recorded prior to the downturn. The result is a downward shift in the level of economic activity. On average, real GDP resumes an upward trend, but that trend remains below the pre-recession level.

Scarring effects are a recurring feature of major economic downturns. Recent analysis using panel data on such downturns in advanced economies over the past five decades confirms the tendency for sizeable and significant scarring (Larch et al., 2022). The average annual shortfall of real GDP three to seven years after a major economic downturn is around 2% less than the level it would have been if the economic shock had not occurred.

Figure C.1

The growth of public investment fluctuates in times of crisis



Source: *Larch et al. (2022).*
Note: *The relationships presented also hold up in regression analysis controlling for automatic stabilisers, systemic banking crises, the presence of subsequent crises, monetary policy and fixed effects, as well as across multiple definitions of the degree of economic scarring represents public investment growth in a given year vs. the average public investment growth in the three preceding years.*

Governments react, on average, quite forcefully to downturns, recording budget deficits of around 3% of GDP. However, most of the discretionary spending is centred on current expenditure, while public investment remains broadly flat or even declines. The lower investment is noteworthy, as the analysis also finds evidence that an actual acceleration of public investment in times of crisis is

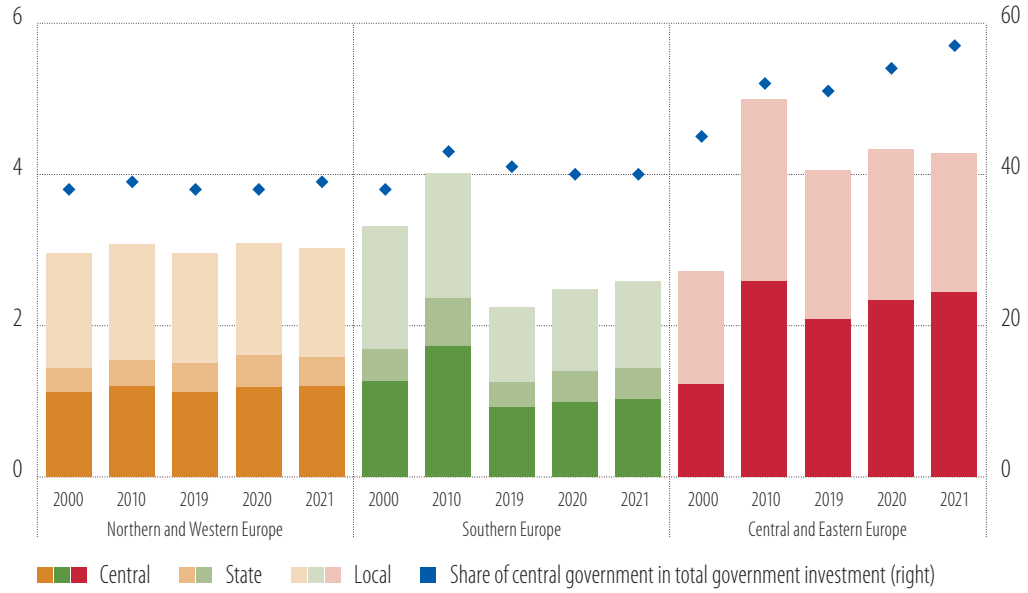
associated with a statistically significant moderating effect on the degree of economic scarring in the subsequent three to seven years (Figure C.1, panel a).

In this context, the Resilience and Recovery Facility takes on particular importance as an instrument to help Member States address medium-term challenges by supporting structural reforms and government investment projects. If implemented effectively with a focus on additional and productive investment, the facility certainly has the potential to limit the heightened risk of scarring after two major economic shocks — the pandemic and the energy crisis — in rapid succession.

In the medium to long term, the succession of economic scarring and higher deficits leads to higher government debt, which in turn tends to limit governments' fiscal wherewithal to react to future recessions. The results of the analysis also show that during a major economic downturn, higher government debt tends to come with lower growth in government expenditure — current spending and investment (Figure C.1, panel b) — and/or lower government deficits. This finding very much confirms the more general consensus in the literature that high government debt limits countries' ability to address crises.

The relative importance of the central, state and local governments in overall public investment has remained relatively stable over the past year. Central governments' share of public investments hovers around 40% for Western and Northern Europe and Southern Europe (Figure 9). In Central and Eastern Europe, the share has been above 50% since the early 2000s and is growing. Nevertheless, gross fixed capital formation of local governments in Central and Eastern Europe, as a share of GDP, has consistently been higher than that of local governments in Western and Northern Europe or in Southern Europe.

Figure 9
Local and state government investment (left axis, % GDP)**, central government investment** (right axis, % share)



Source: Eurostat national accounts, EIB staff estimates. Share of central government refers to the percentage central government investment accounts for in total investment.

Local government investment may have a strong and persistent effect on growth. Government investment, such as building and maintaining adequate infrastructure, is key to creating the conditions private enterprises need to thrive. Local governments are particularly well positioned to serve this role. According to Brueckner,

Pappa and Valentinyi (2022), more decentralised governments are able to deliver more productive public goods, implying a higher fiscal multiplier and a larger crowding-in of private investment. This can be linked to the efficient coordination of different levels of government, but the issue deserves more analysis (Organisation for Economic Co-operation and Development (OECD), 2014). In Box D we argue that local government investment has a more persistent impact on growth than central government investment.

Box D

The effect of local government investment on private investment and growth

Public capital provides key services the private sector needs to prosper. Analyses focusing on the impact of public capital on GDP (such as Bom and Ligthart, 2014) point out that public capital provided by local governments, as opposed to central governments, is more productive. This may reflect local governments' better understanding of local needs. Studies controlling for the business cycle find public capital is more effective in supporting growth.

With a forthcoming working paper, Brasili et al. (2023), the EIB contributes to this literature by taking a slightly different approach. It uses regional data and focuses on the impact of local government investment — a flow instead of a stock variable — on GDP and private investment, compiling an unbalanced panel dataset for 98 NUTS 2 European regions[11] in 13 Member States running from 2000 to 2019. Based on local projection methods, the estimates show evidence of a positive and significant association between investment by local governments and GDP on one hand, and private investment on the other. The multiplier for private investment is clearly positive and significant for the first two years after the shock. The same holds true for the GDP multiplier for the first three years after the shock.

The analysis turns to specific areas of investment to better understand where local public investment can make the greatest difference. Table D.1 shows that, among the categories for which comparable data for 50 regions are available, GDP growth is more sensitive to public investment in education, training and research and development (R&D), and in public administration operations and territorial infrastructure.

Table D.1

Public investment's effect on GDP, by category

	Periods ahead				
Response of GDP to:	1	2	3	4	5
Public investment in general	0.0159***	0.0172**	0.0128	0.0124	0.0052
	(0.00469)	(0.00583)	(0.00721)	(0.00943)	-0.0116
Public investment in:					
Education, training and R&D	0.0064*	0.0013	0.0020	0.0009	-0.0012
	(0.0031)	(0.00391)	(0.00474)	(0.00631)	(0.00796)
Territorial infrastructure	0.0064*	0.0013	0.0020	0.0009	-0.0012
(water, waste treatment)	(0.00192)	(0.00245)	(0.00304)	(0.00393)	(0.00535)
Environmental protection	0.0040	0.0028	0.0020	0.0036	-0.0026
	(0.0021)	(0.00258)	(0.0032)	(0.00381)	(0.00472)
Public administration operations	0.00360*	0.0023	0.0040	0.0030	0.0048
(such as justice, general services)	(0.00167)	(0.00219)	(0.00284)	(0.00338)	(0.00394)
Transport infrastructure	0.0035	0.0006	0.0045	0.0007	0.0006
	(0.00379)	(0.00493)	(0.00646)	(0.00785)	(0.00899)

Source: *EIB staff estimates.*

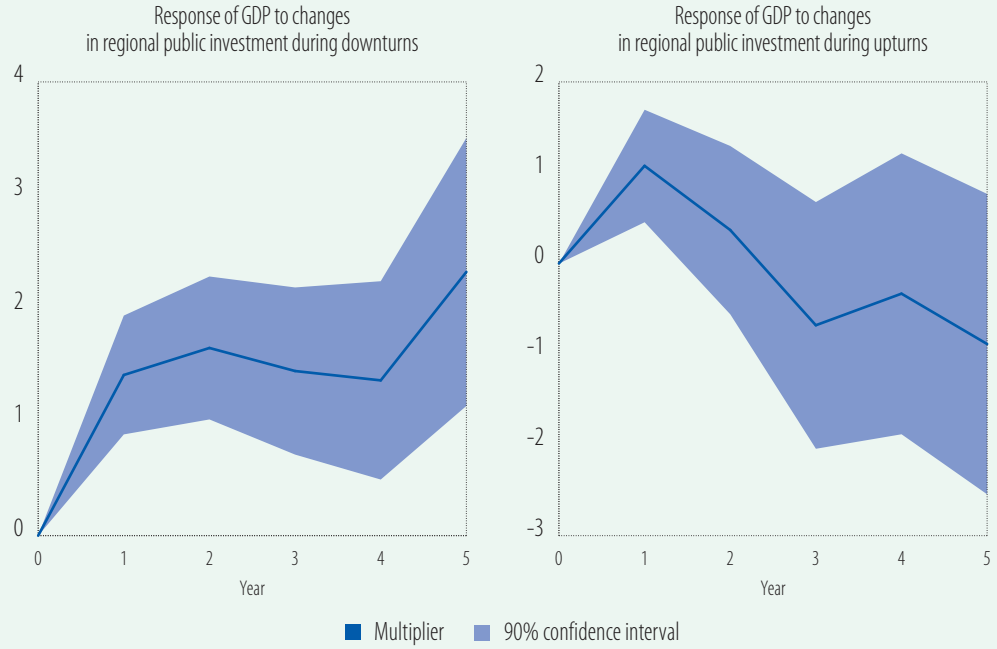
Note: *Response of GDP growth n (1,…,5) periods after one standard-deviation shock to growth, separated by category of local public investment. Standard errors are in parentheses. Statistical significance: *p-value p<0.05, ** p-value<0.01.*

11 Nomenclature des unités territoriales statistiques, or NUTS, is referencing standard for the administrative divisions of countries for statistical purposes. The current NUTS 2021 classification is valid from 1 January 2021 and lists 92 regions at NUTS 1 242 regions at NUTS 2 and 1 166 regions at NUTS 3 level.

Looking at the potential cyclicality of the impact, the results confirm that the response to local public investment is stronger in downturns than in upturns. Regarding the impact of local public investment on GDP, Figure D.1 shows that in downturns, the response is significant in all periods projected and the impact is larger in downturns than in upturns.

Figure D.1

Local public investment's impact on GDP during economic downturns and upturns, measured by multiplier effects



Source: EIB staff estimates.

It is possible that causality goes in the opposite direction — that is, from GDP to public investment. In a context of expanding economic activity, more resources from tax revenues allow for higher spending, including investment. However, one way to check for the absence of reverse causality is to apply an instrumental variable regression to control for the impact of GDP growth on public investment.[12] The instrumented GDP growth is not found to alter public investment. At the same time, the instrument is relevant in explaining GDP.

Overall, evidence exists of a positive correlation between local public investment and private investment, with causality running from public to private investment. Indeed, the multiplier for private investment is clearly positive and significant for the first two years after the shock. The impact of local public investment on GDP seems to be stronger in downturns. The results show that investments in education, training and R&D, public administration and territorial infrastructures are among the most effective at promoting economic growth. These results illustrate how important local governments are in crowding-in private investment for multiple reasons. They are more attentive and sensitive to the needs of the private sector for skills and labour, and they have the knowledge and capacity to adapt to specific local features and to create the right infrastructure and environment for the private sector.

12 Mimicking the approach suggested by Jaimovich and Panizza (2007) and Saccone et al. (2022), we use an instrument, built using world trade growth multiplied by the regional manufacturing share in regional value added, to highlight the regional exposure to external shocks. The "shock" variable should be significantly associated with the regional GDP growth, but uncorrelated with public investment.

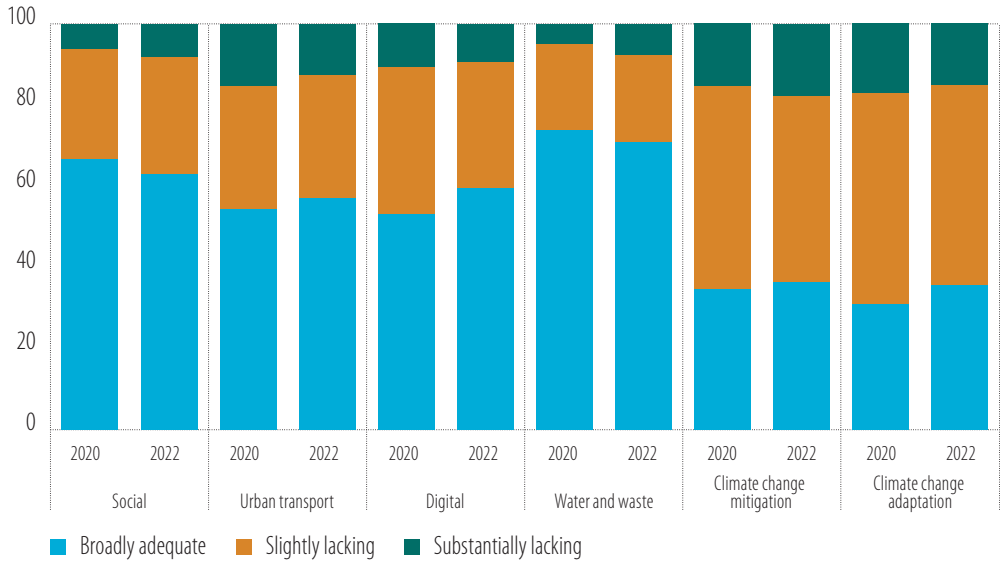
Local governments plan to increase infrastructure investment, but financing remains a constraint

Local governments play a key role in total government investment (Figure 9), including infrastructure. Infrastructure accounts for a significant share of government investment — about one-third in the European Union on average (Wagenvoort, De Nicola and Kappeler, 2010). Amid a dearth of official information regarding infrastructure investment, some light is shed by the recent EIB Municipality Survey conducted from May to July 2022. The survey encompasses 744 municipalities across all Member States.

Across the European Union, the biggest and the most persistent infrastructure deficiencies are observed in the areas of climate change, digital infrastructure and urban transport. Municipalities were asked about the adequacy of their recent investment in each of the following areas: social infrastructure, urban transport, water and waste utilities, climate change mitigation and climate change adaptation. On balance, only 35% of respondents report satisfaction with their investments in climate change mitigation and adaptation (Figure 10). This is followed by urban transport and digital infrastructure, with nearly 60% of respondents saying investments are adequate in each of these categories. Urban transport seems to be mostly lacking among the municipalities in Southern Europe, with less than half of those respondents saying they are satisfied with current infrastructure investments. Digital infrastructure investments are predominantly lacking among countries in Central and Eastern Europe, with about half of respondents reporting insufficient digitalisation.

Figure 10

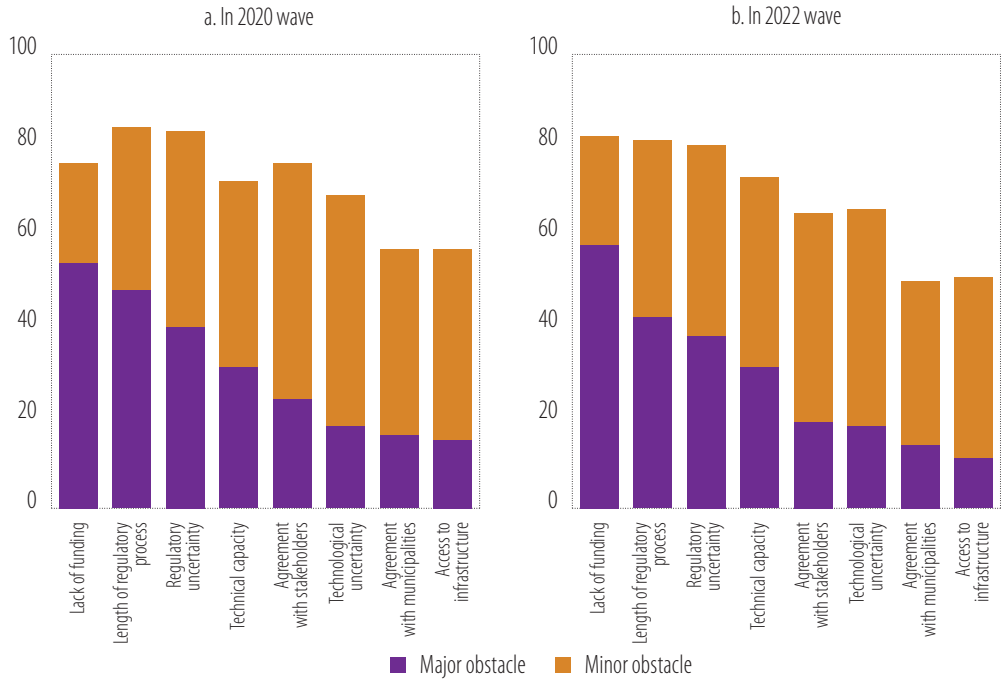
Adequacy of infrastructure investment over the past three years (% of respondents)**, by asset class and survey wave**



Source: *EIB Municipality Survey 2020 and 2022, and EIB staff estimates.*
Base: *All municipalities excluding don't know/refused responses.*
Question: *In the last three years, would you say that within your municipality or city the level of investment in infrastructure projects was broadly adequate, slightly lacking or substantially lacking in each of the following areas?*

Lack of funding, the length of regulatory processes and regulatory uncertainty seem to be the biggest drags on municipal investments. As in 2020, nearly 80% of municipalities continue to claim that their efforts are impeded by lengthy and uncertain investment approval processes. Compared to 2020, however, access to finance has grown as a factor hampering investment. In 2022, lack of funds or financing discouraged investment plans for more than 80% of municipalities — nearly 6 percentage points higher than in 2020. Moreover, lack of funding is the most common major investment barrier, cited by nearly 60% of municipalities (Figure 11b).

Figure 11
Municipal barriers to investment (% of respondents)



Source: *EIB Municipality Survey 2020 and EIB staff estimates.*
Base: *All municipalities excluding don't know/refused responses.*
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?*

Source: *EIB Municipality Survey 2022 and EIB staff estimates.*
Base: *All municipalities excluding don't know/refused responses.*
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?*

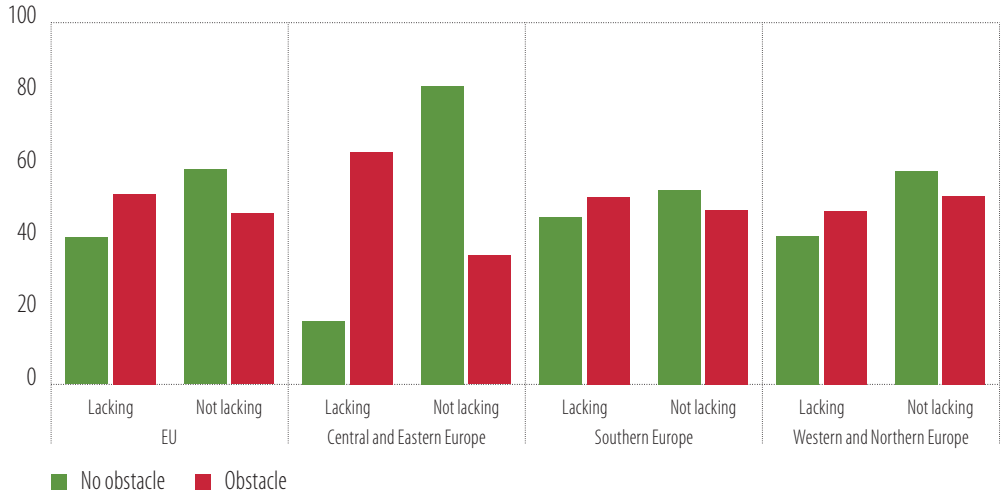
Lack of funding can have a persistent negative effect on investment and on the rollout of municipality investment plans. There is a negative relationship between the reported shortage of finance and the adequacy of investments (Figure 12). Of the municipalities that reported dissatisfaction with recent investment levels in at least three asset categories, more than half report a lack of funding as an investment barrier. This pattern is particularly strong in Central and Eastern Europe, where more than 60% are concerned about funding. Furthermore, for each asset type, municipalities with funding obstacles declare less ambitious investment plans (Figure 13). For social infrastructure, the effects are particularly strong and statistically significant.

In addition to funding, municipalities struggle to find the expertise needed to develop and implement infrastructure projects. The problem is especially pertinent to the twin transition to a green and digital future. Nearly seven in ten municipalities report problems with access to environmental and climate assessment skills, while about six in ten report a lack of engineering or digital skills to deliver their investment programme (Figure 14). Financial skills seem to be the least frequently reported impediment to investment (43% in the European Union), yet more than half of municipalities in Southern Europe struggle to access financial knowledge and skills, with more than one-quarter reporting it as a major problem.

On average, 40% of municipal investments were funded from current income or own resources, 42% by capital transfers and 18% through external financing (Figure 15). Overall, the use of own funds has decreased slightly compared to the 2020 survey. In Central and Eastern Europe, it seems to have been substituted by a broader use of capital transfers. In the 2020 survey, around 44% of municipal investment finance came from capital transfers. In 2022, it was more than 50%. In Southern Europe, own resources were more frequently replaced by capital transfers and external sources of finance. In particular, the share of external finance in this region grew from 9% in 2020 to 12% in 2022. The proportions in Western and Northern Europe appear to be evenly distributed across the three sources of financing and are stable over time.

Figure 12

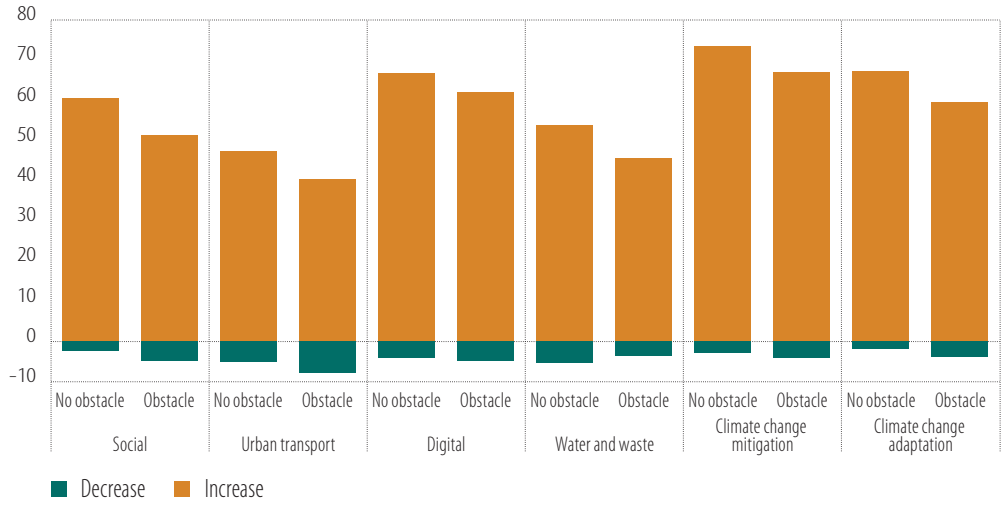
Municipal infrastructure funding obstacles (% of respondents)**, by investment adequacy in the last three years**



Source: *EIB Municipality Survey 2022 and EIB staff estimates.*
Base: *All municipalities excluding don't know/refused responses.*
Notes: *Lacking investments consists of municipalities that declare slightly or substantially lacking investment in at least three out of six asset categories (see Figure 10 for reference).*
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 13

Municipal infrastructure investment plans (% of respondents)**, by lack of funding obstacle and asset class**



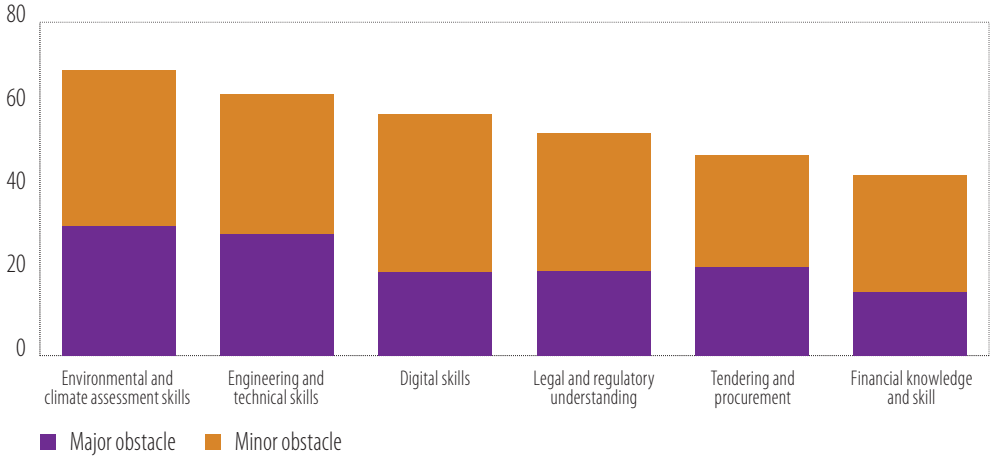
Source: *EIB Municipality Survey 2022 and EIB staff estimates.*
Base: *All municipalities excluding don't know/refused responses.*
Question: *For each of the following areas, if you compare the average annual infrastructure investment you are planning for the next five years vs. the average annual infrastructure investment recorded in in the last three years, does your municipality or city expect to increase, decrease or have around the same level of spending on infrastructure investment?*

Policymakers should address the identified structural impediments to local governments' infrastructure financing. Investments from local governments, especially in infrastructure, are a significant part of public investment, quantitatively (Figure 9) and qualitatively (Box D). Removing impediments to local

government investment should therefore be a priority for national governments and EU policymakers. Financing, administrative capability, implementation skills and the apparent need for improved procedures in allocating the available funds to different projects are among the most pressing constraints for local authorities. National policymakers should take note, involve local governments more in the selection of local projects eligible for financing and make bolstering administrative capacity a policy priority. This will allow for a better and fuller utilisation of the large volume of funds available through the Recovery and Resilience Facility and European structural and investment funds.

Figure 14

Availability of expert skills is an obstacle to implementing investment programmes (% of respondents)



Source: *EIB Municipality Survey 2022 and EIB staff estimates.*
Base: *All municipalities excluding don't know/refused responses.*
Question: *For each of the following areas, to what extent is access to experts a problem to the delivery of your investment programme?*

Figure 15

Composition of municipal financing (% of respondents)**, by region**

Source: *EIB Municipality Survey 2022 and EIB staff estimates.*
Base: *All municipalities excluding don't know/refused responses.*
Question: *Can you tell me approximately what proportion of your infrastructure investment activities over the last three years was financed by each of the following?*

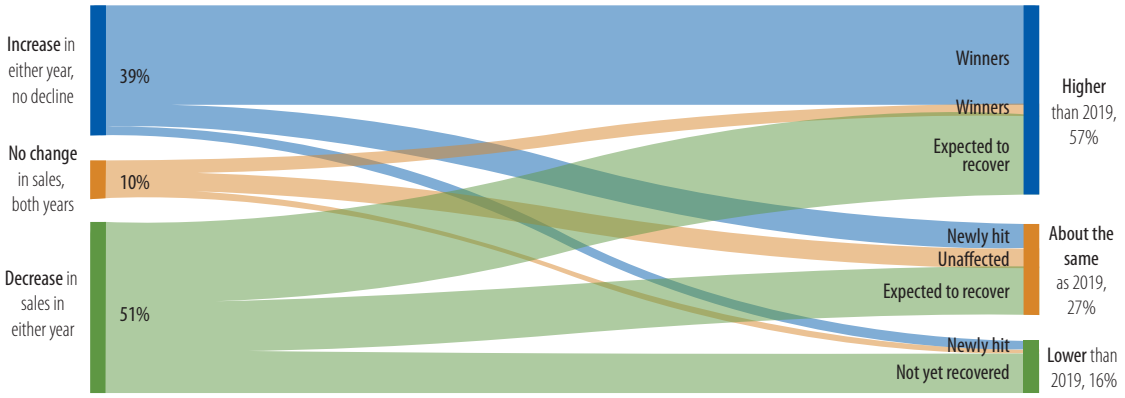
Corporate investment as seen through the EIB Investment Survey

A swift recovery from the pandemic

The recent economic turbulence hit businesses in the European Union, but firms have been relatively quick to recover (Figure 16). EIBIS 2022 provides information about the effect of the COVID-19 crisis on company sales. Firms reported the change in sales for 2020 and 2021 as well as the expected change in 2022. Figure 16 maps the sales dynamics of EU firms since the pandemic. Nearly 33% of firms ("winners") have experienced no decline in sales since 2019, and they do not expect a decline in 2022. About 38% of firms say sales dropped from 2020 to 2021, but expect their sales in 2022 to reach at least 2019 levels ("expected to recover"). Some 6% of firms had stable sales throughout the period ("not affected"), while nearly 13% of firms have not recovered and do not expect to recover in 2022 ("not yet recovered"). About 11% of firms expect their sales in 2022 to match or undershoot those of 2019, despite having beat them in 2021 ("newly hit"). Overall, 16% of firms expect lower sales in 2022 than pre-pandemic levels. The effect of the pandemic on firm finances was much less damaging than originally forecasted.

Figure 16
Effect of COVID-19 on EU firms' sales

Changes in sales in 2020, 2021 and expected change in sales by the end of 2022, compared with 2019 sales (% of firms)



Source: *EIBIS 2022.*
Note: *Firms are weighted by value added.*
Question: *Compared to 2019, before the pandemic started, did your company's sales and turnover in 2020 decline, increase or stay the same? Compared to 2020, did your company's sales and turnover in 2021 decline, increase or stay the same? Compared to 2019, do you expect your sales or turnover in 2022 to be higher, lower or about the same?*

The uneven effect of the pandemic lingers two years on. The pandemic hit economic sectors asymmetrically, with those most reliant on social interaction suffering the most (Figure 17). That said, some firm-level characteristics made an impact. Larger firms and firms with higher labour productivity were more likely to fall in the winners' group, while smaller firms were more likely to be among those not yet recovered.[13]

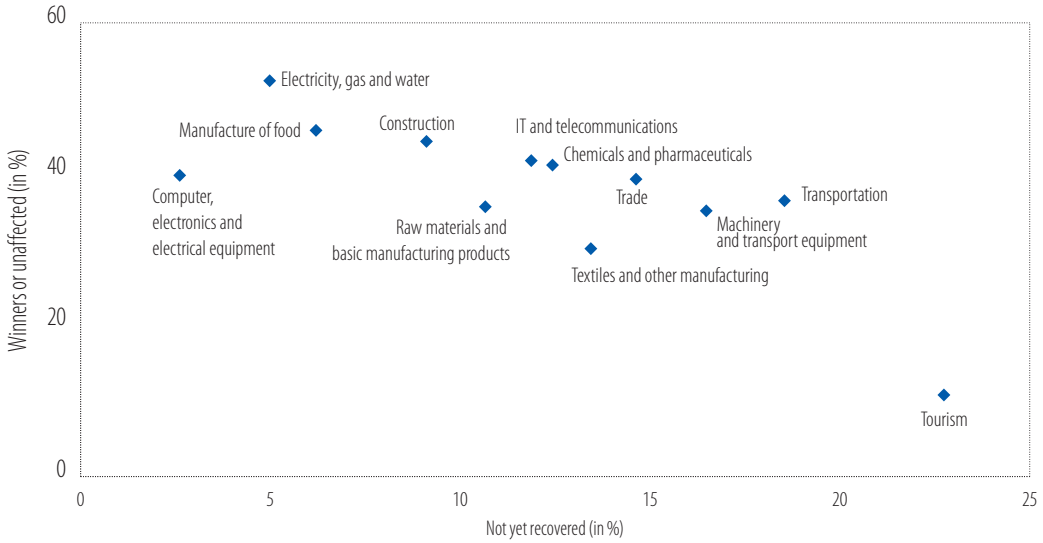
The pandemic shock continued to negatively affect firm investment in 2021. Unsurprisingly, firms from the winners' group were the most likely to have increased investment in 2021. Firms whose sales have recovered and those whose sales were only affected in 2022 were least likely to have reduced investment in 2021 and most likely to have increased it. A higher share of firms whose sales have not yet recovered

13 Size and labour productivity are measured in 2019. Size and productivity effects are statistically and economically significant, controlling for sector and country of origin.

from the pandemic have reduced investment in 2021 (Figure 18a). According to investment plans for 2022, most of the firms that have not yet recovered intend to catch up. This group is the most likely to increase investment in 2022 (Figure 18b). Recent economic turbulence has already upset investment plans, as the newly hit group has the second-lowest share of firms planning to increase investment and the highest share planning to reduce it in 2022.

Figure 17

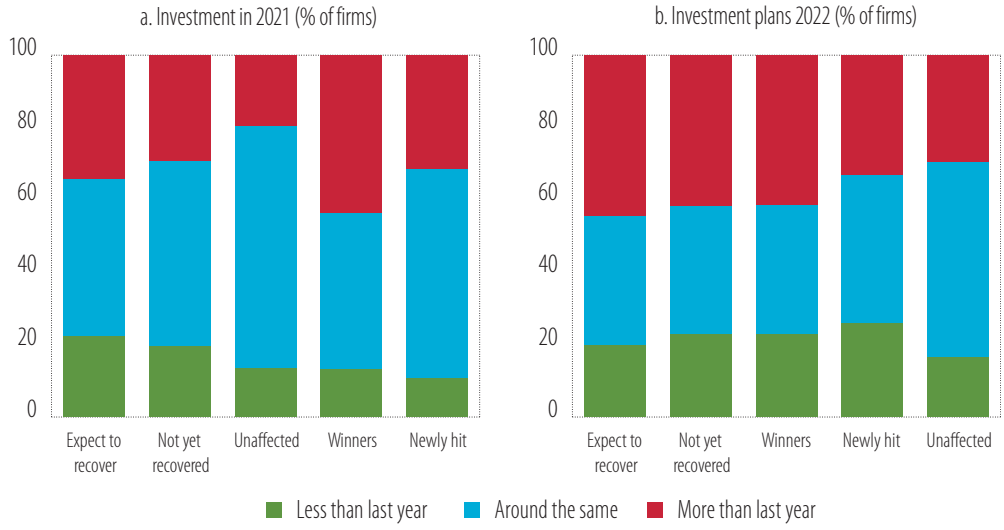
Share of firms that are winners or unaffected, and share of firms not yet recovered



Source: *EIBIS 2022.*
Note: *Firms are weighted by value added.*
Question: *Compared to 2019, before the pandemic started, did your company's sales and turnover in 2020 decline, increase or stay the same? Compared to 2020, did your company's sales and turnover in 2021 decline, increase or stay the same? Compared to 2019, do you expect your sales or turnover in 2022 to be higher, lower or about the same?*

Figure 18

Investment plans, by COVID-19 impact on sales

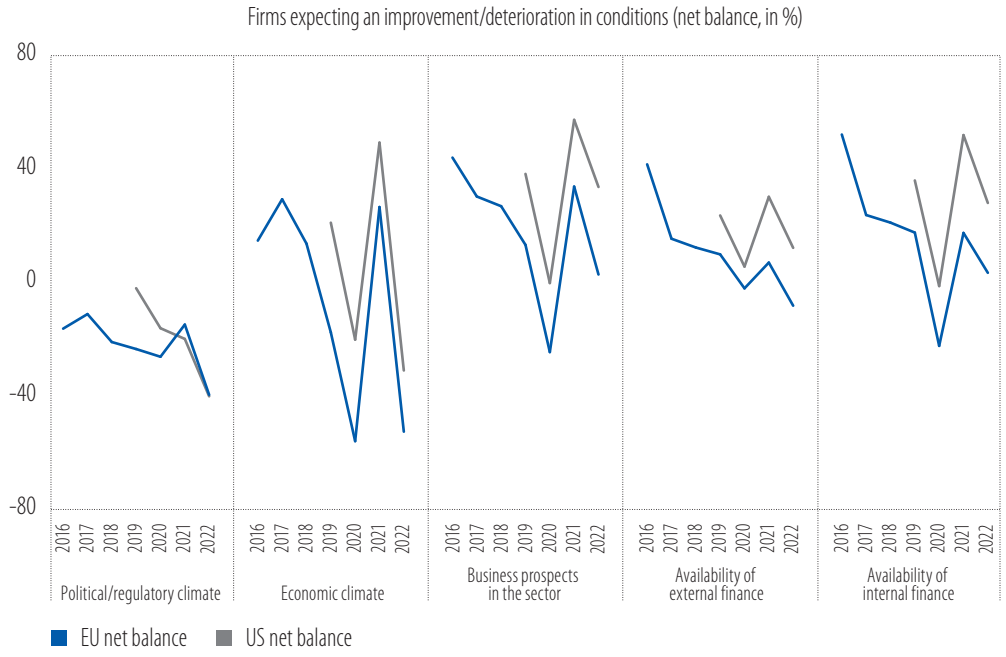


Source: *EIBIS 2022.*
Note: *Firms are weighted by value added.*
Question: *Overall, was your investment in 2021 more, less or about the same amount of investment as in the previous year? For the current financial year, do you expect your total investment spend to be more, less or about the same amount of investment as last year?*

European firms' investment outlook deteriorated substantially in 2022

The short-term outlook deteriorated in the first half of 2022 (Figure 19). EIBIS was in the field between April and June 2022. At that time, firms predicted a major deterioration of the economic climate over the next 12 months, commensurate with that in 2020. Business prospects have also deteriorated, albeit by less. More firms expected the availability of external finance to deteriorate, following tightening monetary policy in Central and Eastern Europe and signals that the European Central Bank would continue to tighten it in the second half of 2022. Firms in the United States expected a similar deterioration in the economic climate but were more optimistic about business prospects and the availability of finance than their EU peers.

Figure 19
Business sentiment in the European Union and the United States

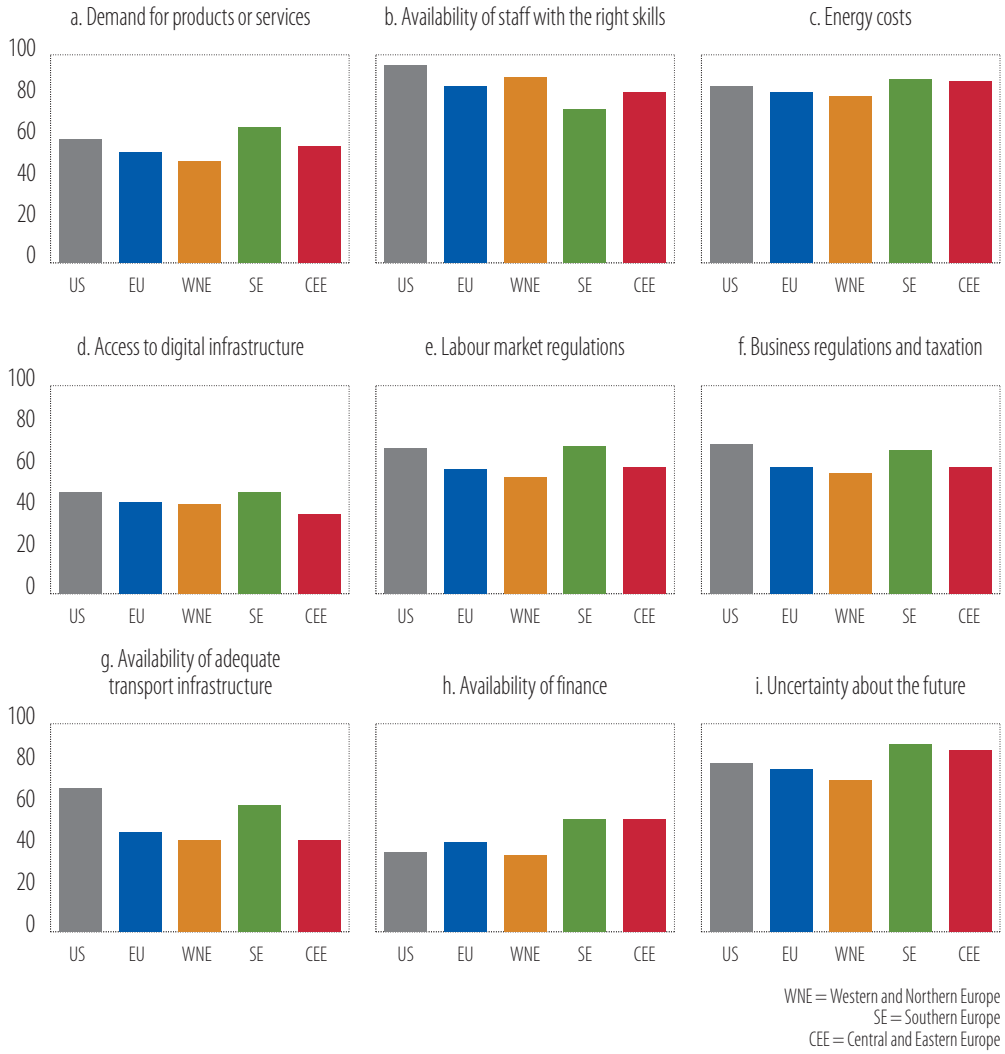


Source: *EIBIS 2016-2022.*
Base: *All firms (excluding don't know/refusals to respond).*
Question: *Do you think that each of the following will improve, stay the same, or get worse over the next 12 months?*

Concerns about the effects of high energy costs on investment increased significantly in 2022 (Figure 20). Energy costs have become the second-most cited impediment to investment (82% of EU firms), after the availability of staff with the right skills (85%) and just ahead of uncertainty about the future (78%). In 2021, 64% of firms in the European Union were concerned about high energy prices. There is a broad variation across countries, as well, from 96% in Greece to 63% in Finland.

Perceptions about high energy costs are rather evenly spread across size classes. Larger firms are more concerned about the availability of staff with the right skills than smaller firms, while smaller firms are more concerned about uncertainty than larger ones. Concerns about the effects on investment of the availability of staff with the right skills and uncertainty about the future have also increased relative to 2021. Perceptions about other barriers to investment remain broadly stable.

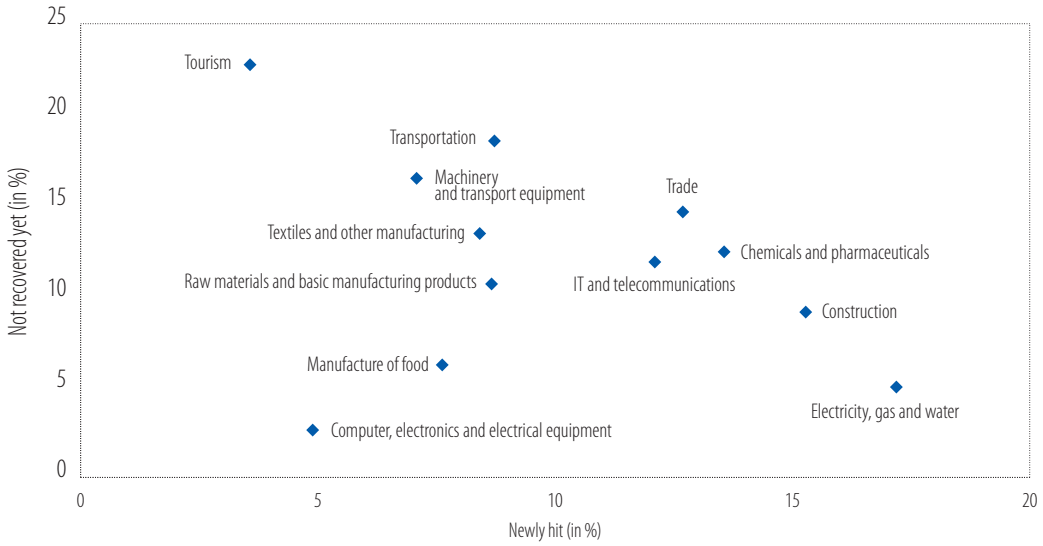
Figure 20
Barriers to investment (% of firms)



Source: *EIBIS 2022.*
Base: *All firms (excluding don't know/refusals to respond).*
Note: *Firms are weighted by value added.*
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?*

The energy crisis is having a bigger effect on industries that were less affected by the pandemic (Figure 21). The ongoing economic turbulence creates substantial policy challenges, though the impact has been worse for the sectors that were less affected by the pandemic shock. Firms that are still recovering from the pandemic are therefore enjoying some respite, while more affected sectors should be in a relatively good position to navigate the adverse economic environment. That said, the uncertainty brought about by this new environment has significantly affected both the group of newly hit firms and those whose sales were most affected by the pandemic. This will weigh on investment.

Figure 21
Share of firms that are not yet recovered, and share of firms newly hit



Source: *EIBIS 2022*
Note: *Firms are weighted by value added.*
Question: *Compared to 2019, before the pandemic started, did your company's sales and turnover in 2020 decline, increase or stay the same? Compared to 2020, did your company's sales and turnover in 2021 decline, increase or stay the same? Compared to 2019, do you expect your sales or turnover in 2022 to be higher, lower or about the same?*

High energy prices provide an opportunity and an incentive for firms to increase their investment in energy efficiency, balancing out the decline in other investment. New economic turbulence adds pressure to firms already under strain from the pandemic. At the same time, businesses would benefit from embracing a quicker energy transformation. Investment in energy-saving technologies reduces operating costs and exposure to volatile prices for fossil fuels. The current high levels and their expected persistence should push firms to invest in energy-saving equipment and production technologies. Firms with very high energy intensity have the biggest incentives. However, other considerations — such as deteriorating financing conditions, falling demand and uncertainty (see Chapter 6) — could put a brake on firms' investment.

Europe continues to trail peers in intangible investment

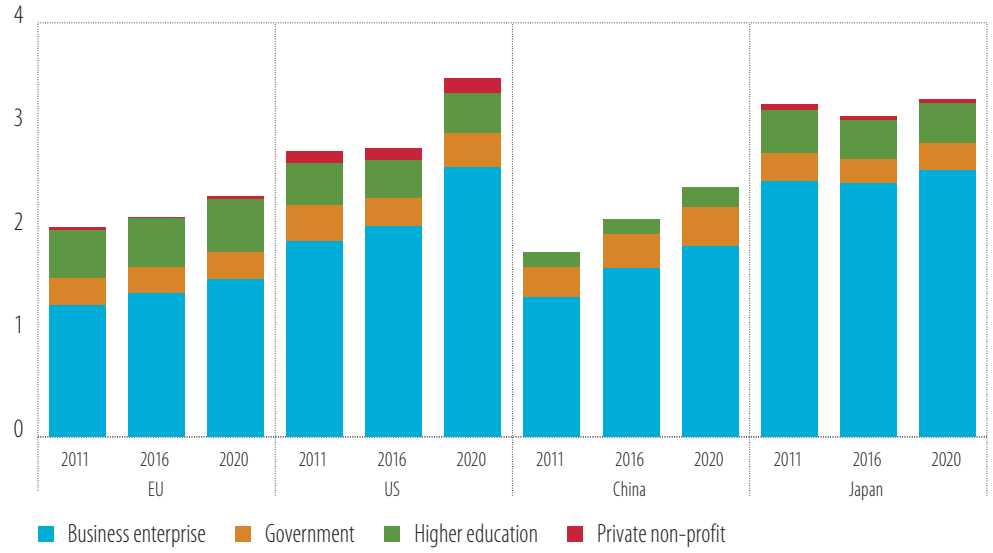
Innovation and investment in intangible capital are key to sustaining high productivity growth and increasing wealth. However, they are difficult to quantify and measure. Official statistics cover only part of intangible capital, and there is no official direct measure of innovation. To complement official data on intangible capital, this section provides information on innovation activity and investment in intangible capital based on aggregate statistics on expenditures for R&D, patents and information gathered for the EIBIS.

Aggregate R&D and patenting activities

Europe remains far from its goal of dedicating 3% of GDP to gross domestic expenditure on research and development (GERD), with current levels standing at 2.3% of GDP. Expenditure on R&D is a key indicator of innovation activity. One of the main EU policy goals is to invest 3% of GDP on GERD, with 2% coming from business enterprise expenditure on R&D (BERD). While Japan and the United States have already exceeded this goal, the European Union (Figure 22) is lagging, with R&D expenditure remaining

below 2.5% of GDP. Businesses are the main contributor to R&D expenditure in the European Union, contributing slightly more than 1.5% of GDP in 2020 (below the 2% target).

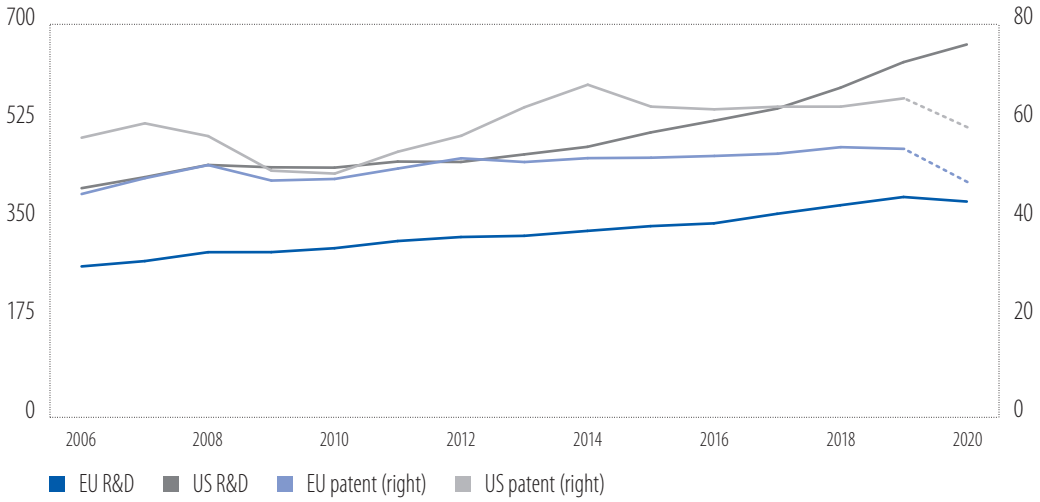
Figure 22
Gross domestic expenditures on R&D (% GDP)



Source: *Eurostat.*
Note: *GERD as a share of GDP.*

In Europe, R&D expenditure and patent applications have stagnated, falling further behind the United States (Figure 23). R&D expenditure in the United States rose strongly, compensating for a stagnation in patenting. Given that R&D expenditure is often considered an input in the innovation process and in patenting, Europe's lower spending and patent performance could be a harbinger for less EU innovation in the years to come.

Figure 23
Evolution of R&D expenditures and patents over time (left axis: USD billion, constant prices; right axis: patent count)



Source: *OECD and Patent Cooperation Treaty (PCT) patent count (Patstat).*
Note: *R&D expenditures are measured in USD constant prices using 2015 as a base year and purchasing power parities. Patent counts for 2020 are not complete.*

While Europe is trailing the United States in digital innovation (Chapter 5), Europe's position in green innovation appears more promising (Box E). In absolute patent counts and relative focus, Europe continues to lag behind the United States in patents related to digitalisation, with no clear sign of catching up. Its performance in green innovation is better but is increasingly contested. Despite Europe's lead in patenting activities for green innovation, not all investment measures are as positive — for example R&D. In addition, the US Inflation Reduction Act, which is expected to provide almost $369 billion for energy and climate change projects, could give an enormous boost to US activities in green innovation.[14]

Box E

Innovations generating environmental benefits

The development and diffusion of technologies that generate environmental benefits are crucial for green growth. By now it is clear that the challenge of climate change cannot be tackled without technological 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). By lowering the cost of greenhouse gas abatement or pollution reduction, green innovation can ensure that the European Union reaches climate neutrality in a cost-efficient manner. For example, from 2010 to 2019, technological breakthroughs in green technologies have decreased the unit costs of solar energy (-85%), wind energy (-55%) and lithium-ion batteries (-85%), leading to a strong increase in adoption rates (Intergovernmental Panel on Climate Change (IPCC), 2021).

Europe's main strengths lay in the areas of electrification, energy efficiency and the transport and mobility sector. Not only does Europe hold most internationally oriented climate-related patents in these areas — more than China and the United States — but it also saw the highest increase in patenting in these domains compared to other regions over the past decade.

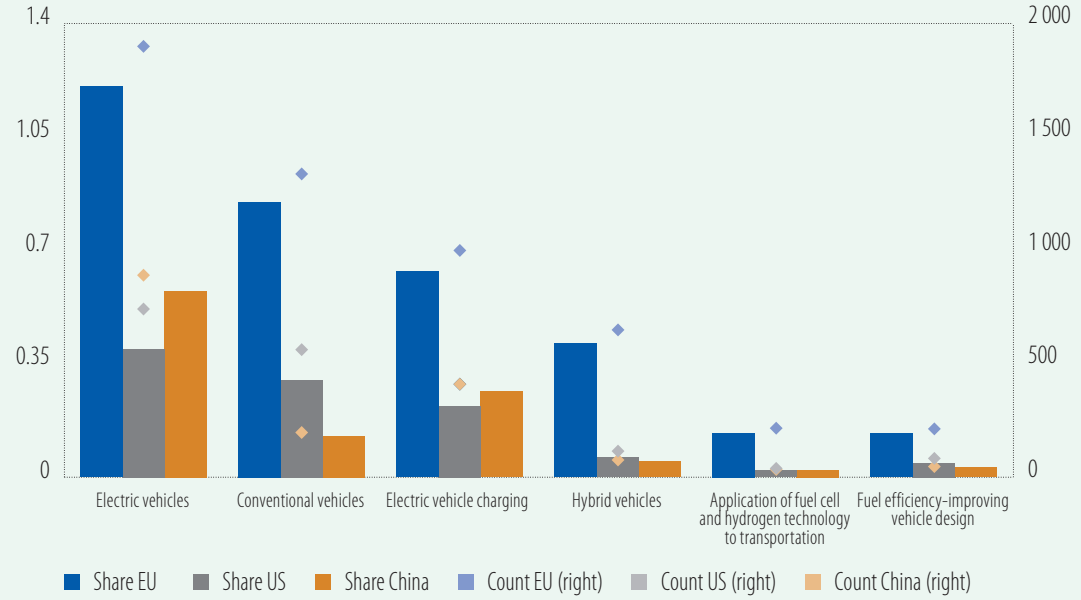
In the transport and mobility sector the focus is currently on electric vehicles, an evolution that goes hand in hand with current policy priorities. Still accounting for 24% of direct carbon emissions from fuel combustions, transport and mobility is one of the key sectors needing (and currently undergoing) a shift towards clean energy (International Energy Agency (IEA), 2020). Figure E.1 shows that Europe is prioritising development in this area.

Europe seems to have a competitive advantage in key and enabling technologies. It is a leading innovator in wind energy. Solar, on the other hand, is not a centre of EU expertise, and China is the driving force in that area (Figure E.2a). Smart grid and energy storage technologies are viewed as enabling the electrification transition (Figure E.2b). In both, Europe and China are ahead of the United States when it comes to the number of new innovations or the share of the global patent portfolio.

In addition, the focus worldwide remains on well-established technologies. Technologies like hydrogen have yet to be thoroughly developed (EIB, 2022a). Although progress in this area is highest in Europe and still increasing, it is still only in its initial stages (Figure E.3).

14 See Box D in Chapter 1 for more information about the US Inflation Reduction Act.

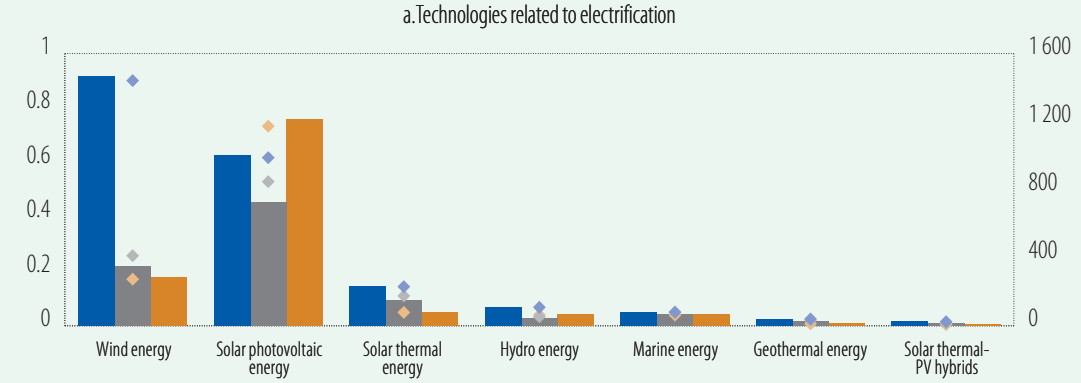
Figure E.1
Climate change mitigation technologies (left axis: % of total patents: right axis: patent count) **related to transport and mobility, 2018-2020**



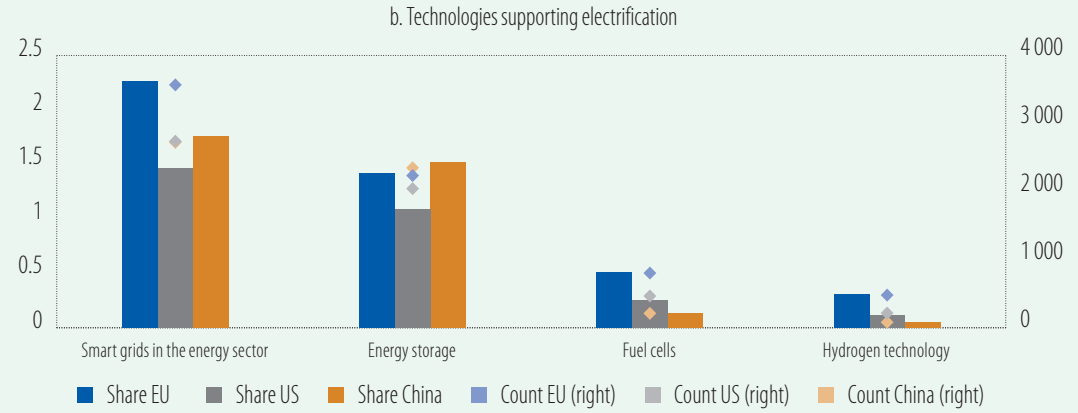
Source: *Authors' calculations based upon PATSTAT (PCT) data in collaboration with Expertise Centre for Research and Development Monitoring (ECOOM).*

Part of the technologies developed in transport and mobility are closely related to energy efficiency. When it comes to fuel efficiency, the motorisation of electric vehicles or the application of hydrogen technology, advancements are highly dependent on developments in the energy sector and the level of efficiency that can be attained. If coal or other polluting fuels are used to generate the electricity needed to charge electric cars, the progress in this area will not pay off.

Figure E.2
Climate change mitigation technologies in electrification (left axis: % of total patents; right axis: patent count)

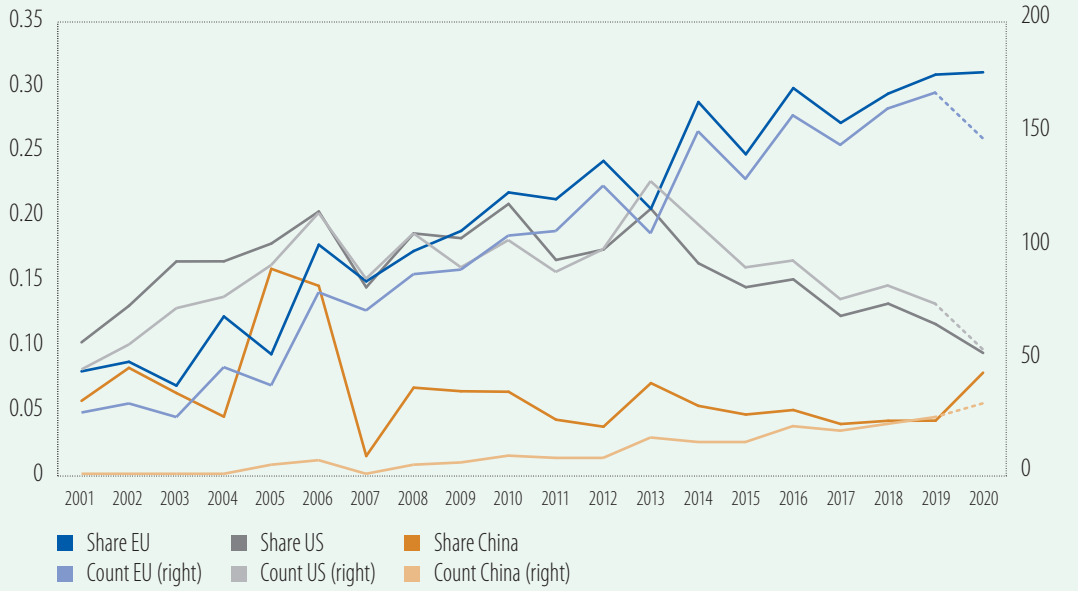


Source: *PATSTAT (PCT) data prepared in collaboration with ECOOM.*
Note: *The bars show the share of climate change mitigation technologies related to electrification in the total domestic patent portfolio (in %), the diamonds show the count of these patents in the respective region, during 2018-2020.*



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 diamonds show the count of these patents in the respective region, during 2018-2020.*

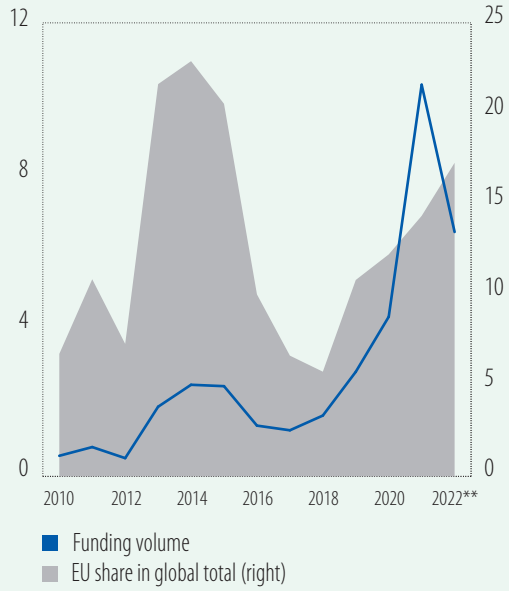
Figure E.3
Climate change mitigation technologies related to hydrogen
(left axis: % of total patents; right axis: patent count)**, 2001-2020**



Source: *Authors' calculations based upon PATSTAT (PCT) data in collaboration with ECOOM.*

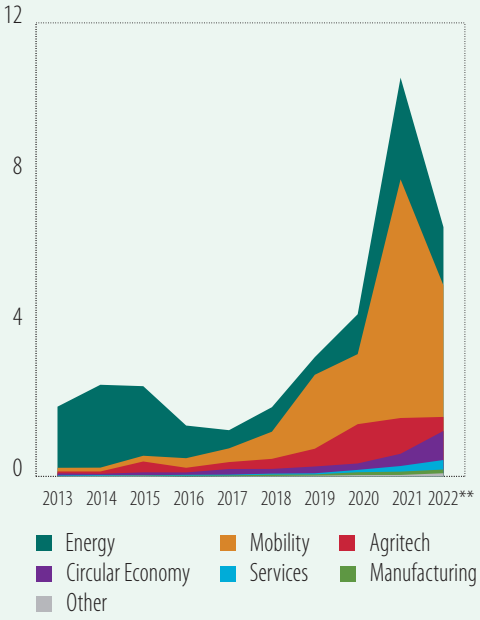
The development of green technologies is critically dependent on the availability of equity-based financing provided by outside sources. Venture capital and private equity growth funding volumes for EU green technology companies have risen strongly in recent years (Figure E.4). From 2018 onwards, the market experienced exponential growth, reflecting the 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 E.4
EU greentech funding volume
(left axis: EUR billion; right axis: in %)



Source: *European Small Business Finance Outlook (ESBFO) (Kraemer-Eis, 2022).*
Note: ** Venture capital and private equity growth financing for greentech companies headquartered in the EU27*
*** Annual totals were incomplete when the data was gathered (11 August 2022).*

Figure E.5
Recent trends in some select environmental segments of EU greentech (EUR billion)



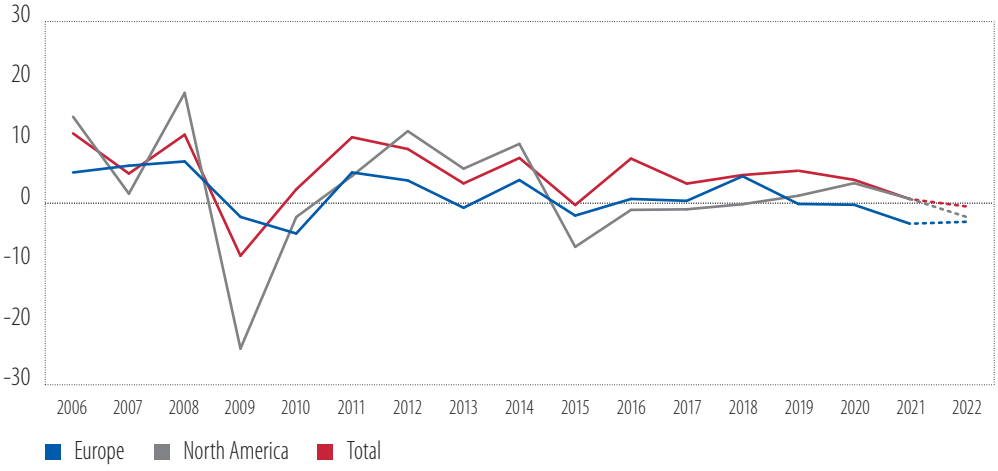
Source: *ESBFO (Kraemer-Eis, 2022)*
Note: *Venture capital and private equity growth deals in EU greentech companies. Data for the year was incomplete at the time of gathering (August 2022).*

Green technology companies are typically active across a variety of fields (Figure E.5). Emission abatement in the transport sector is widely recognised as one of the most challenging aspects in the European Union's net-zero carbon strategy. Unsurprisingly, the European green technology industry has grown increasingly focused on mobility solutions in recent years, and investments in mobility and transport were the driving force behind the recent growth in funding for green technologies, accounting for 60% of investments in 2021.

Clean energy investments, the second-largest funding category, cover renewable energy infrastructure as well as equipment development and production. These investments accounted for 26% of investment in green technologies in 2021. Given the Ukraine war and Europe's efforts to reduce its dependence on Russian fossil fuels, as outlined in the REPowerEU initiative, demand for clean energy innovation is likely to increase significantly in the years ahead. Agritech companies with business models focused on things like innovations in insect-based protein production, sustainable soy production or internet of things technology for vertical farming systems are essential players in making agriculture more sustainable. In 2021, they accounted for 9% of the green technology sector in the European Union. Although still relatively modest in size, circular economy companies have received a growing amount of green technology funding recently, attracting 3% of funding for green technologies in 2021, but preliminary data for 2022 shows a significant increase.

The recent economic turbulence could cause innovation activity to stagnate further. To get a better view of what to expect, we can look to the trends in Patent Cooperation Treaty (PCT) applications, by date of receipt at the International Bureau of the World Intellectual Property Organization (WIPO). These data show that innovation activities respond to the business cycle. Patent applications declined during the global financial crisis, especially in the United States. Growth accelerated again shortly thereafter. After growing stably in the subsequent years, patent applications again fell in 2020 and 2021, with a contraction expected in 2022.

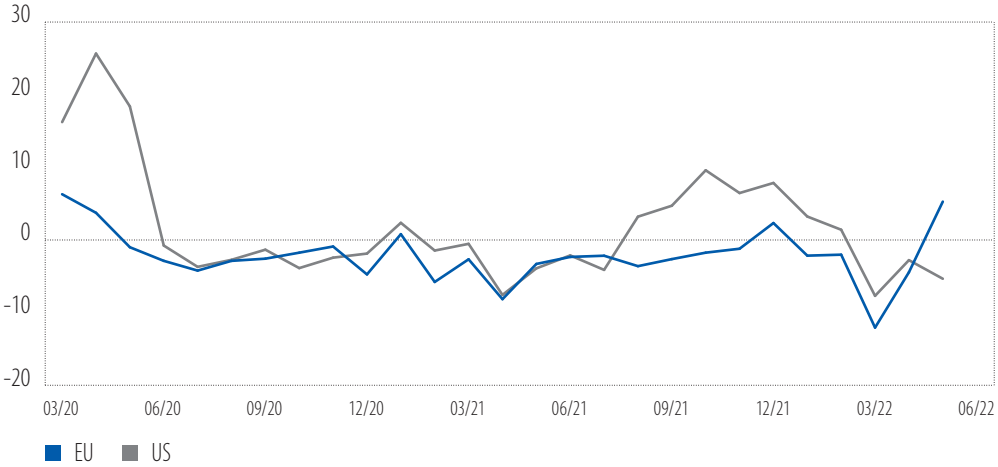
Figure 24
Annual growth rate of PCT applications (in %)**, by date of receipt**



Source: *WIPO statistics database. Last updated: September 2022.*
Note: *Data for 2022 are incomplete.*

Innovation activities were clearly hit during the coronavirus pandemic, with fewer patent applications in the European Union and the United States since the beginning of 2020. Zooming in on monthly changes in growth rates over the past years shows an overall steady decline in patent applications since the pandemic, albeit with more dynamism in the United States (Figure 25). With the COVID-19 crisis already pushing down growth rates in applications, the current situation could put further pressure on innovation activities.

Figure 25
Monthly three month moving average growth rates of PCT applications (in %)**, by date of receipt**



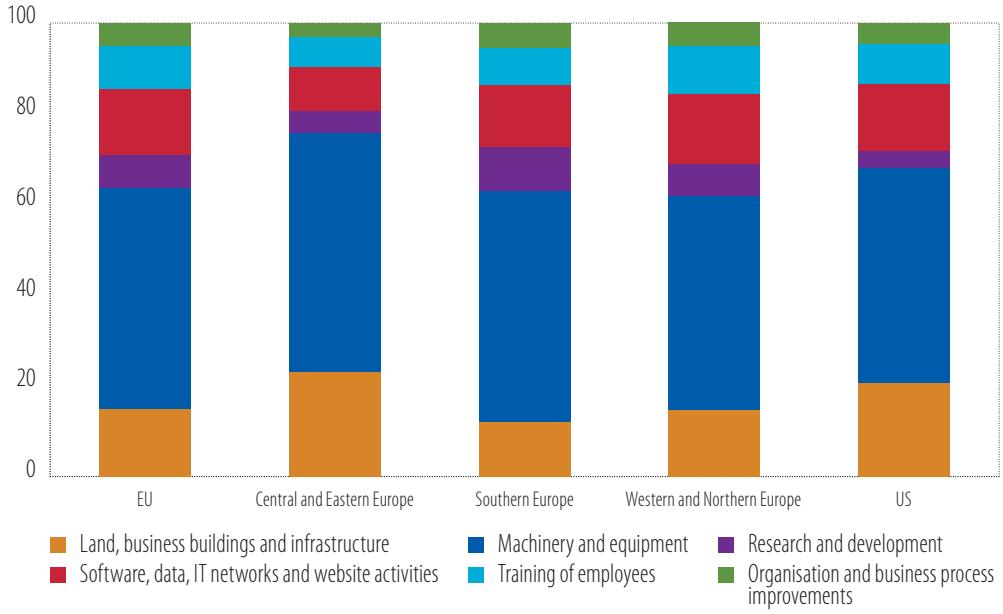
Source: *WIPO statistics database. Last updated: September 2022.*
Note: *Data for 2022 are incomplete.*

Given the crucial role of innovation in economic growth, policies to support it are urgently needed in Europe, specifically in a period of crisis. Falling further behind in innovation will have a detrimental effect for economic growth in the European Union and for its global economic leadership. Areas in which EU businesses and researchers excel are subject to fierce competition, and they could soon be dominated by global rivals. Policymakers may need to redefine the European Union's focus if it is to remain a competitive innovation player.

Intangible assets and innovation as seen through EIBIS data

Investment in intangible assets — such as R&D, software and databases, employee training and organisational capital — represents more than one-third of total investment. The EIBIS allows for a better understanding of overall developments by studying firm-level outcomes. According to EIBIS data, EU firms allocated 37% of their total investment to intangible assets in 2021, slightly above the United States average of 32% (Figure 26). Within the European Union, the share of investment spent on intangibles is lower in Central and Eastern Europe (24%) than in Western and Northern Europe (38%) or Southern Europe (37%).

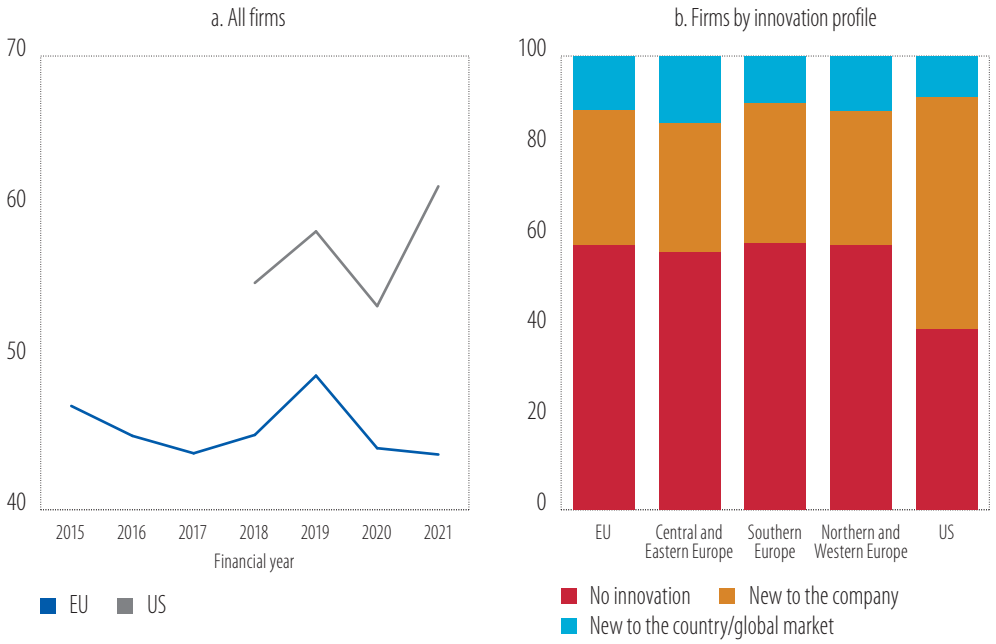
Figure 26
Investment composition in 2021 (% of total investment), **by region**



Source: *EIBIS 2022.*
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?*

The European Union has a higher share of firms that do not innovate than the United States. This gap in innovation rates has grown over time (Figure 27a). Innovation does not have to come through products and services that are wholly new to a country or the global market. Firms can also adopt and adapt technologies that already exist in their market. In the United States, for example, the share of firms that invest in adopting products or services that are new to the company is significantly larger than in the European Union (Figure 27b). This difference in the share of adopters is the main driver of the innovation gap between the United States and the European Union.

Figure 27
Investment in innovation (% of firms)



Source: *EIBIS 2016-2022.*
Note: *Data on US firms are only available for 2018. Firms are weighted by value added.*
Question: *What proportion of the total investment in the previous financial year was allocated to developing or introducing new products, processes or services? Were the new products, processes or services that you developed or introduced new to the company, new to the country, or new to the global market?*

Box F
Intangible investment during the COVID-19 crisis[15]

Intangible capital acts as an important driver of productivity and economic performance in an increasingly knowledge-based economy. As intangible assets are closely linked to digital transformation (Van Ark, 2016; Corrado et al., 2017), innovative activity (Montresor and Vezzani, 2016) and firm resilience (Landini et al., 2020; Demmou and Franco, 2021), understanding investment dynamics in intangible assets is key to supporting the long-term growth of the EU economy.

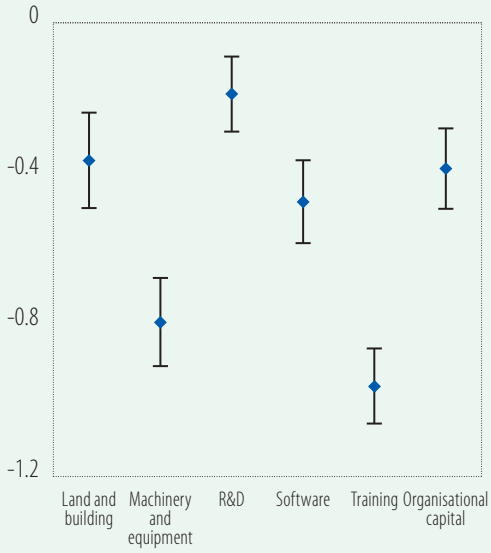
It is now well established that, during the global financial crisis of 2008-2009, intangible investment showed relative resilience compared to tangible investment, which declined substantially more (Corrado et al., 2016). However, evidence on the COVID-19 crisis is still scarce. This box seeks to address this gap by investigating the investment of firms in Europe across different assets. It also looks at the role of financial constraints and economic shocks during the pandemic.

Research conducted by the European Commission and the EIB find heterogeneity in the extent of decline in investment among both intangible and tangible assets (Figure F.1). R&D investment declined the least in 2020, by around 20% on average, while investment in training (an intangible asset) and machinery and equipment (a tangible asset) declined the most. The decline was smaller for investment in land and building, software and organisational capital. These results come from

15 This box was prepared by Peter Bauer (European Commission, Joint Research Centre).

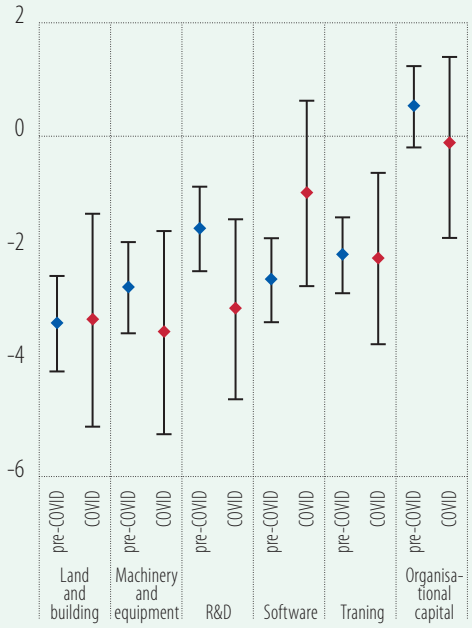
estimations that control for basic firm attributes (size, age, sector and country), and the findings remain largely the same regardless of the estimation method (regressions using pooled ordinary least squares (OLS) or firm fixed effect) or of the measure of investment activity (log investment, probability of investment).[16]

Figure F.1
Impact of COVID-19 on investment (change in logarithm)**, by assets**



Source: *Authors' estimates based on EIBIS 2021.*
Note: *Pooled ordinary least squares regressions. Lines denote 95% confidence intervals.*

Figure F.2
Impact of financial constraints on investment (change in logarithm)**, by assets**



Source: *Authors estimates based on EIBIS 2021.*
Note: *Two-stage least squared regressions. Lines denote 95% confidence intervals. Firms are defined as financially constrained if they report the availability of finance as a major obstacle to investment.*

We detect a statistically significant "small firm effect" for machinery and equipment, software and training — meaning that the smaller the firm, the larger the decline in investment activity. Part of the large adverse effect of the pandemic on investment stems from a big decline in firms' turnover during the crisis.[17] To shed more light on this aspect, we analysed the elasticity of investment to income by estimating the response of investment to a large (at least 25%) decrease in sales for firms in 2020.

We find that training, machinery and equipment, and software were the most sensitive to income shocks during the COVID-19 crisis, while investment in land and building, R&D and organisational capital were the least sensitive. Thus, the elasticity of investment to income shocks helps to explain the strong decline of machinery and equipment and the mild decline of R&D investment during the pandemic. The sensitivity of training can be associated with difficulties of in-person training due to restrictions on gatherings and social distancing rules.

16 As each year there are many firms that do not invest at all in certain assets, we measure the change in the amount of investment by expressing investment as log(investment+1). This way, our results can be interpreted as average percentage changes.

17 Another important factor could have been the increased uncertainty during the COVID-19 crisis. The analysis of this factor is outside the scope of this box.

We find that for almost all assets, pre-pandemic productivity shielded investment from the COVID-19 crisis. This is partly because the income of more productive firms declined less. After controlling for large drops in sales, the resilience provided by productivity remains significant for two key assets: R&D and training.

Regarding the role of financing, we find that financial constraints generally decrease investment. We define firms as constrained if they report the availability of finance to be a major obstacle to investment (Figure F.2). This effect was comparatively low for R&D before the COVID-19 crisis.[18]

In 2020, as a response to the COVID-19 shock, firms initially expected external finance to be less available, but policy support helped prevent that from translating into a higher number of financially constrained firms. However, the detrimental effect of financial constraints was still strong for investment in land and building, machinery and equipment, R&D and training. In some cases, notably for R&D investments, we see an increased sensitivity to financial constraints, although this change is not statistically significant. It is likely that the tightening of liquidity during the crisis (an important determinant of finance, especially for intangible assets) forced financially constrained firms to decrease their R&D investments.[19]

From a policy point of view, our results mean that, despite strong policy support that helped alleviate the financial constraints on firms, these constraints were nevertheless an obstacle during the COVID-19 crisis to investment in R&D and training — two vital intangible assets for long-term productivity growth.

Innovative firms resisted the recent crisis better (see also Box F). When looking at different sales profiles, the share of winners that saw their turnover increase from 2019 to 2022 is significantly higher among firms that introduced products or services that were new to the country or the global market. More than 44% of EU innovative firms can be classified as winners, compared to 35% of winners among adopters and 32% among firms that do not innovate (Figure 28).[20] At the other end of the sales spectrum, the share of firms affected by the COVID-19 crisis and the war in Ukraine (the categories "not yet recovered" and "newly hit") is 18% for innovators, compared with 21% for adopters and 25% for firms that do not innovate. The consequences of the war in Ukraine therefore appear to have hit the sales of active innovators less severely.

In response to the pandemic, innovative firms are more likely to invest in their digital transformation and to reconfigure their supply chain. A large share of firms invested to become more digital during the crisis and to transform their supply chains. Innovators are much more likely than non-innovative firms to do this (Figure 29), and the difference between innovation profiles is similar for US firms. Addressing barriers to digital infrastructure and skills in the European Union, both of which impede the adoption of digital technology, should be a priority if policymakers want to support digital transformation and bridge the growing corporate digital divide between the European Union and the United States (Rückert et al., 2021).[21]

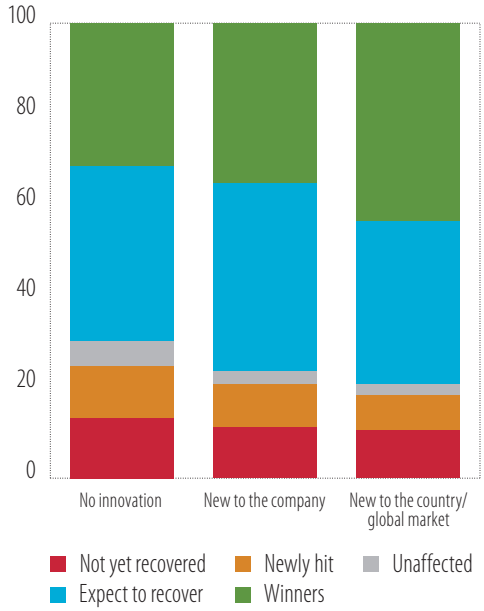
18 Endogeneity of financial constraints because of unobserved firm heterogeneity and reverse causality poses a challenge when estimating causal effects. To mitigate this problem, we applied an instrument variable approach. We used indicators of pre-existing financial fragility, like excess leverage and low cash, as instruments, as these are positively correlated with the probability of being financially constrained.

19 As indirect evidence for tight liquidity for financially constrained firms, we find that the profit situation deteriorated more among constrained firms during the pandemic, compared to non-constrained firms.

20 To simplify the exposition, Figures 28 and 29 only show the results for EU firms. The patterns are similar for the United States, although the sample size for US firms in the EIBIS is much smaller.

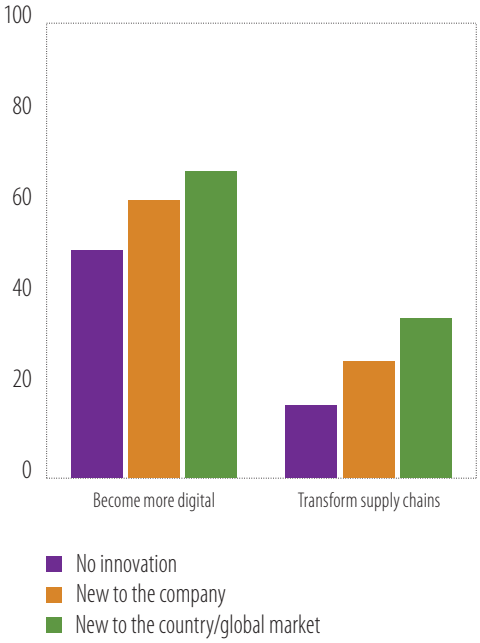
21 See also the discussion in Chapter 5 of this report.

Figure 28
Sales profiles and innovation in the European Union (% of firms)



Source: *EIBIS 2022.*
Note: *See Figure 16 for a definition of sales profiles. Firms are weighted by value added.*
Question: *Were the new products, processes or services that you developed or introduced new to the company, new to the country, or new to the global market?*

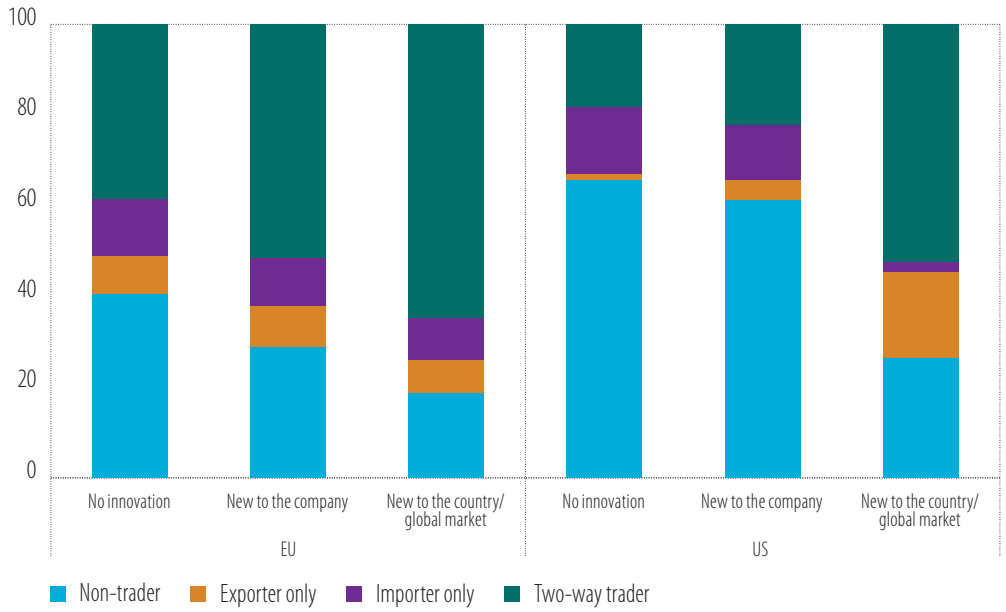
Figure 29
As a response to COVID-19, EU investment has become more digital and more focused on supply chains (% of firms)



Source: *EIBIS 2022.*
Note: *Two-stage least squared regressions. Lines denote 95% confidence intervals. Firms are defined as financially constrained if they report the availability of finance as a major obstacle to investment.*
Question: *Were the new products, processes or services that you developed or introduced new to the company, new to the country, or new to the global market? 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)? As a response to the COVID-19 pandemic, have you taken any actions or made investments to transform your supply chain or your outsourced activities (bring more stages to the same location or closer to your business's home country)?*

Innovative firms are more likely to engage in trade, by exporting or importing products and services. While 40% of non-innovative firms in the European Union do not engage in international trade, this share decreases to 29% for adopters and 19% for innovators (Figure 30). Similarly, the share of two-way traders (firms that exported and imported products and/or services) in the European Union is 65% for innovators and 51% for adopters, compared with only 39% for firms that do not innovate. Perhaps unsurprisingly, the share of non-trader firms in the United States is higher because of the larger size of the domestic market, but the trade patterns with respect to innovation levels are similar. These results are also in line with studies stressing that exporters tend to be more productive and innovative because they 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 firm performance does not necessarily imply a causal link.

Figure 30
Trade and innovation (% of firms)



Source: *EIBIS 2022.*
Note: *Firms are weighted by value added.*
Question: *Were the new products, processes or services that you developed or introduced new to the company, new to the country, or new to the global market? In 2021, did your company export or import goods and/or services?*

Investment in climate change mitigation and adaptation rebounds

Climate investments are progressing incrementally, but they fall short of what is needed to transform economies and achieve carbon neutrality. The rebound observed in 2021 mostly benefited clean energy investments, which account for two-thirds of climate investments in the European Union, the United States and China. Energy efficiency investments regained momentum, driven by incentives in the construction sector and by dynamic sales of electric cars. In the current energy crisis, climate innovation — already bolstered by post-pandemic recovery packages — is critical for accelerating the commercialisation of rapidly emerging technologies, including energy storage and green hydrogen.

Investment in climate increased in 2021, after stagnating in previous years

After a slowdown in 2020, climate change investments rebounded strongly in 2021 in the European Union and the United States. European climate investments reached nearly EUR 290 billion in 2021 — a 28% rise from 2020 levels, according to the EIB database on climate change mitigation investment (see data annex). These were boosted by the large stimulus packages deployed in the aftermath of the pandemic, including the Just Transition Mechanism and the overarching NextGenerationEU plan as part of the European Green Deal (Figure 30). The increase in investment in 2021 was also helped by the adoption of the EU taxonomy for sustainable activities, and more broadly by the vast array of European-level and domestic policies to support net-zero climate objectives. Climate investments in the United States grew by 17% in 2021, but they still lag behind European spending.

Current spending on climate mitigation needs to increase significantly if carbon neutrality is to be reached by mid-century. 2% of GDP was devoted to climate mitigation in 2021. The havoc wreaked by the war in Ukraine and the new paradigm on energy security have temporarily shifted priorities in

public energy spending in Europe. As of November 2022, European governments had pledged over EUR 550 billion to cover households' and firms' ballooning electricity and gas bills. Further transfers from various packages are under consideration. Meanwhile, fossil fuel producers saw their net income rise by USD 2 trillion in 2022.

Beyond the immediate need to address the unfolding energy crisis, policymakers reaffirmed their commitments to climate objectives, paving the way for global clean energy investments to double by 2030, to about USD 2 trillion (IEA, 2022). However, USD 4 trillion in investment is needed globally by 2030 to meet the 1.5°C goal. The International Monetary Fund (IMF) and the IEA estimate that 0.6% to 0.9% of global GDP should be allocated to energy transformations over the next decade to meet climate objectives. Availability of financing notwithstanding, numerous investment barriers continue to block climate investments (Box G).

Box G

Barriers to climate investment

Investment barriers are specific factors that affect the cost of investing, the risk of investing and the level of the competition in a market. They are often location or country specific. The EIB's experience financing investment projects in all EU countries has allowed it to collect insight on the most relevant and common barriers to investment. In the European Union, four main types of factors can produce investment barriers:

(1) Regulation (regulatory uncertainty, regulatory fragmentation and administrative procedures)
(2) Market size and structure (with a lack of European Union-wide standards very often holding back investment projects in national markets that are still small and fragmented)
(3) Public sector promoter constraints (weak project planning and preparation capacity and difficulty coordinating funding resources)
(4) Access to finance

Regulation. The first obstacle for climate investors is related to the very definition of what a climate project is. The EU sustainable finance agenda contains a classification system defining economic activities that make a substantial contribution to environmental objectives under the EU taxonomy. However, the development of such a system is being hampered by a lack of understanding or ability to define the classifications. This situation should improve once the EU taxonomy and the sustainability-related disclosures under the Sustainable Finance Disclosure Regulation are fully in force at the beginning of 2023, but it will require an immense effort across the European Union to establish the information flows necessary to track green investments consistently.

Market size and structure. In line with the 2030 greenhouse gas reduction targets and the 2050 carbon neutrality objective, different industries' approach towards decarbonisation essentially determine key investment needs, and therefore set the boundary for the market size and structure for climate finance. Investment barriers in sectors with a pressing need for low-carbon investment include the following:

- For the most part, transformational technologies that permit **energy-intensive industries** to reduce their carbon emissions are not yet commercially viable. In other words, low-carbon alternatives remain more expensive than conventional processes relying on fossil fuels. The challenge to investment in low-carbon solutions is exacerbated by pressure from international competition, often from countries or regions with lower environmental and social standards.
- The fragmented nature and the large number of small producers in the **agriculture and food industries** present challenges for climate investment, as they must all move towards lower carbon production practices to drive overall improvement. Intermediated lending could facilitate the

development of advisory programmes at the national level to support changes toward lower-carbon, more sustainable practices. In addition, the industry also finds it difficult to identify and incorporate climate-related risks into the value chain. In this respect, investments made by competitors are the most important market signals, suggesting that the sector will move toward climate resilience relatively slowly until it reaches a critical mass of investment.

- The **transport** sector needs to achieve the European Union's 2030 climate and energy targets through a combination of decentralisation, decarbonisation (including electrification) and digitalisation. Passenger and freight rail projects are capital intensive, lengthy and complex. They are typically carried out by the public sector at the municipal or local level and are therefore exposed to public sector promoter constraints and limited access to finance. Alternative fuels (such as hydrogen infrastructure) to support transport activities are currently still in the early stages of development, with supply and demand of fuel cell vehicles currently at comparatively low levels.
- Meeting the current 2030 target may well require doubling or tripling current capacity for **renewable power generation**. Deploying such massive renewable capabilities is likely to pose challenges to system integration, local support and coordination between government agencies responsible for energy and climate policy. Investment barriers to renewable energies mainly concern development barriers. Permitting procedures are generally difficult and severe restrictions may be in place, which are partly a reflection of local opposition.
- **Energy efficiency** projects face problems of imperfect information. Energy prices are volatile while energy needs are determined by unpredictable factors like the weather. In addition, the variety of contractual relationships in the building sector (buyers and sellers, owners and renters, and borrowers and lenders) can reduce incentives to invest in energy efficiency, to the extent that owners do not have to pay energy costs for buildings that are rented out. These problems are magnified by high upfront costs and a multitude of parties involved in energy efficiency investments.
- **Public sector promoter constraints.** Adaptation to climate change is typically initiated, financed, and implemented by the public sector. However, national strategies often lack estimates of the adaptation investment need, and do not typically include concrete proposals for capacity-building exercises that would teach promoters to see how a project encompasses climate change. If local project promoters lack the ability to identify climate risks and to integrate greater resilience into project designs, identifying adaptation projects will be difficult. There may therefore be a gap between the development of national strategies and their translation into a pipeline of bankable projects.

For climate change mitigation, the main obstacles faced by local and regional authorities stem from a lack of awareness, capability and capacity to identify the investments needed. Climate financing classification and reporting takes resources, and authorities (particularly small ones) facing budgetary constraints may be unable to develop the necessary capacity. The aggregation of small-scale projects managed by different authorities into a larger portfolio remains a potential solution for connecting financing partners with climate financing opportunities.

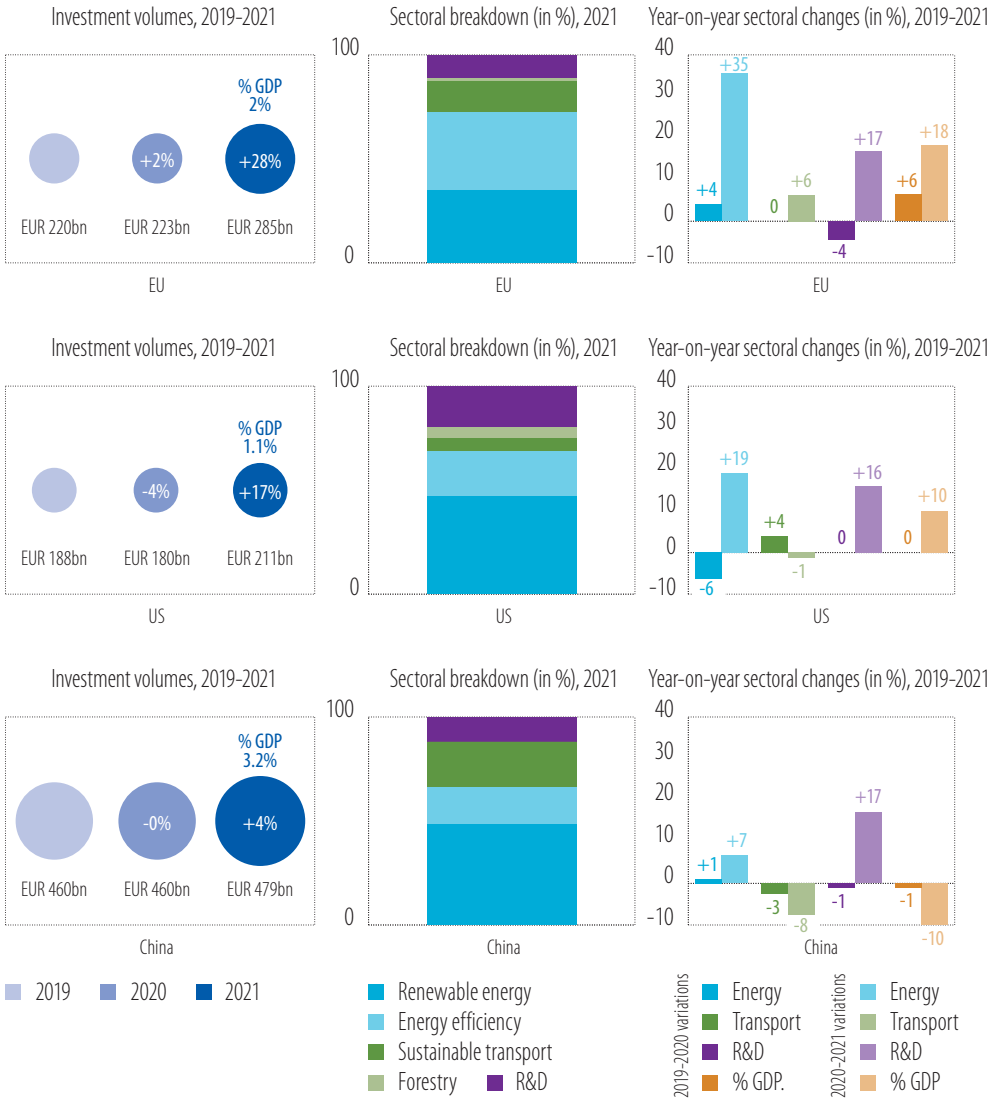
Access to finance. Information gaps (particularly for finance for small and medium firms) are one of the main barriers to green finance in general, and climate action in particular. The smaller the promoter and/or the project and the more there are, the more difficult it is for a financing institution to acquire the information necessary to classify an investment as green. If potentially viable green investments are not clearly identified, they may not benefit from tailored funding opportunities.

The EIB has observed growing interest among its intermediary clients, primarily banks, in opportunities to prove innovative climate financing products — products that could support energy efficiency upgrades, renewable power generation, green buildings, circular economy, green transport, climate-smart agriculture, etc. In fact, intermediaries in the European Union cannot afford to miss out on the transition to low-carbon and resilient economies. Climate-related risks may directly affect their clients' financial positions, making climate risk an important element of any credit decision. Furthermore,

financial intermediaries also need to understand the climate risks posed to their assets in general and design measures to mitigate them.

Despite this increased interest, climate change considerations are far from becoming mainstream business for commercial banks. Technical assistance and advisory support for banks is crucial to help intermediaries engage in green lending, and to build sustainable lending capacity. The EIB provides such support by developing advisory and support tools for financial intermediaries and by offering them specific advisory packages.

Figure 31
Climate change mitigation investments, 2019-2021



Source: *International Energy Agency, Eurostat, Joint Research Centre, World Bank, OECD and EIB staff estimates.*
Notes: *Data for investment in forestry in China were unavailable. Non-energy estimates for 2021, wherever missing, were derived from data on gross fixed capital formation in related sectors.*

The gap between European and Chinese climate spending is progressively closing as policy objectives diverge. The industry-led pandemic recovery and energy security concerns in China triggered a rebound in fossil fuel usage and investments in 2021, to the detriment of cleaner alternatives. After a year of stagnation in 2020, the volume of Chinese investments in climate mitigation increased slightly in 2021, rising 4% compared to 2020. China's commitment to reaching carbon neutrality before 2060 has not yet translated into a sizeable shift in investments. China needs USD 17 trillion in investments to meet its climate goals, but it lacks the predictable regulatory environment and good access to markets and finance required to unleash private sector participation (World Bank Group, 2022).

Some sectors that are key to climate mitigation objectives receive insufficient support, narrowing the odds of delivering the energy transition on time. With 60% of transport carbon emissions coming from heavy-duty transport, the deployment of sustainable transport solutions is not just critical to economic development, but also essential to carbon neutrality. And yet dedicated investments have levelled off in recent years in most regions and countries. In line with the aspiration of many Europeans to use trains rather than planes for short-distance travel (EIB, 2022b), railway developments are now a priority in the European Green Deal. The Connecting Europe Facility mobilised EUR 5.4 billion to help connect roads, railways, inland waterways, short-sea shipping routes, ports and airports across the continent. The forestry sector also receives insufficient support. The EU Forest Strategy for 2030, another contribution to the European Green Deal announced in July 2021, acknowledges the role of forests on the path toward carbon neutrality. It is based on the environmental, social and economic benefits of sustainable forest management.

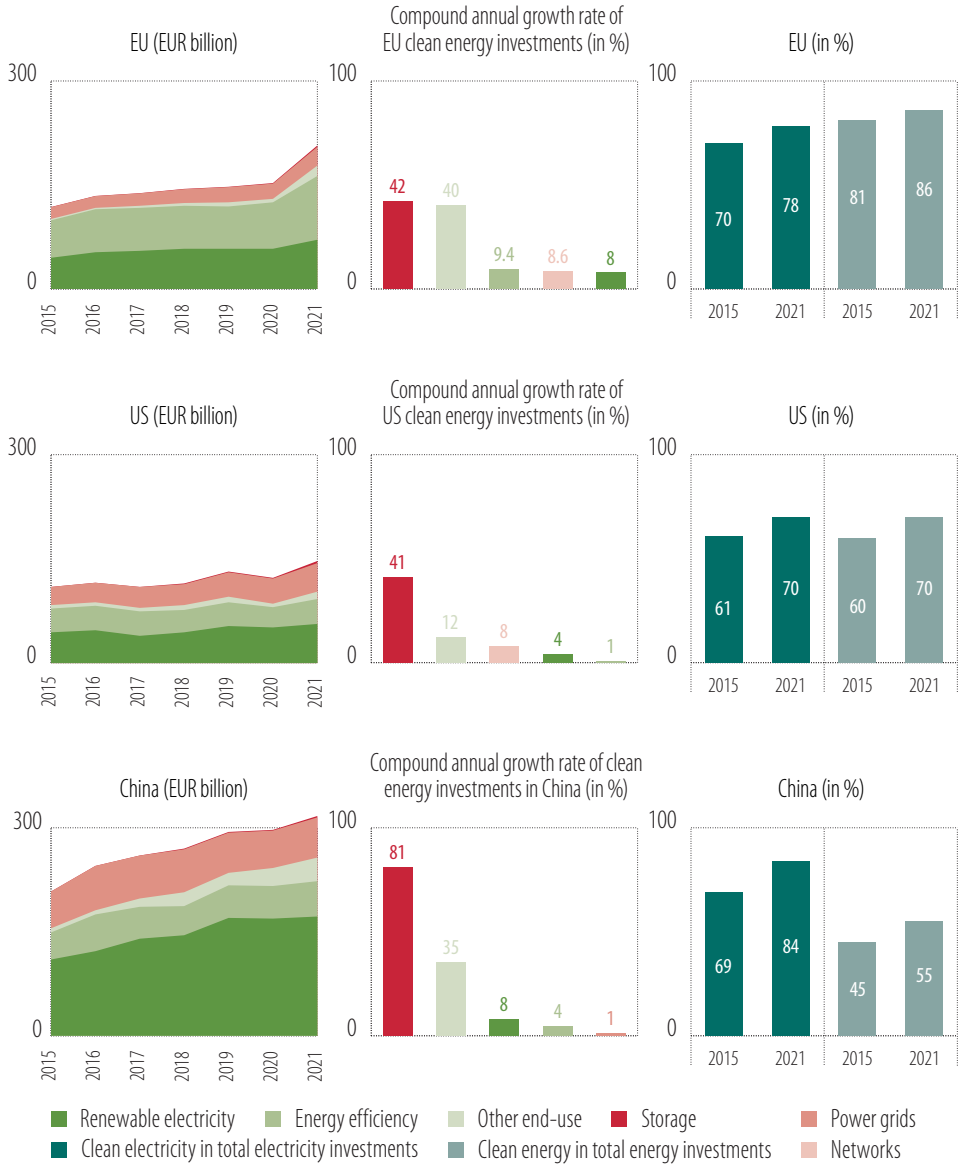
Electricity

Boosted by policy measures, spending on clean electricity projects accelerated sharply in 2021 even before the energy crisis. Over 70% of total climate investments in Europe, and 60-65% in the United States and China, were devoted to renewable energy and energy efficiency in 2021 (Figure 31). The increase in the European Union (35%) was notably helped by the adoption of the EU taxonomy for sustainable activities, a classification system establishing a list of environmentally sustainable economic activities. The taxonomy clearly identifies renewable energy and energy efficiency as the cornerstone of the bloc's energy strategy, as confirmed by the REPowerEU plan in response to the war in Ukraine (see Chapter 6). In the United States, the Inflation Reduction Act is expected to provide new impetus to clean energy investments. These strong policy signals and incentives, combined with a global shift towards more transparency and climate risk disclosure, encourage the alignment of corporate and financial strategies with net-zero objectives.

Solar and wind energy have become default options for clean energy investment, and for investors they remain the most attractive alternatives to fossil fuels. The volumes of financial support for wind and solar projects are now on par in Europe and the United States. These include production capacity increases and associated investments in upgrades of power transmission and distribution networks. From 2020 to 2021, renewable investments increased by almost EUR 20 billion in the European Union, twice the amount in the United States. Solar capacity additions in Europe have been growing consistently at 15% a year for the last three years. In cumulative terms since 2015, they have surpassed wind energy. This strong growth in wind and solar capacity results from favourable policy and regulatory environments, but also declining costs (Figure 32). Spending in China is still more than twice what it is in the European Union, however. Investments in renewable electricity levelled off in China because of further cost reductions in large-scale solar and wind projects, but 50% of new wind capacity globally (and 40% of solar) were built in China in 2021 (International Renewable Energy Agency (IRENA), 2022a).

The recent supply chain disruptions are unlikely to alter renewable energy's competitiveness in the medium term. The volume of solar panels imported to Europe from China (the dominant supplier globally) have increased 250% since the war in Ukraine began, reaching well above EUR 2 billion by mid-2022. However, the rise in material costs may affect the risk profile of some projects and act as a brake on clean energy adoption — but only temporarily, as policy frameworks and market conditions remain particularly favourable to solar and wind projects.

Figure 32
Climate mitigation investments in the energy sector, 2015-2021

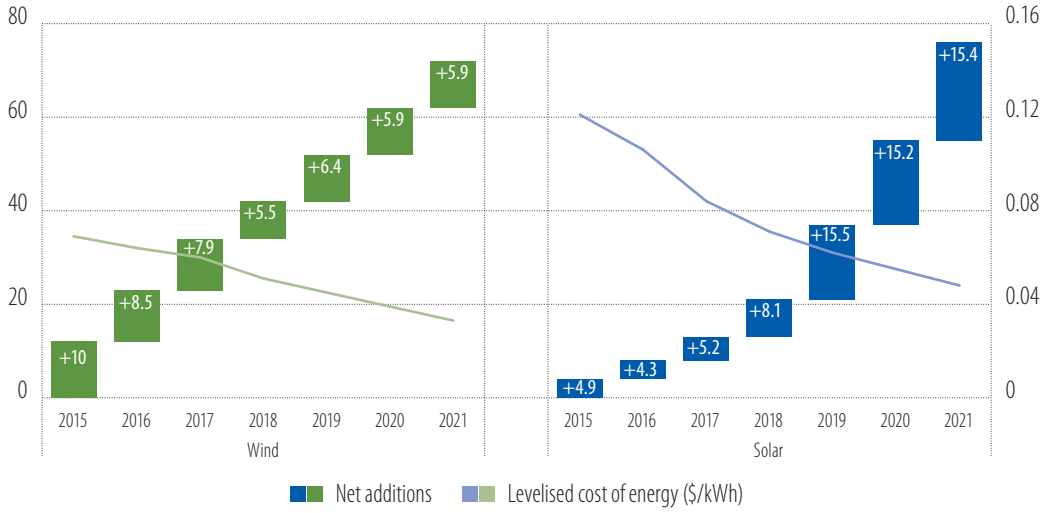


Source: *EIB staff estimates based on International Energy Agency data.*
Note: *For each column/country group, technology breakdowns of energy investments (first row) are followed by compound annual growth rates for key sectors and technologies pointing to fast-growing/emerging clean energy solutions (second row). The third row of indicators highlights the shift towards clean energy investments.*

Investors' appetite for energy storage options and clean fuels like green hydrogen appears to be growing. Energy storage technologies are often seen as the missing link between the deployment of intermittent renewables technologies — mainly solar and wind — and effective transmission to end-users. Spending remains low (less than EUR 2 billion in Europe in 2021), but it is growing rapidly (+40% every year on average in Europe and the United States since 2015, and up to 80% in China). There is also a strong political push to foster innovation and develop strategic industries through industrial coalitions (like the European Battery Alliance or the European Clean Hydrogen Alliance), to reduce dependence on non-EU suppliers and address energy security concerns exacerbated by the war in Ukraine. Support from institutional investors can help reduce the structural risks to innovative industrial projects.

Figure 33

Additions of wind and solar capacity in the European Union (left axis, in %)**, weighted average** (levelised) **cost of electricity** (right axis) **2015-2021**



Source: *IRENA (2022b).*

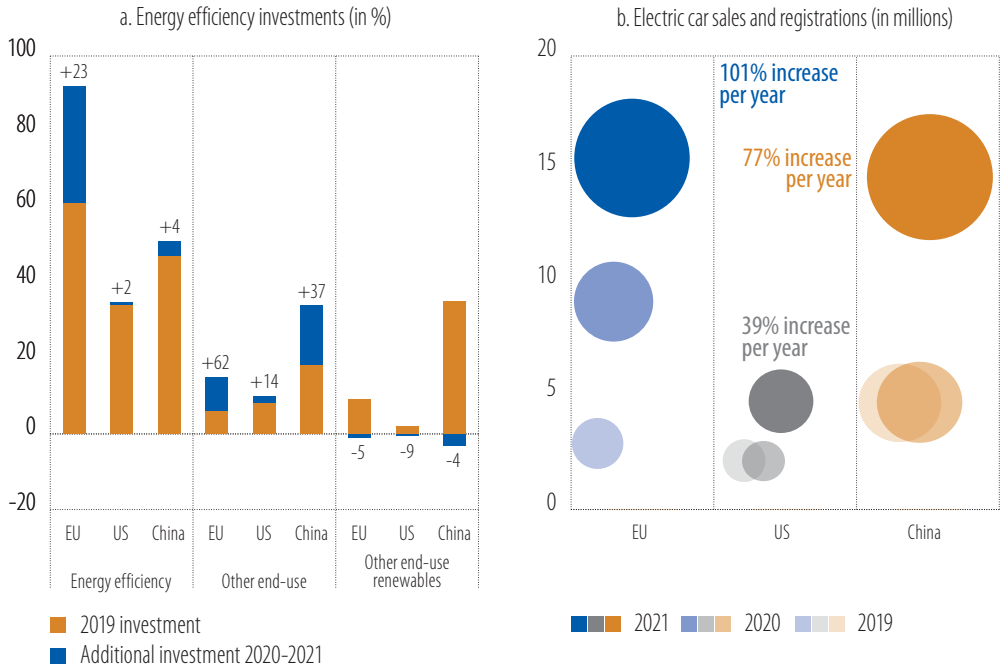
Chronic underinvestment still plagues reliable and dense power networks, which are essential for integrating large-scale renewable energy and providing quality electricity services. Russia's invasion in Ukraine turned the spotlight on the critical importance of reliable grids and cross-border interconnectors to lessen the risk of domestic electricity shortages. Investments to upgrade grids also need to keep pace with renewable energy investments. The European Union devotes just 13% of clean electricity spending to power grids — less than half the share in the United States. Recognising the need to modernise the power grid and enable more flexible management of the EU energy system, the European Commission designed an EU action plan to digitalise the energy system. The plan calls for investments worth EUR 556 billion by the end of the decade. Similar concerns are observed in the United States, where growing blackouts impede economic activity and less than 200 miles of electricity transmission lines were completed in 2021. The country is weighing USD 13 billion in grid modernisation projects, and the Biden-Harris administration awarded USD 3 billion to companies in October 2022 to supercharge the manufacturing of electric vehicles and grid infrastructure in 12 states.

Energy efficiency

European governments designed their recovery plans in 2020-2021 with a focus on energy efficiency, seeing it as economically and environmentally sound. Two-thirds of public spending on recovery were directed to energy efficiency in 2021. This was mainly driven by the retrofit of buildings in Europe, and to a lesser extent by efficiency measures adopted in industries (IEA, 2021) (Figure 34). Overall, energy efficiency investments in Europe grew 23% in 2021. New business models are emerging, stimulated by the implementation of stricter building codes, standards and labelling schemes. Supported by venture capitalists, energy efficiency startups use digital services to monitor energy consumption and deliver value to customers and energy system operators. In Europe, the constraints on energy supply and the hike in energy prices in the wake of Russia's invasion of Ukraine have only made energy efficiency and other energy saving measures more attractive. Energy savings are an integral part of the REPowerEU plan.[22] Early estimates suggest that gas demand was down 10% in Europe by November 2022, driven by the voluntary adoption of energy saving measures by certain large industrial energy consumers, reduced activity in some cases and households' response to spiking energy prices.

22 See Chapter 6 for details on targeted energy efficiency measures.

Figure 34
Increase in energy efficiency investments, electric car sales and registration, 2019-2021



Source: *IEA (2022). Bubble size indicates the volume of total car registrations.*

Electric vehicles have reached mass market in some countries, pulling carbon emissions down. With 20% of total sales and 2.3 million cars delivered in 2021, Europe is making headway in electric mobility. But China exhibited even stronger growth in 2021 (+37% and 3.3 million units sold). Globally, electric vehicles sales reached 6.6 million in 2021 and are poised to cross the 10-million-unit mark in 2022 despite supply chain disruptions, strict lockdowns in Asia and some uncertainty on car manufacturers' ability to meet demand (Bloomberg New Energy Finance (BNEF) Clean Energy Ministerial (CEM), 2022).

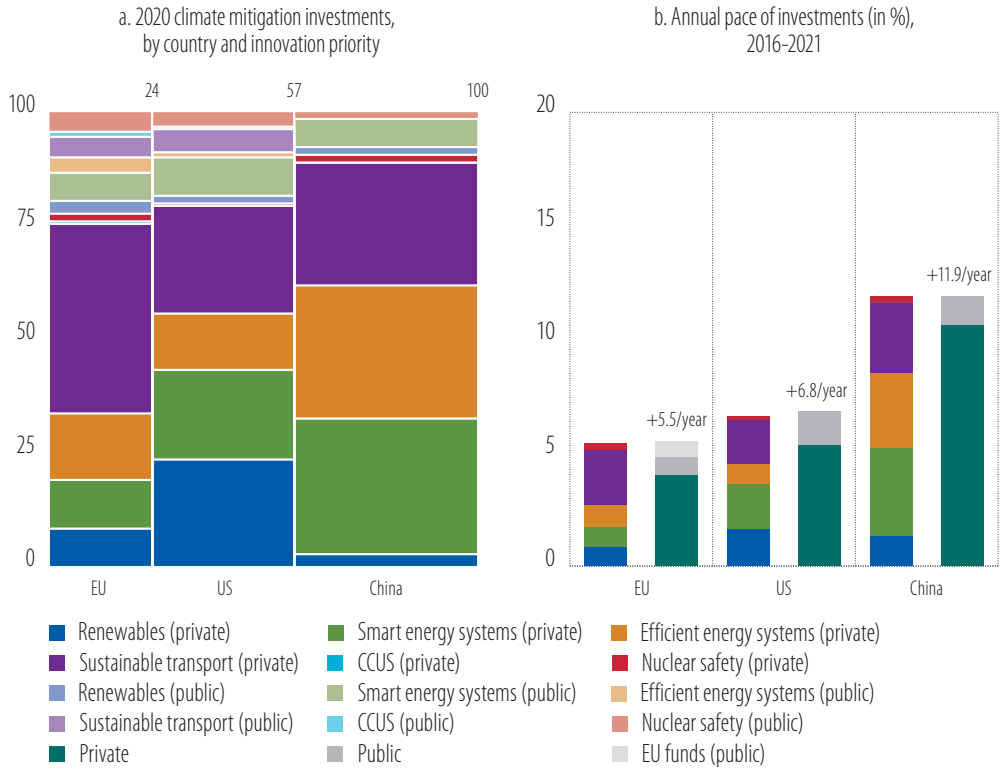
European R&D is particularly strong in sustainable transport

Climate innovation investments were part of government response to the pandemic, and are again taking centre stage during the energy crisis. After a year of stagnation in 2020, R&D spending bounced back and increased by 16-17% in Europe, the United States and China. The United States and China consolidated their positions as R&D leaders. About 18% of climate investments in the United States are devoted to R&D. China, however, is catching up and has increased spending by an average of 12% annually over the last five years. With an annual budget slightly above EUR 32 billion in 2021, Europe's support for climate innovation is losing some ground to its competitors (OECD, 2022). Preliminary estimates for 2021 R&D spending suggest a strong increase in sustainable transport in Europe, favoured by the Recovery and Resilience Facility. The transport sector was a key beneficiary of public spending on R&D in 2021 (+44% relative to 2020), in contrast with overall R&D budgets and energy-related R&D budgets, which grew 6-7%.

Corporate R&D in Europe is concentrated in industries that were hit hard by the COVID-19 crisis, causing the drop in overall R&D activity in 2020. In 2020, 12% of climate mitigation investment went to R&D, 85% of which was provided by the private sector. Only Germany, Denmark and Austria had dedicated 0.3% or more of their GDP to R&D spending. In 2021, business R&D in Europe showed signs of recovery, growing at faster pace than before the crisis (OECD, 2022).

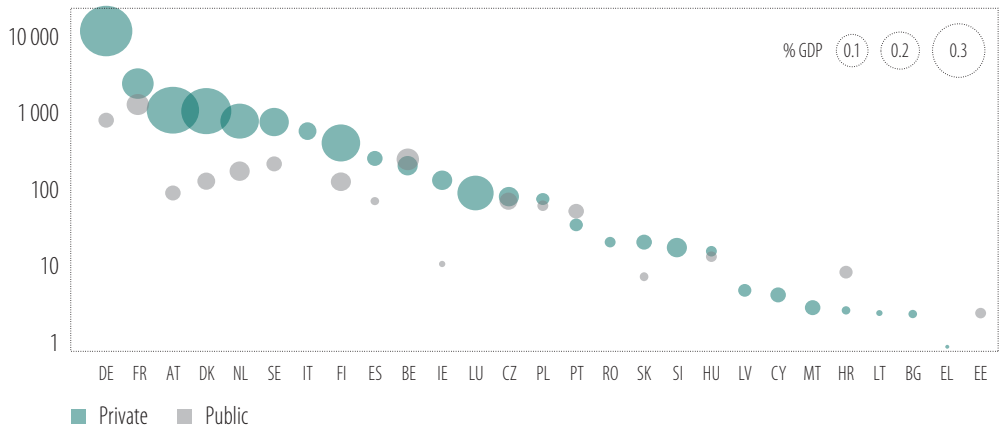
Patent data confirms the European priority of developing greener transportation and mobility, a key area shifting towards clean energy. 1.2% of the European patent portfolio (compared with 0.4% in the United States and 0.6% and China) is devoted to electric vehicles and the development of European supply chains, including manufacturing green materials and developing battery technologies and charging networks. Electrification and its enabling technologies — such as wind, solar, smart grids and fuel cells — are also the object of numerous European patent registrations.

Figure 35
Breakdown of climate mitigation investments, and annual pace of investments



Source: *Joint Research Centre.*
Note: *CCUS stands for carbon capture, utilisation and storage.*

Figure 36
Public and private R&D investments (EUR million) **in 2020, by country**



Source: *Joint Research Centre.*

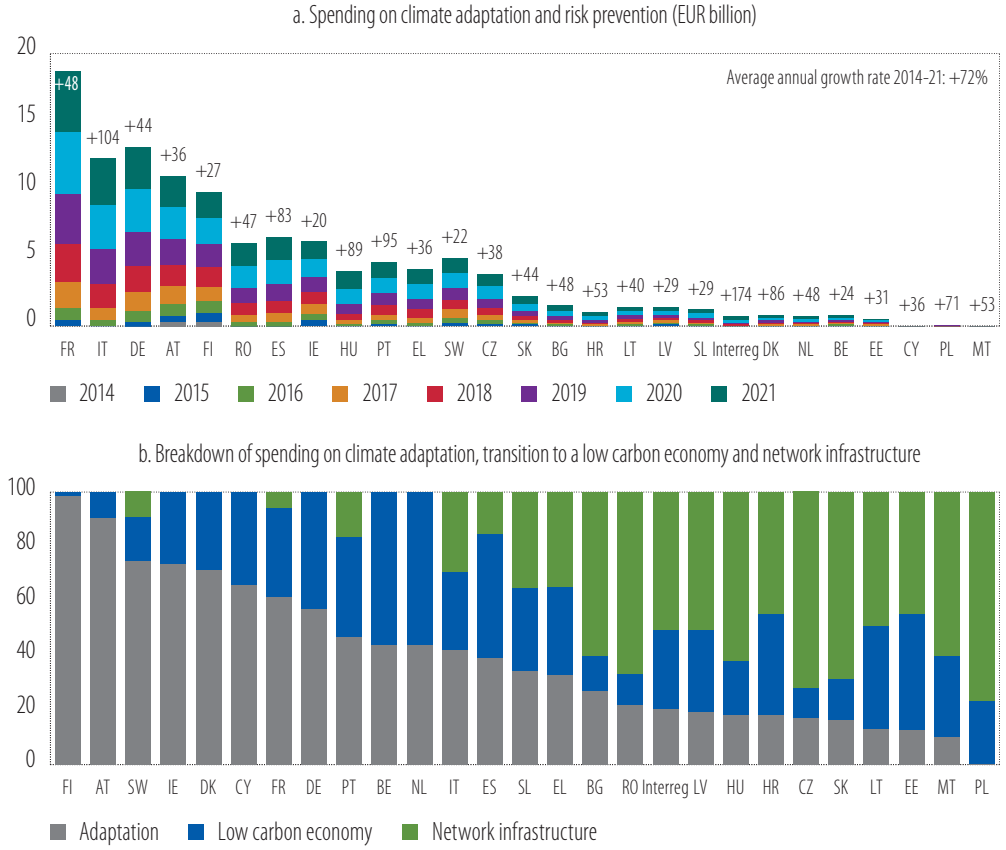
Financing of climate adaptation is gradually rising

The financing gap between climate mitigation and climate adaptation is closing only very slowly. Investors and decisionmakers are showing increasing awareness — and concern — about the economic and social impacts of climate change on livelihoods and economic activity. Rating agencies, banks and insurance companies are developing novel science-based methodologies and location-specific assessments to assess actual exposure to current and future climate risks. Yet, the global volume of investments devoted to adaptation projects accounts for less than 10% of global annual spending on climate (Climate Policy Initiative (CPI), 2021; United Nations Framework Convention on Climate Change (UNFCCC), 2021).

Financing from European structural and investment funds is growing for climate adaptation and risk prevention. The cumulative volume of investments grew yearly by 72% since 2014, reaching nearly EUR 120 billion. However, France, Italy and Germany alone accounted for one-third of total spending, and stark differences remain between EU countries (Figure 37). Until now, the bulk of adaptation funding was allocated to risk management measures in the agricultural and forest sectors. The climate resilience of infrastructure, which is often of national strategic importance and a pillar of economic activity, remains largely underserved. Adaptation funds are now on a par with spending on the low-carbon economy and the development of network infrastructure, but they mainly target Western European countries. The development of network infrastructure remains a priority in Central and Eastern European countries (chiefly Poland) to the detriment of adaptation measures and despite the region's acute exposure to future climate risks.

Figure 37

Spending on climate adaptation, risk prevention and the transition to a low-carbon economy



Source: *European Structural and Investment Funds.*
Note: *Numbers above bars in panel a show cumulative increase since 2014.*

Conclusion and policy implications

Investment in the European Union has come under serious pressure following a string of unfavourable developments. High energy prices are increasing inflation, directly and through second-round effects, as producers pass the rising costs on to their customers. This erodes real incomes and slows down aggregate demand, which in turn leads to lower investment. At the same time, a persistent and large gap in productive investment and in innovation between the European Union and the United States threatens to widen the productivity gap. Investment in innovation, intangible capital and advanced machinery and equipment is fundamental to enhancing productivity growth. The failure of many EU members, particularly in Southern Europe and in Central and Eastern Europe, to increase investment in these assets holds down productivity in their economies.

The surprising resilience of government investment might be threatened by the reintroduction of fiscal rules and the phasing out of stimulus measures. Government investment has been increasing over the past two years, fuelled by fiscal stimulus programmes and unfettered by EU fiscal rules. In some countries, particularly in Southern Europe, the rebound came after years of depressed levels of government investment. While the Recovery and Resilience Facility continues to provide a solid boost for countries that deliver on promised reforms and projects, investment momentum needs to be maintained if Europe is to secure its energy supply and facilitate the digital and green transition.

Using national and Recovery and Resilience Facility resources hinges on improving capacity. Available funds and implemented reforms are no guarantee of investment. Significant investment barriers impede the rollout of projects, including those in national recovery and resilience plans. Furthermore, the ability of local and national governments to identify and implement projects is uneven across the European Union and within countries, which also leaves available finance unused. Concerted policy effort, possibly coordinated at the EU level, is needed to address these obstacles to government investment.

Europe may be ahead in certain innovative domains, such as green innovation, but European policymakers must be vigilant to maintain dominance. Europe may find it difficult to remain on top in the areas in which it currently excels, particularly given the strong positions of the United States and China in the development of new digital technologies. The European Green Deal and the European Union's digital strategy are central to the recovery plan for Europe. Combined with the national recovery and resilience plans, these initiatives present a unique opportunity to transform the EU economy and make it greener, more digital and more innovative. European policies should also internalise the policies of other major economies. The US Inflation Reduction Act, for instance, raises concerns about whether the playing field in innovation will remain level, especially climate-related innovation. Such a lack of international policy coordination, especially among partner countries, threatens the openness of trade.

The European Union's current innovation strengths are just one step in the process, and policy intervention is needed to create, develop and roll out innovation quickly enough and at the right scale. It is especially important that the policy instruments — carbon pricing, regulation and public support for clean R&D — be deployed simultaneously and in a coordinated manner, as this would allow major synergies to be exploited. 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 to develop technologies (such as hydrogen and carbon capture and storage) that Europe needs to reach carbon neutrality.

Policy coordination at the EU level is needed to address mounting downside risks to investment. Investment in the European Union is stifled by impediments that must be addressed, mostly through national policies and EU coordination. At the same time, EU members should strengthen project implementation capacity, especially at the local government level, so that allocated financing reaches the most urgently needed projects and is used efficiently. Targeted government investments must leverage the complementary abilities of the public and private sectors to boost private investment. Policies at the national and EU level that address high economic uncertainty are also crucial. Coordinating all these policies at the EU level would ensure an efficient and effective use of resources by creating synergies. EU level responses to the pandemic worked effectively, and they could provide guidance going forward.

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Chapter 3

A corporate sector buffeted by shocks

The COVID-19 crisis was followed by a very sharp rebound in economic activity. By the first half of 2022, economic activity in the European Union had rebounded to well above pre-crisis levels, but activity was still below the trend expected before the pandemic. The gap of expected output was shrinking with the economic recovery, but the Ukraine crisis reduced growth, and the gap is now expected to enlarge. At the same time, the economic performance of EU countries is fluctuating widely.

While governments and EU policies supported the recovery in investment and shielded companies, pockets of vulnerability have developed. The policy support deployed during the COVID-19 crisis was unprecedented and multifaceted. The strong response protected businesses and paved the way for a fast recovery. Before the war, governments had begun to debate how to phase out this support amid strengthening economies. Now, new areas of weakness are emerging. While bankruptcy levels remain surprisingly low overall, they have started to rise in the sectors most affected by the pandemic. At the same time, many companies have yet to repay the government-guaranteed loans issued during the COVID-19 crisis.

Corporate investment is facing major, interconnected headwinds. Chief among them are the harsh rise in borrowing costs and disruptions caused by the war in Ukraine, including the energy shock, huge uncertainty and trade disruptions. With inflation surging, monetary policy has entered a cycle of rising interest rates, and credit standards have tightened. This has hit firms financially. After years of low rates and abundant liquidity, investment could suffer. Its ability to absorb higher borrowing costs is unknown. The war in Ukraine is also pushing up production costs (especially for energy and raw materials), lowering profits and weakening the liquidity of companies in the most energy-dependent sectors.

It is paramount that the adverse economic situation does not derail the recovery in investment. Rising costs, reduced demand and more restricted access to credit make it more difficult for businesses to invest. Increased uncertainty cannot be allowed to cause financial fragmentation among EU countries. Credit must continue to flow between countries. Maintaining confidence in the integrity of the common market is vital to preventing liquidity and funding sources from drying up in many regions.

Beyond the short- and medium-term challenges, the political agenda must continue to focus on long-term goals. With the green and digital transition in full swing, investment needs remain high. Restricted access to finance will weigh on the twin transition and societies' welfare, hampering investment in several countries and for certain assets. To maintain investment momentum, Europe needs to continue to make progress on integrating its financial system. A more integrated and developed financial system will, in turn, support the far-reaching twin transition to more green and digital economies.

Introduction

This chapter focuses on European companies, their resilience and the risks to their future investment from the challenging post-COVID-19 economic environment (with sharp monetary policy tightening and an ongoing energy crisis). Policy support enabled firms to navigate the COVID-19 crisis better than feared and corporate investment reacted less to the collapse in economic activity than might have been expected. This chapter reviews the major developments in corporate investment and financing in the European Union, with a view to assessing corporate vulnerability and challenges and gauging the likely impact on capital expenditure.

While the pre-war picture was generally positive, uneven trends among sectors and types of firms were already materialising. Policy support had been very successful in supporting the recovery. However, vulnerability had increased. It was far from clear whether the recovery was self-sustained. Following the Russian invasion of Ukraine, new types of vulnerability have emerged and economic forecasts have been revised downwards. This chapter analyses these new types of vulnerability and quantifies their unequal impact on economic sectors and EU countries.

The chapter consists of three sections and three boxes. The first section delves into the strong post-COVID-19 recovery. It includes a box providing new evidence on the uneven impact of the COVID-19 crisis on different firms. The second section shows how monetary policy tightening and the war in Ukraine are increasing firms' vulnerability. In this clearly adverse investment environment, maintaining confidence is key to avoiding financial fragmentation across the European Union. The third section focuses on the structural features of the EU financial system, the specific conditions faced by small and medium-sized enterprises (SMEs), non-bank finance and overall integration. It reviews the main findings of the EIF Private Equity and Venture Capital Survey. It shows why public intervention is required and why progress on Europe's capital markets union cannot be delayed. The first box in this section reviews estimates of credit gaps obtained from the Enterprise Survey. The second box shows how public financial instruments, such as guarantees or venture debt, crowd in investment in specific firms or specific assets.

A steep but short-lived recovery between two major crises

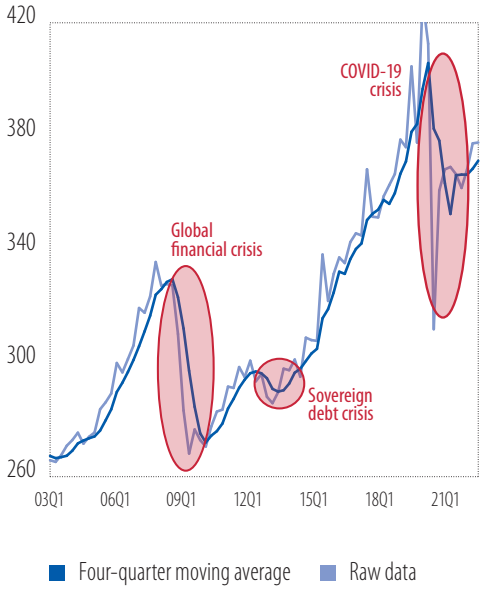
Firms have been less scarred by the pandemic than previously feared. On the back of strong policy support, internal funding sources remained resilient, while external funding continued to flow abundantly. This enabled firms to stockpile financial resources at the beginning of the crisis and paved the way for capital expenditure to rebound strongly later on. Looking ahead, information extracted from the EIB Investment Survey (EIBIS) shows that external financing sources are expected to dry up as public guarantees expire and the environment becomes more adverse.

Policy support protected firms and laid the groundwork for a sharp investment rebound

The recovery in corporate investment began in mid-2021, and it was still in full swing when the energy crisis hit. In real terms, corporate investment was 20% higher in the fourth quarter of 2019 than in the third quarter of 2008 (before the global financial crisis) (Figure 1). During the COVID-19 crisis, however, corporate investment pulled back sharply. It eventually bottomed out at the beginning of 2021, declining to 13% below its pre-crisis level, a fall comparable to the global financial crisis. Investment then started to recover, but by the second quarter of 2022, annual flows were still 6% below levels recorded during the fourth quarter of 2019. The changes are less dramatic when Ireland is removed from aggregate figures for the European Union.[1]

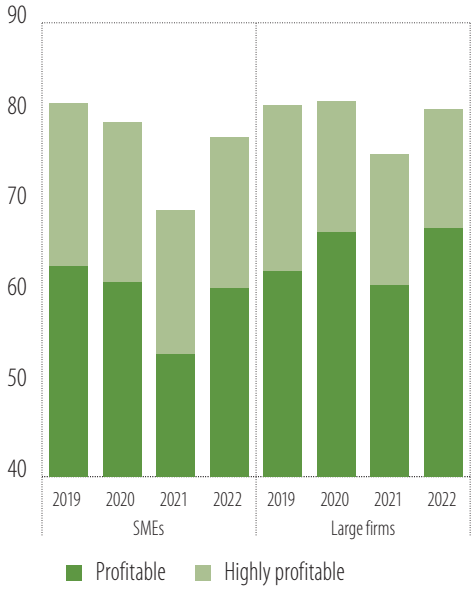
1 Prior to the crisis, European investment was boosted substantially by the repatriation of investments in Ireland (see Chapter 2 in EIB, 2022d).

Figure 1
Real corporate investment (real terms in 2005 euros)



Source: *EIB staff estimates based on Eurostat data.*
Note: *The most recent record is the second quarter of 2022. Seasonally and calendar adjusted data.*

Figure 2
Share of profitable firms (in %)



Source: *EIB staff estimates based on EIBIS 2019-2022.*
Question: *Did your company generate a profit before tax? Firms are defined as profitable if profits are below 10% of turnover, and highly profitable if above.*

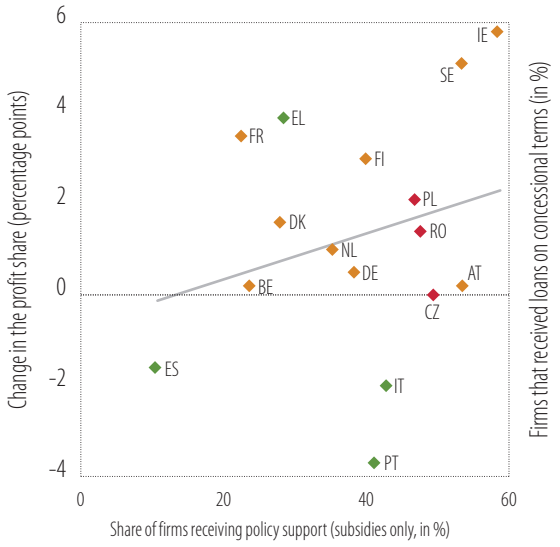
The share of profitable companies recovered in 2022 and was slightly below pre-crisis levels for SMEs and large companies. Figure 2 shows the share of profitable companies surveyed in the EIBIS. This share is normally relatively stable, but it fell sharply during the COVID-19 crisis (by 8 percentage points for SMEs and 6 percentage points for larger firms). Each category recovered, but only partially, filling around three-quarters of the gap created by the crisis. In 2022, 80% of European firms were profitable.

Stronger policy support was associated with a quicker recovery in the share of firms making a profit. Figure 3 associates the rebound in profits (using as a proxy the change in the share of firms making a profit before the crisis) with the share of firms that benefited from policy support in each EU country.[2] In most EU countries, the profit share is above pre-crisis levels. However, there is major disparity between countries, particularly those in different regions. The profit share is well above pre-crisis levels in all countries in Central and Eastern Europe, but this is not the case for most countries in Southern Europe (Italy, Portugal and Spain).

The COVID-19 crisis stretched the distribution of firms' sales growth (Box A). Weaker firms suffered slightly more from the COVID-19 crisis. At the same time, policy support was allocated to firms that were hit particularly hard, which appear on the lower and upper quantiles of the growth distribution, showing that support was somewhat targeted. Interestingly, digitalisation helped firms resist the crisis, with a small sample of fully digitalised firms seeming to have suffered less from the COVID-19 shock across all levels of sales and employment growth (all quantiles).

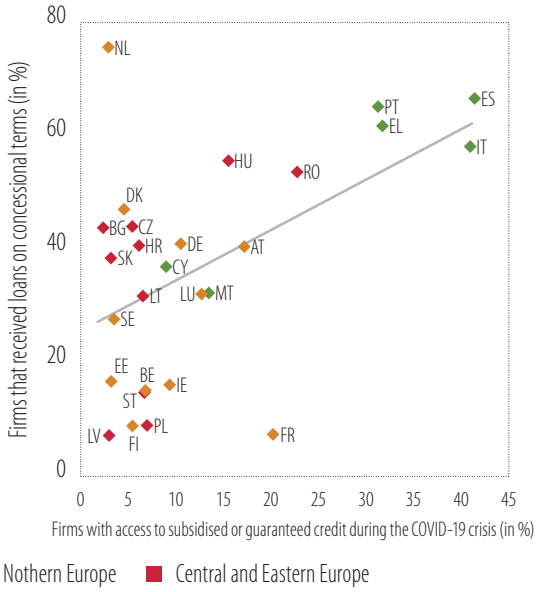
2 The profit share is obtained as the ratio of entrepreneurial income to the value added of non-financial corporates. The change in the profit share relates to the first quarter of 2022 (moving average of four quarters) to 2019.

Figure 3
Intensity of the pandemic-related policy support and rebound in profits



Source: *EIB staff estimates based on EIBIS 2021 and Eurostat profit data.*
Note: *Only subsidies are considered to be policy support.*

Figure 4
Pandemic-related policy support and concessional lending



Source: *EIB estimates based on EIBIS 2022.*
Question: *X-axis: Since the start of the pandemic, have you received any financial support? Answer A. Access to new subsidised or guaranteed credit that will need paying back in the future but may have preferential treatment. Y-axis: The share of firms that received loans on concessional terms among those that borrowed from bank loans in 2022.*

A substantial share of firms was still receiving pandemic-related support in mid-2022. When the EIBIS was conducted in the middle of 2022, one-sixth of the firms that got help during the crisis were still receiving support. Around 60% of firms received support according to EIBIS 2021, meaning that one in ten European firms were still receiving some type of help in 2022.

Much pandemic-related policy support came in the form of loans with a concessional component — in other words, better terms than the market was offering. Figure 4 plots the share of firms that were able to access subsidised or guaranteed credit as part of the pandemic response, together with the share of firms reporting that they received access to loans on concessional terms. The shares vary widely among countries, ranging from 3% to 42% of firms with access to pandemic-related policy support and from 8% to 76% for loans on concessional terms. The positive slope of the line shows that the two elements go hand in hand.[3]

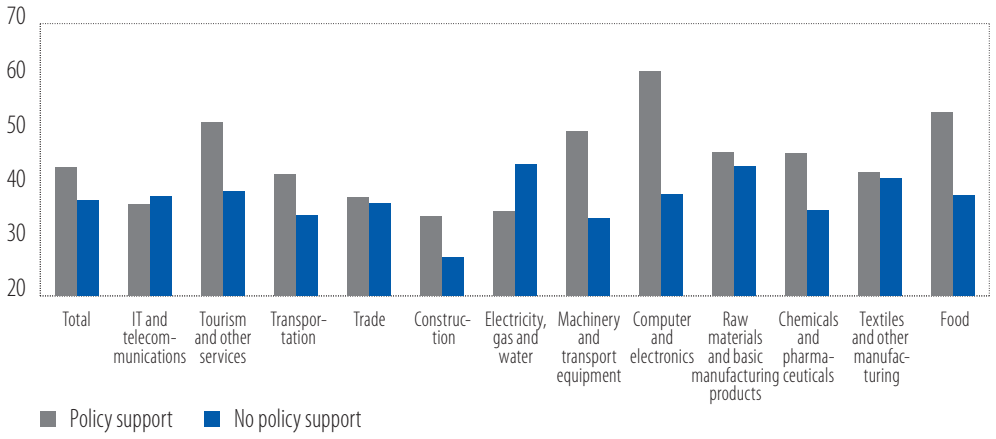
Firms benefiting from policy support tended to increase investment to a greater extent. Figure 5 shows the share of firms expecting to accelerate investment in the different sectors of the European economy. In most areas, firms that benefited from policy support were more likely to accelerate investment than those in the same sector that did not receive support. In the overall economy, the difference is 8 percentage points. This is consistent with earlier evidence of the positive impact of the policy support

3 The sample on which the share is computed changes, meaning that the correlation is not perfect. The share of loans at concessional rates for firms that benefited from bank loans is higher than the share of firms that benefited from guaranteed or subsidised credits in the overall population of firms. This also includes firms not using external finance and/or not using bank loans for borrowing.

(EIB, 2022d). Using more sophisticated techniques, Harasztosi et al. (2022) showed that among firms losing similar amounts of money, supported firms planned to raise investment more than unsupported firms. The difference is especially marked for companies whose sales declined heavily. In the computer and electronics sector, more than 60% of firms expected to expand investment after having benefited from policy support, around 20 percentage points more than those that did not receive such support.

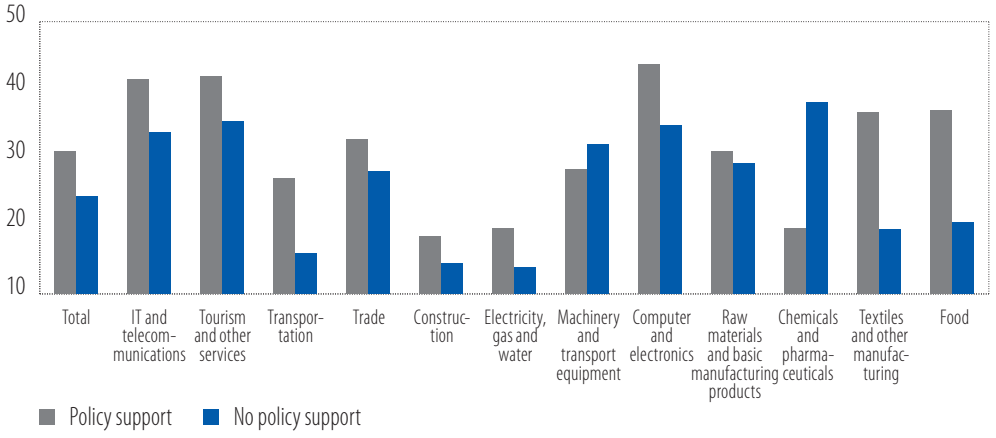
Supported firms have more ambitious investment plans (Figure 6). Moreover, the share of firms investing in the development of new products is higher for those that received support. In the overall economy, the average difference is 9 percentage points.

Figure 5
Share of EU firms accelerating investment (in %)



Source: *EIB staff calculations based on EIBIS 2022.*
Question: *For the current financial year, do you expect your total investment spending to be more than last year?*

Figure 6
Firms investing to develop new products (in %)



Source: *EIB staff calculations based on EIBIS 2022.*
Question: *And as a response to the COVID-19 pandemic, have you taken any actions or made investments to develop new products, services or processes?*

While subsidies can have a sizeable effect on the investment of finance-constrained firms, this impact can be short-lived. Focusing on the case of Hungarian firms, Goel et al. (2022) assess the effects of subsidies that did not need to be paid back on financially constrained and unconstrained SMEs. Using

bank queries to identify firms that applied for but did not receive a loan, the authors show that credit constraints may reflect other shortcomings, such as an absence of good management or viable projects.

Box A

Where did COVID-19 hit the hardest?[4]

The COVID-19 shock had a strong negative effect on aggregate economic performance, with the average firm taking a hit to its sales and financial performance. Little, however, is known about how the crisis affected firms depending on their characteristics. How did it distort growth? Were the firms that struggled most before the pandemic hit the hardest? Or did the COVID-19 shock disproportionately affect tomorrow's superstars — firms at the upper end of the sales distribution — thus hurting future growth?

This box analyses how COVID-19 support packages affected firms, sorting them by their pre-crisis sales performance. It is commonly assumed that negative macroeconomic shocks will hit poorly performing firms especially hard, while high-performing firms are more viable and therefore less likely to close (Kozeniauskas et al., 2022). The exit of poorly performing firms can stimulate the economy if the freed-up resources are reallocated to better-performing firms, but the reallocation process may be very long when a very large share of firms fail. During the COVID-19 crisis, policy support was deployed to prioritise speed over targeted support (Cirera et al., 2021). However, the firms most in need were more likely to receive support, suggesting that some targeting took place.

A subsample of digitalised firms was also included in the analysis to reflect concerns that the shock could have hit high-potential firms at the upper end of the sales growth distribution. For example, the COVID-19 crisis could have been particularly damaging for firms that made high-risk innovative investments to expand their capacity, only to be confronted with lower demand. The pandemic also could have been more damaging for high-growth firms (those in the upper quantile of the growth distribution), particularly since evidence suggests that seed money and early-stage financing were more affected by the COVID-19 shock than late-stage deals (Benedetti Fasil et al., 2021).

Quantile regression was used to perform an in-depth assessment of these effects. This analyses the effect of the COVID-19 crisis on the distribution of firms' growth rates for the whole sample, as well as for subsamples of firms receiving policy support and subsamples of digitalised firms. The impact of the COVID-19 crisis on firm outcomes was estimated using:

$$GR_i = a + \beta_\theta COVID_i + \varepsilon_{\theta i} \quad (1)$$

Where the quantile regression coefficient β_θ varies over the conditional quantiles θ (over the quantiles of ε_θi). [GR]_i corresponds to growth of sales.

Our results show that the crisis negatively affected firms across the distribution of sales growth, and that the impact on lower quantiles was slightly larger. This means that COVID-19 hit the sales of declining firms harder than growing firms (Figure A.1, blue line). Moreover, the subsample analysis shows that the pandemic affected firms receiving any type of policy support more strongly, especially in the lower quantiles. The coefficients are larger for firms that received policy support. The coefficients are about twice as large for declining firms (for example, coefficients of about -0.40, compared to coefficients of about -0.15 at the lower quantiles of Figure A.1). This confirms that policy support was targeted at least to some extent, and went to those most in need (Harasztosi et al., 2022).

4 This box is based on the forthcoming working paper Coad et al. (2023).

More digital firms resisted the shock better. Digitalised firms seem to have suffered less during the pandemic, presumably because online business models could better adapt to the sudden shift to social distancing and lockdown measures. Firms that have incorporated digital technology to a substantial degree (reporting that they have organised their entire business around it) appear to have been immune to the negative effects of the pandemic, especially at the higher quantiles in the distribution of sales growth (Figure A.2).

Figure A.1
COVID-19 impact on sales growth, all firms and those that received support

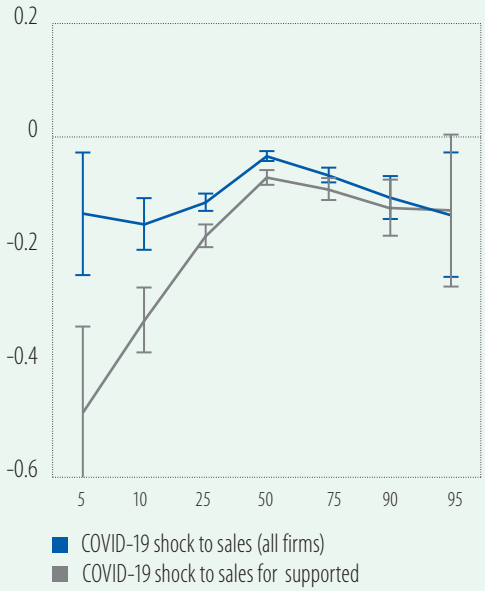
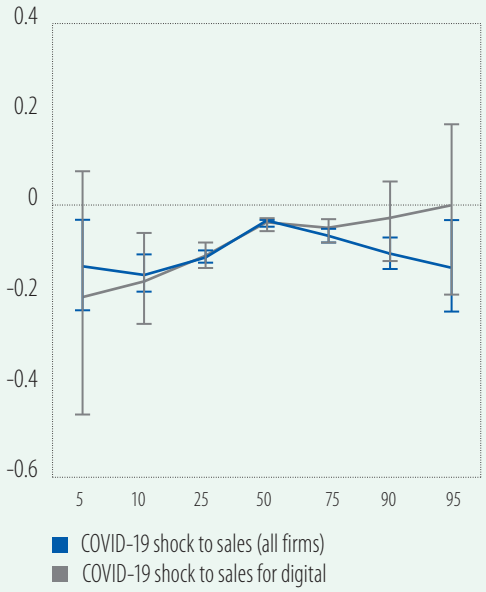


Figure A.2
COVID-19 impact on sales growth, all firms and digital firms



Source: *EIB staff estimates based on the EIBIS and Bureau van Dijk's ORBIS database. See Coad et al. (2023).*
Note: *Quantile regression results for equation 1. Sample of firms that implemented digital technology. The x-axis indicates the percentile distribution of sales growth. The y-axis indicates the COVID-19 impact on sales growth.*

During the COVID-19 crisis, investment contracted to a greater degree than profits, raising firms' net saving rates. Figure 7 shows the evolution of net borrowing over investment. The corporate sector is naturally a net borrower over time. However, an unusual pattern has unfolded in Europe since the global financial crisis, with investment falling short of corporate savings by around 10% across the European Union and by much more in Central and Eastern Europe[5], meaning that firms saved more than they invested in most years. Net corporate savings increased further during the pandemic and reached record levels in 2021, with non-financial firms increasing liquidity and capital buffers to better withstand future shocks. Since then, the strong rebound in investment has outpaced the growth in profits and, as a share of investment, net corporate savings have returned to averages seen after the global financial crisis.

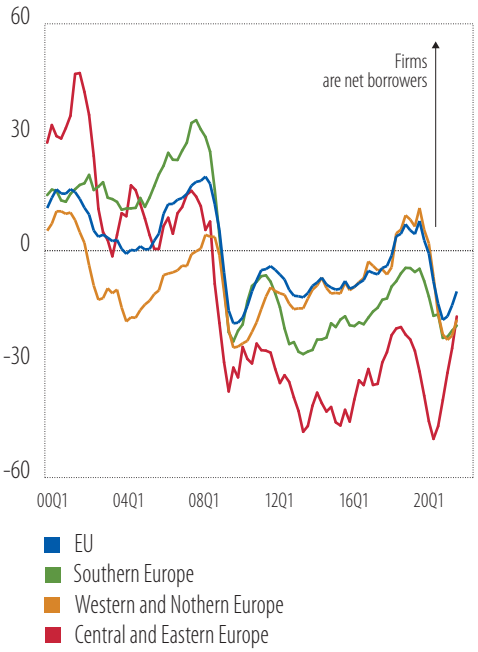
The strong rebound in corporate profits is unlikely to last

Profits have recovered strongly following the pandemic. Figure 8 shows how profits evolved during the global financial crisis and the COVID-19 crisis, two major episodes. While profits slumped comparably during each event, activity collapsed to a greater extent during the COVID-19 crisis. Strong policy support,

5 These dynamics reflect a range of factors which have curbed investment and spurred savings (EIB, 2020).

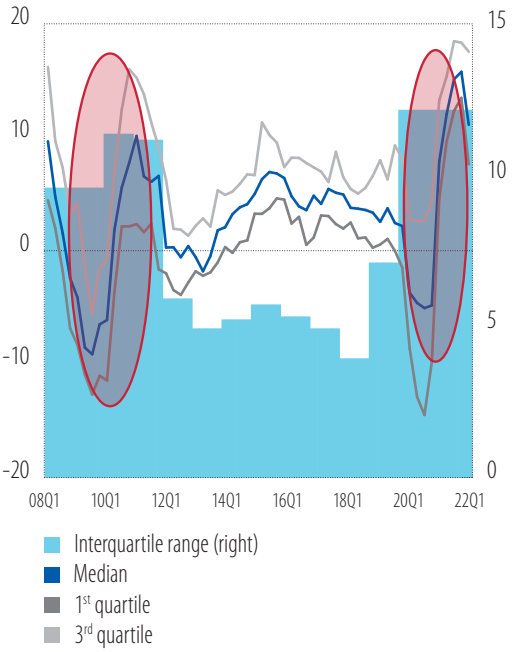
however, meant that profits shrank less than would be expected considering the decline in activity. Starting in the second half of 2021, profits rebounded at an unprecedented pace, from a contraction of 8% in the first quarter of 2021 to 15% growth one year later.

Figure 7
Net borrowing as a share of investment (in %)



Source: *EIB staff calculations based on Eurostat.*
Note: *Last record available is the second quarter of 2022. Non-financial corporate sector only.*

Figure 8
Growth in entrepreneurial income and dispersion (annual growth, in %)



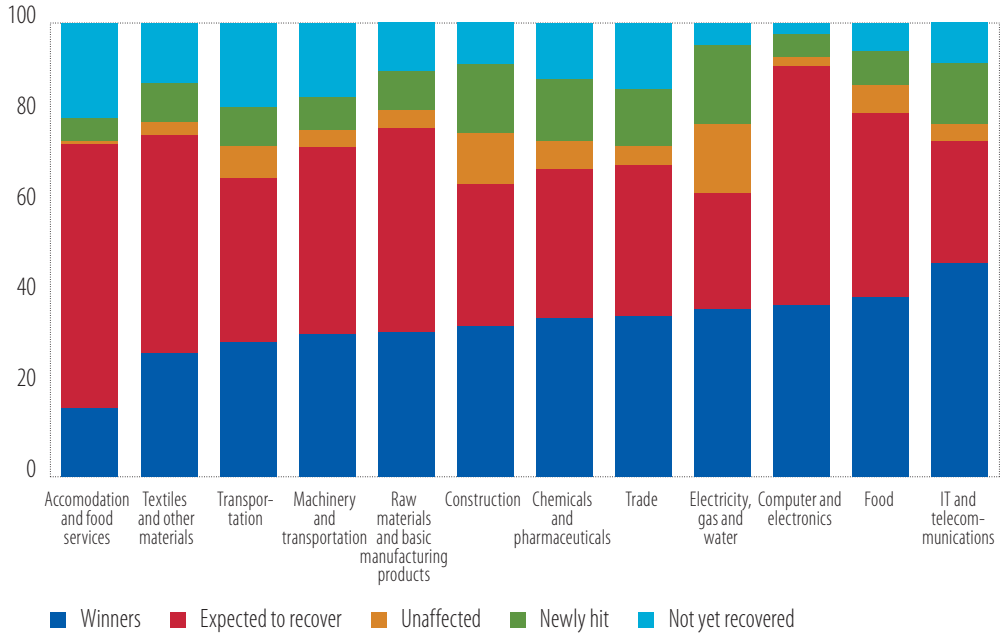
Source: *EIB staff calculations based on Eurostat.*
Note: *Last record available is the second quarter of 2022.*

A specific EIBIS question is used to assess the pandemic's impact on sales. Chapter 2 separates firms into five groups depending on the evolution of profits since 2019: the winners, those expected to recover, the unaffected, the not yet recovered and the newly hit.[6] For one-third of firms ("winners"), sales never declined one year to the next, and those firms actually expected sales in 2022 to be higher than before the pandemic. For 38% of firms, sales were hit but were expected to return to 2019 levels in 2022. The pandemic barely affected 11% of firms, but those firms expected sales to be depressed in 2022. These firms were not (yet) showing other signs of distress. Nearly 13% of firms did not expect to recover from pandemic-related losses in 2022.

The COVID-19 impact was clearly borne out in all sectors. Figure 9 reports the share of companies falling into each of the five categories for 12 sectors. COVID-19 had a particularly pronounced effect on contact-intensive services sectors such as transportation, accommodation and food services. At the other end of the spectrum, the effect was benign or even positive for computer and electronics, as well as for IT and telecommunications (EIB, 2022). Figure 9 confirms this finding, showing that there were fewer "winners" in the service and transport sectors than in IT and telecommunications.

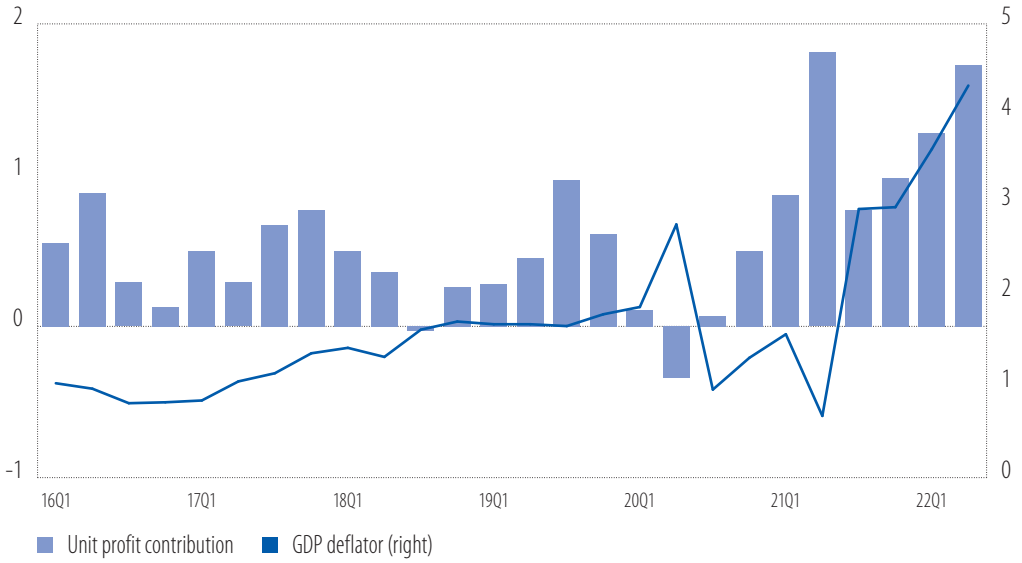
6 See Chapter 2 for more details on the classifications of the firms according to their profit evolution since 2019.

Figure 9
Firms' share of sales in different sectors compared to before the COVID-19 crisis (in %)



Source: *EIB staff calculations based on EIBIS 2022.*

Figure 10
Contribution of firm profits to inflation (left axis: contribution in percentage points; right axis: annual change in %)



Source: *EIB staff calculations based on Eurostat.*
Note: *Last record available is the second quarter of 2022. Prices are calculated using the value added deflator in the European Union. GDP stands for gross domestic product.*

Rising prices have buoyed firms' profits, but they have also fuelled inflation. Figure 10 shows the evolution of the value-added deflator and unit margins, which serves as a proxy for profits.[7] It appears that since the COVID-19 recovery, firms have been able to expand their unit margins amid strong demand. Until the middle of 2022, unit margins have continued to expand strongly, so that the impact of the energy crisis on profits has been contained.[8] Increases in costs have been passed on through selling prices, thereby mitigating the impact on firm margins and helping them to rebuild their balance sheets.

Companies will have to learn how to navigate an inflationary environment, as higher inflation is likely to persist. The short-term inflationary outlook is being driven by the strong post-crisis rebound and the energy crisis. However, several trends are likely to become more entrenched (Schnabel, 2022b), with increased market concentration, ageing, deglobalisation and the green transition potentially resulting in structurally higher inflation rates. As inflation intensifies, firms will begin to factor it into their development plans. Nonetheless, structural changes along with stronger policy frameworks and stable long-term inflation expectations make a return to stagflation less likely (Igana et al., 2022a).

Looking ahead, the EIBIS provides a bleak outlook for investment finance (especially external sources). Figure 11 shows firms' expectations regarding the internal and external capacity to finance investments. A negative number indicates that there are more firms expecting a deterioration than firms expecting an improvement. The figure shows that since 2016, firms have mostly been optimistic, with two exceptions: during the first year of the COVID-19 crisis, and during the last EIBIS wave in 2022. At these points, the net balances leaned mostly towards a worsening situation. After seeing an improvement during EIBIS 2021, firms now expect their financial resources to deteriorate. This is especially clear for external sources of finance.

Figure 11

Expectations regarding sources of finance over time and by type of firm
(net balance in percentage points)

Source: *EIB staff calculations based on EIBIS 2022.*
Note: *Net balance refers to the difference between the percentage of firms expecting an improvement minus and those expecting a deterioration.*
Question: *Do you think that each of the following will improve, stay the same, or get worse over the next 12 months? A. Availability of internal finance within the company (e.g. internal funds like cash). B. Availability of external finance (e.g. bank financing, private or public equity).*

7 The value-added deflator reflects the evolution of the price of one unit of goods consumed domestically. It takes into account changes in unit labour costs, unit taxes and unit profits.

8 In the euro area, the strong surge in selling prices has mitigated higher commodity prices and has boosted corporate profits in the sectors most heavily influenced by global demand (Schnabel, 2022a).

Abundant credit is likely to dry up

At the beginning of the crisis, borrowing enabled firms to pile up cash (EIB, 2022). Later, bank lending remained strong and started to fuel firms' capital expenditure. Debt levels increased during the pandemic as many governments helped maintain access to credit, but since companies had parked the resources in cash, net indebtedness did not increase overall (EIB, 2021). However, an increase in corporate debt may affect investment over the medium term (Albuquerque, 2021). The bank lending survey by the European Central Bank (ECB) indicates that inventories and working capital drove the surge in demand for bank credit from the beginning of the COVID-19 crisis until the middle of 2021. It is only from the first half of 2021 that business investment started to grow, and it remained strong until the first quarter of 2022.

In hindsight, the expected increase in non-performing loans proved overly pessimistic as the economy rebounded faster than expected (Enria, 2022). Average bank asset quality continued to improve, but the quality of loans supported by previous measures remains a concern (European Banking Authority (EBA), 2022). Banks reported a non-performing loan ratio of 1.9%, down from 2% in the previous quarter. A possible rise in non-performing loans could cause credit conditions to tighten. According to the bank lending survey, credit conditions started to tighten in the second half of 2021.

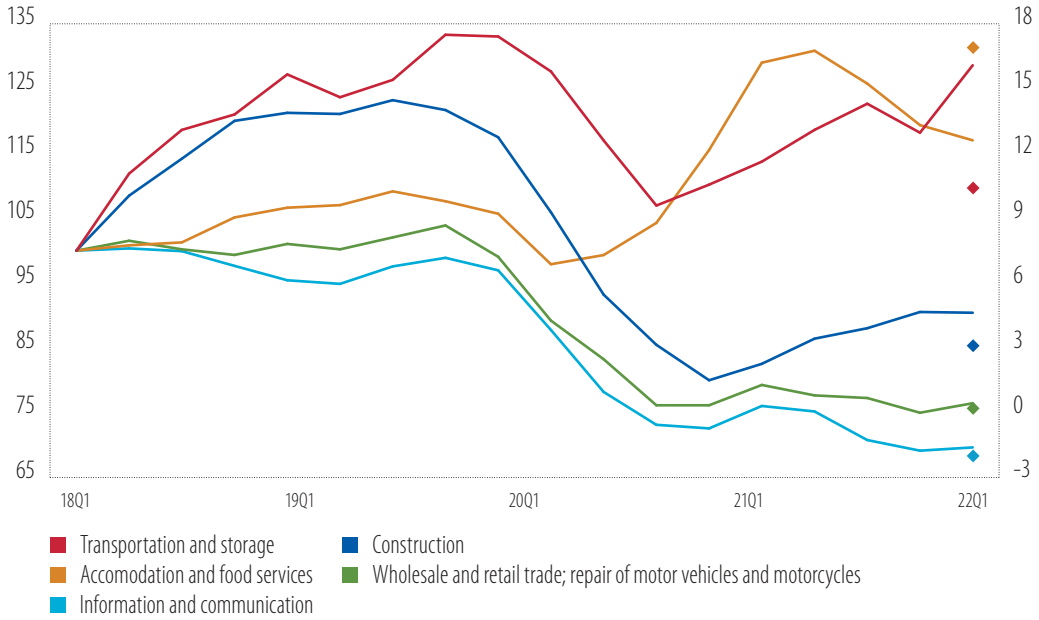
It is unclear how the unravelling of state guarantees for loans will affect credit. Figure 11 shows that expectations regarding external finance are somewhat more negative than those regarding internal profits. About 10% of firms continue to benefit from public support programmes being progressively wound down or transformed. While bankruptcies remain low overall, they could rise in the next few years, leading banks to tighten credit. Moreover, as interest rates rise, banks experience higher opportunity costs for maintaining credit to troubled firms. Finally, the rise in uncertainty also negatively affects the availability of credit.

Firm bankruptcies are clearly associated with expected losses from the COVID-19 crisis. Figure 12 breaks down the data by sector, plotting the evolution of bankruptcies since 2019 against the sales losses caused by COVID-19 in 2021. Bankruptcies clearly decreased in the sectors less affected by the crisis (such as wholesale trade), and in those that benefited from it (such as information and communication). Conversely, the most affected sectors (such as accommodation and food services and transport) recorded an increase in bankruptcies compared to before the crisis. Pockets of vulnerability are concentrated in the hardest-hit sectors (Albrizio et al., 2022; Archanskaia et al., 2022b). Analysis of individual countries also supports this conclusion (Cros et al., 2021).

Overall, a closer look at different economic sectors alleviates the concern that public support was too generous for firms during the COVID-19 crisis. As yet, there is no clear sign that support reduced the exit of unproductive firms and prevented Schumpeterian creative destruction. Archanskaia et al. (2022a) show that the COVID-19 shock adversely affected the financial health of not only low-productivity firms, but also high-productivity ones. This means that the broad-based policy support did not impinge on productivity by preventing firms from exiting the market. However, the pandemic leaves a legacy of highly indebted firms that do not all look alike, and it is important to improve insolvency and restructuring proceedings and scale up efforts to collect real-time data on firm balance sheets to better direct fiscal support to viable firms (Albrizio et al., 2022).

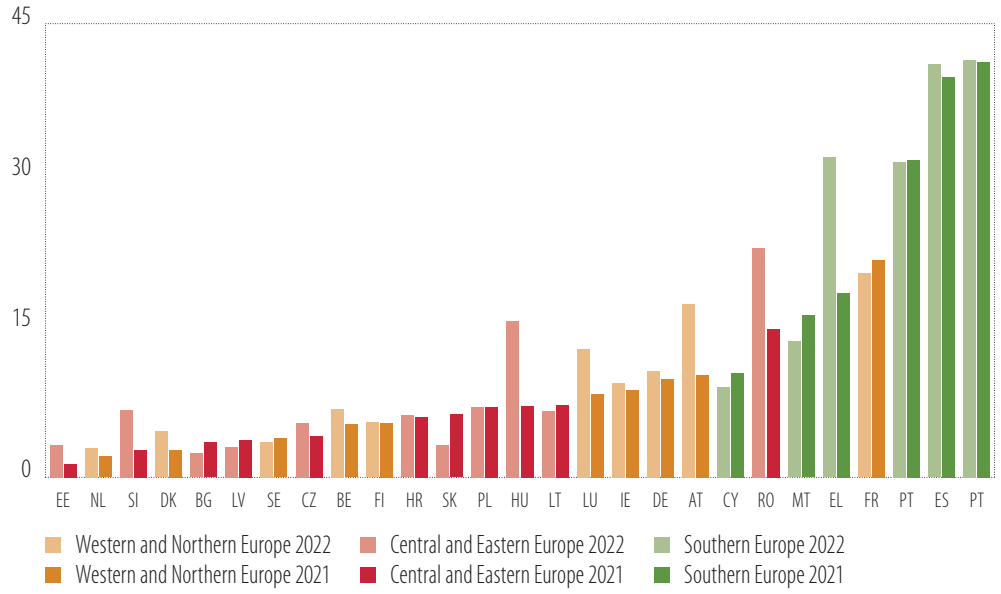
To compensate for firm exits and support economic growth, the number of new businesses being created must remain strong. History would suggest that more firms are created in upturns and more are liquidated in downturns. Yet the recent COVID-19 recession is somewhat at odds with this simplistic view. While most nations suffered a deep economic contraction, the creation of new firms followed very different patterns depending on the country. Spain, for instance, experienced a sudden halt in the creation of new firms, while France had a boom, even if output fell by comparable amounts in both countries. Kharroubi (2022) argues that growth expectations drive the creation of new firms. He finds that the economic outlook influences whether new firms enter the market, mainly because of the effect it has on public and private investment. This suggests that policies focused on increasing private and public investment can often help increase the number of new firms and improve business dynamism.

Figure 12
EU firms ceasing to operate (left axis: in %) **and expected losses related to COVID-19** (right axis: inverted scale)



Source: *EIB staff estimates based on Eurostat.*
Note: *See EIB (2021) for the expected losses related to COVID-19. The index of firms ceasing to operate uses a baseline of 100 reflecting the first quarter of 2018. The diamonds indicate the expected change in the share of firms losing money based on simulations done in 2021.*

Figure 13
Share of firms having benefited from subsidised or guaranteed credit (in %)



Source: *EIB staff calculations based on EIBIS 2021.*
Question: *Since the start of the pandemic, have you received any financial support? A. Access to new subsidised or guaranteed credit (loan, overdraft or credit card from a bank or other finance provider) that will need paying back in the future but may have preferential or reduced interest rates and/or an extended repayment plan.*

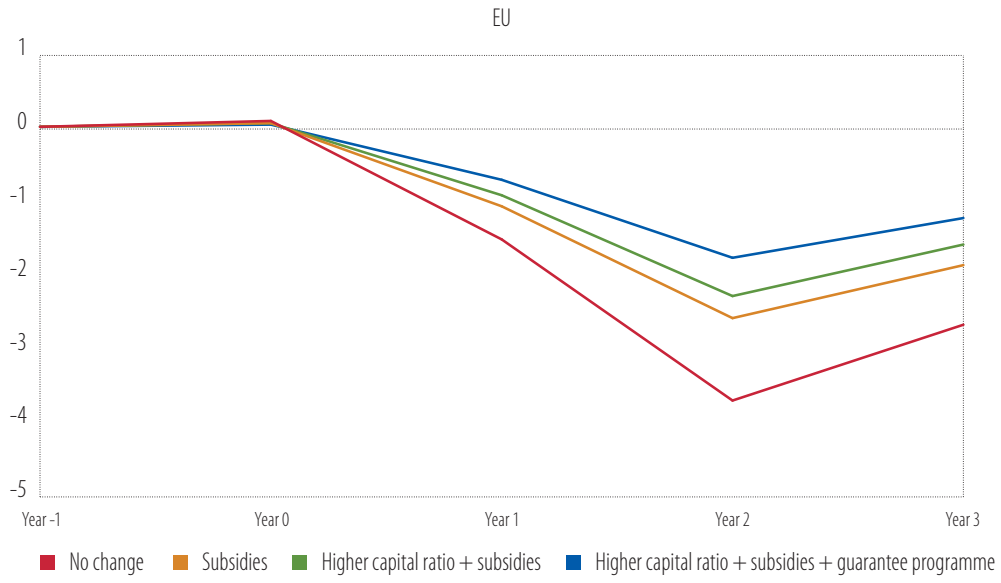
It is important to disentangle the different forms of support and to look at the various compositions. In Europe, about 60% of firms received support via at least one specific policy and 18% received public loan guarantees, helping to keep credit affordable for firms. Figure 13 shows that the nature of the support varies from jurisdiction to jurisdiction (guarantees were activated more in Southern European countries). EBA (2022) reports that in the euro area, the total volume of loans subject to public guarantees amounted to EUR 366 billion in the first quarter of 2022, with nearly 90% of public loan guarantees concentrated in three countries: France, Italy and Spain.

Higher capital ratios and public guarantees can help the flow of credit during crises. Bank-level information can be used to estimate how credit, particularly loans, react to a shock over time. The change in the ratio of non-performing loans can act as a proxy for the shock. Banks tend to lend less when their portfolios face higher risk. However, estimates show that loans are reduced by less when a bank's capital ratio is higher. The sensitivity of bank loans to risk is reduced when policy support comes largely from public guarantees, but it is unchanged when policy support is mainly deployed through subsidies.

The policy support deployed during the crisis is softening the deterioration in credit conditions. Figure 14 shows the change in credit supply growth from year zero (assumed to be 2022) to year four, following the gross domestic product (GDP) deviation from the trend in 2020-2021. A negative reading does not mean that loans are decreasing, but instead implies that bank credit is not supportive and holds back the issuance of new loans. Without policy support and with no change in capital ratios since the global financial crisis, the total loans issued from the start of the crisis until the end of 2023 would be almost 4% lower than in the three-year period before the pandemic. Subsidies alone dampened the impact, reducing it to slightly more than 2%. As banks were more capitalised, they were better able to withstand the crisis, although the impact of higher capitalisation was low. Cascarino et al. (2022) quantify the extent to which public guarantees created additional credit across programmes with different coverage ratios and over time. Credit was highest (around EUR 0.84 per EUR 1 of guarantees) for fully guaranteed loans originating in the first quarter of the programme (the second quarter of 2020).

Figure 14

Credit supply sensitivity to risk depending on absorption capacity and policy support



Source: EIB staff estimates based on the forthcoming work Álvares et al. (2023).

ECB measures to provide banks relief by reducing their capital requirements during the pandemic successfully supported the credit supply, and the measures did not result in banks taking on undue risk. Couaillier et al. (2022) found that while reduced capital requirements supported lending, allowing banks to operate below the Pillar 2 guidance had no significant impact on their lending behaviour.[9] Furthermore, banks appeared reluctant to draw on their existing capital buffers, implying that the positive effect of capital relief on lending was stronger for those with smaller capital reserves.

New sources of vulnerability

As explained above, corporate investment remained resilient until the middle of 2022, but companies now face a challenging environment. The prevailing monetary policy and the war in Ukraine are likely to hurt firms and reduce their capital expenditure, while many of them are still recovering from the COVID-19 crisis. Although in broad terms, the COVID-19 crisis hit contact-intensive sectors like services and transport while the war is affecting energy-intensive sectors, the fallout of the two shocks on countries varies greatly. Countries in Southern Europe were harder hit by COVID-19, while the war poses more serious problems for economies in Central and Eastern Europe. With a view to illustrating the importance of safeguarding confidence in European economies, this section introduces a scenario simulating a situation in which a loss of confidence increases financial fragmentation and triggers a funding crisis.

Firms face higher borrowing costs

Central banks embarked on a very abrupt cycle of monetary tightening in the first half of 2022. The sources of inflationary pressures differ on either side of the Atlantic, which explains why tightening started later in the euro area (when it became clear that the war in Ukraine would drive up energy prices over a longer period). Short-term rates in some Central and Eastern European economies have increased by far more than the 200-basis point rise in the euro area since July 2022. In addition to shifting the interest rate curve upwards, monetary policy tightening also steepened it. In December 2022, the shift up was around 300 basis points compared to the beginning of the year, an almost unprecedented rise in the euro area over such a short period of time.[10]

As already clear in the bond market, borrowing costs are set to rise. The sudden removal of accommodative financial conditions has fuelled a bearish bond market and 2022 was among its worst years ever. Figure 15 shows that since the start of 2022, corporate bond yields have increased by more than 300 basis points for 5-year debt. Since the global financial crisis, European firms have increasingly funded themselves by selling bonds (Andersson et al., 2022; Holm-Hadulla et al., 2022), but corporate debt issuance has been lacklustre since the start of 2021. It is almost at a standstill, with cash-rich firms preferring to dig into their pockets instead of paying high yields.

Premiums paid for risky debt have widened. Figure 15 shows that the spread between 5-year A and BBB debt has increased by 50 basis points, from 25 basis points to 75 basis points. This rise started at the beginning of the year, when it became clearer that central banks would start tightening monetary policy. Investors are effectively reassessing firms' ability to withstand much higher borrowing rates. After years of negative of very low market rates, firms must ensure they can sustain much higher borrowing costs. More heavily indebted borrowers are under pressure.

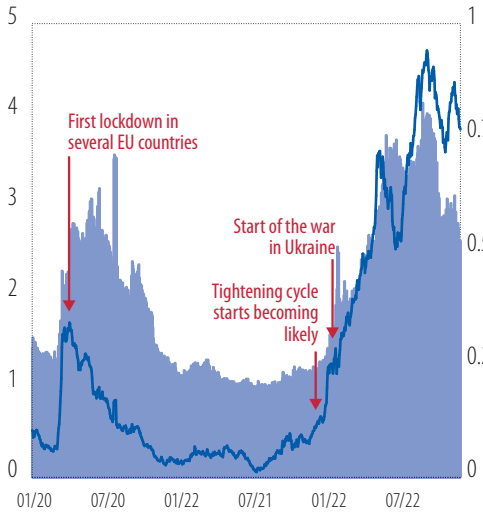
Financial conditions are tightening overall. Figure 16 reports an estimated index of financial conditions based on a large set of series related to financial prices and flows. Since the beginning of 2022, the index has risen as pressure on European financial markets has increased. Relatively accommodative conditions

9 The Pillar 2 guidance is a bank-specific recommendation that indicates the level of capital that the ECB expects banks to maintain in addition to their binding capital requirements. It serves as a buffer for banks to withstand stress.

10 See Chapter 1 for more details on monetary policy and financial markets.

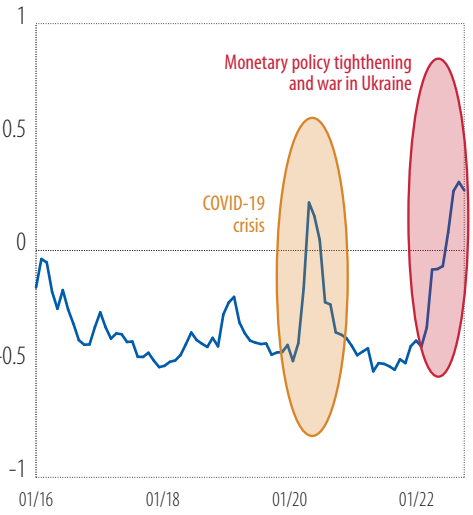
had tightened significantly by September 2022. This tightening is estimated to be stronger than at the beginning of the COVID-19 crisis. However, it comes after a long period of ultraloose financial conditions, and the index remains far below the high point recorded during the global financial crisis (0.4 vs. 2.4).

Figure 15
Corporate 5-year bond yield and A to BBB risk spread (left axis: in %; right axis: basis points)



Source: *EIB staff estimates based on Refinitiv.*
Note: *Last record available is August 2022.*

Figure 16
Financial condition index in the European Union (rise=tightening)



Source: *EIB staff estimates based on Andersson et al. (2021).*
Note: *Last record available is September 2022. An increase reflects tightening. The values are de-meaned over 2007-2022.*

Rising market rates have started to spread to corporate bank borrowing rates. Figure 17 reports the composite firm bank borrowing rates for the major euro area economies. These rates have remained comparable and almost unchanged since the start of the COVID-19 crisis, lingering at very low levels until the end of summer 2022 and rising sharply thereafter. Interestingly, the rates have remained similar for different countries, reflecting the flexible reinvestments of the maturing pandemic emergency purchase programme (PEPP) portfolio and the setup of the Transmission Protection Instrument, which ensures that monetary policy is transmitted smoothly across the euro area. However, rate hikes will feed into bank lending rates. Most empirical studies conclude that the rates will be fully passed on over time.[11] Given the prominent role of bank finance, higher rates will have a major impact on firms' external financing costs.

In contrast to previous episodes of financial tightening in the euro area, bond spreads have not yet widened significantly (Figure 18). Andersson et al. (2022) show that, when driven by a financial shock (such as during a crisis), tightened financial conditions hurt loan issuance and widen borrowing spreads for all countries and borrower sizes. However, this time the size spread (the spread between the borrowing costs for small loans and large loans) has not yet been substantially affected[12], and has remained in a very narrow range since the beginning of 2022.

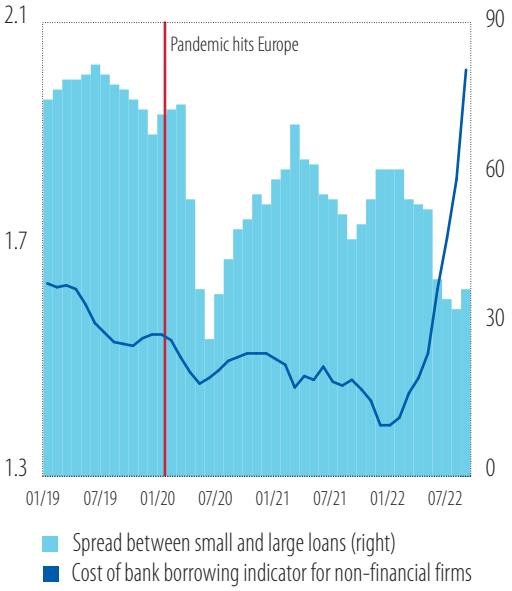
11 The length of the period depends on several factors specific to each country, such as the degree of competition in the banking sector, the share of loans at floating rates and/or their average maturity.

12 Small loans are those below EUR 250 000 and large loans those above EUR 1 million.

Figure 17
Cost of corporate bank borrowing (in %)

Source: *EIB staff estimates based on ECB data.*
Note: *Last record available is September 2022.*

Figure 18
Overall cost of borrowing and spread
(left: in %; right: in basis points)



Source: *EIB staff estimates based on ECB data.*

Further monetary tightening is likely to reinforce rate hikes. First, much of the analysis suggests that at the end of 2022, short-term rates were still below the terminal rate (the peak of rate hikes, estimated to hover above 250 basis points). Second, at the end of October, the ECB recalibrated the third series of targeted longer-term refinancing operations (TLTRO III) to strengthen its link with monetary policy tightening by indexing the interest rate on all remaining operations to the average applicable ECB interest rates. Finally, quantitative tightening (the unwinding of the asset purchase programmes) will also begin at some point. Each of these three measures will contribute to further monetary policy tightening.

The impact of war-induced price rises and demand shocks

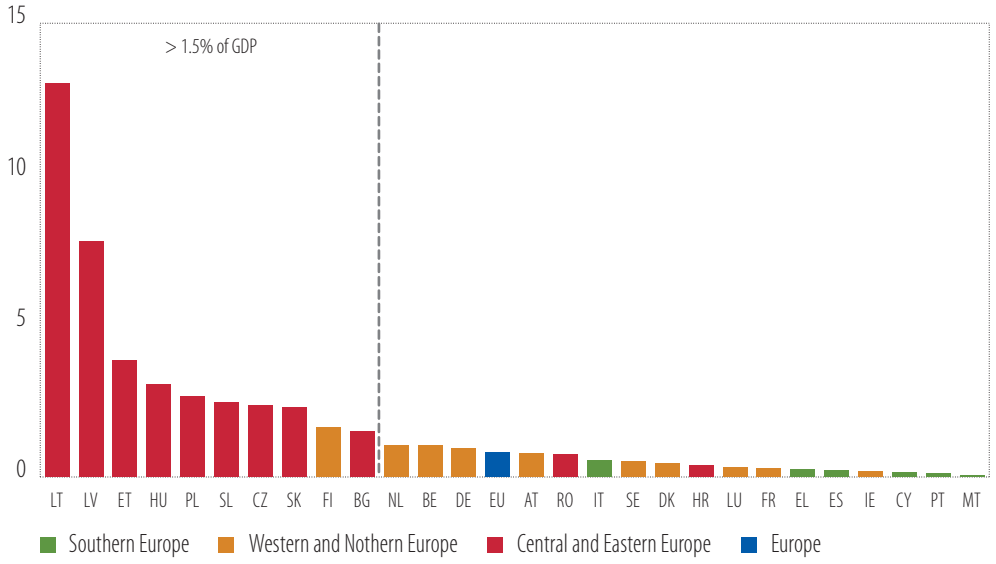
The war in Ukraine is directly destabilising EU firms by reducing exports and by raising prices for energy and commodities, which is likely to compress profits (EIB, 2022a). First, the war has led to a sharp reduction in exports to Russia and Ukraine, curtailing sales in these markets. Second, higher prices for energy and commodities are squeezing profits. The shock has spread unevenly among EU economies, due to differences in their export exposure, energy dependencies and energy mix.

Export exposure is generally low at the European level, although with large differences among countries. Since the beginning of the conflict, EU exports to Russia and Ukraine have declined by about 40%, but overall EU export exposure to Russia and Ukraine is low (around 1% of GDP in 2019). However, this exposure varies greatly from country to country. As shown in Figure 19, exports account for more than 1.5% of GDP in ten EU countries and well above 5% in Latvia and Lithuania. In general, countries in Central and Eastern Europe export more to Russia and Ukraine, while Southern Europe is much less exposed.

While EU energy dependence has declined, energy costs are still a major drag on companies' margins. As European economies have grown, they have become more service oriented. Since services sectors tend to be less energy-intensive, Europe's dependence is less pronounced (Bjornland, 2022). Technological progress and heightened concerns about climate change have also increased energy efficiency. Yet despite these developments, Europe remains a very large energy importer. Its energy bill, which was

EUR 330 billion in 2019, doubled in the 12 months up to August 2022, largely because of higher energy prices. Rising energy costs have historically been associated with declines in firm profits, as shown in Figure 20. When energy prices reached record highs in 2012, which were nevertheless far below current levels, firm profits declined dramatically. More recent signs of less pronounced energy dependency are reflected in strong pricing power of firms during the COVID-19 recovery, as explained above.

Figure 19
Share of exports to countries either sanctioned or involved in the Ukraine war, (2019, % GDP)



Source: *EIB staff calculations based on Eurostat.*

Figure 20
Energy prices and profit margin indicator (left axis: inverse scale, 2015=100; right axis: percentage point deviation from 2015)

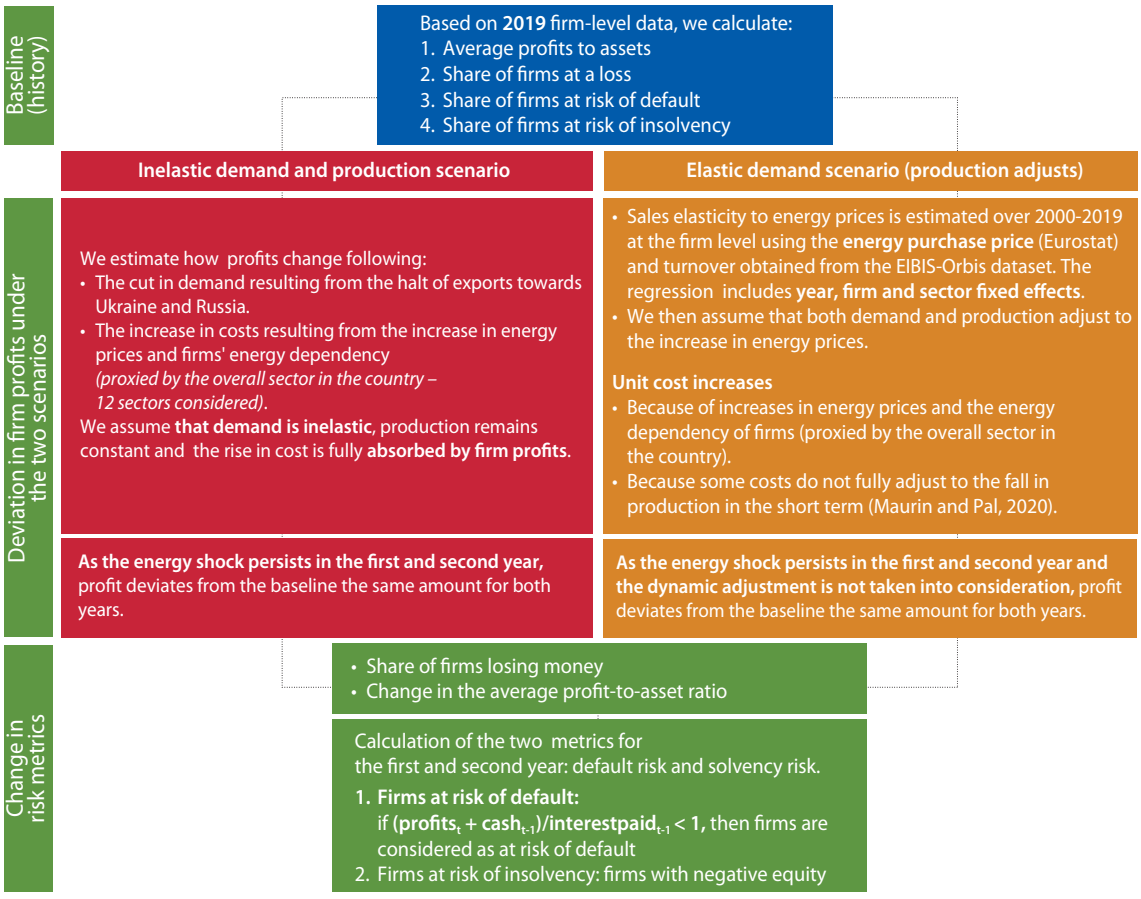
Source: *EIB staff calculations based on Eurostat.*
Note: *The raw margin indicator is the ratio between gross value added for the corporate sector and intermediary consumption.*

In the current crisis, countries suffer more if their energy dependency is based on oil and gas (Zingersen, 2022). In ten EU countries, Russia accounts for more than half of energy imports from outside the European Union.[13] Those countries tend to rely more on oil and gas. Given their higher dependency on Russian gas, Hungary, Slovakia, Italy, the Czech Republic, Austria and Germany are particularly vulnerable to reductions in Russian gas supplies. Conversely, the countries more reliant on renewable energies, biofuels and nuclear energy import less from Russia. Beyond the direct import exposure, countries' exposure to international markets is also key. Russia is a very important supplier. As the war limits Russian exports to Europe — owing to embargoes, capacity destruction, supply bottlenecks and military needs — prices have skyrocketed on international markets, meaning that countries with no direct imports from Russia are also affected.

International energy prices flow through to domestic prices very differently in each EU country, especially in the short term. As shown in Figure 21, the same change in international energy prices (coal, gas and oil) resulted in very different prices for companies in EU countries. Prices have increased by 80% in the European Union as a whole since 2021, ranging from a low of 10% in Luxembourg to a high of 140% in Denmark. As mentioned above, such wide fluctuations are partly explained by differences in the energy mix. However, other factors such as the period during which the energy price is fixed in the contractual agreement, taxes, regulation, transportation costs. Local margins play a role, too (Du Bella et al., 2022).

Table 1

Transmission channels considered in the activity scenarios



Source: *EIB.*

13 When ranking these countries from 50% to 100% dependence, Romania is followed by the Czech Republic, Poland, Lithuania, Bulgaria, Hungary, Finland, Estonia, Slovakia and Latvia.

Table 1 illustrates the impact the rise in energy prices and the war in Ukraine will have on the economy. The impact of the shocks to each country and sector is influenced by differences in their exposure to exports and increases in domestic energy prices, firms' dependence on energy by sector and country, and the initial balance sheet strength and profitability of each firm. The impact is estimated through the lens of scenarios that enable us to simulate the profit evolution of firms that have participated in at least one wave of the EIBIS, about 60 000 EU firms.

Two possible situations are considered when simulating the change in profits resulting from the shocks. In the "no reaction" case, it is assumed that besides a reduction in exports, demand is not affected by rising costs and selling prices are kept constant. Production is maintained and the energy shock is fully absorbed in companies' profit margins. In the "adjustment" case, part of the energy cost increase is passed on through higher selling prices, demand is reduced and production follows suit. As production is reduced, certain costs, such as employment costs, decrease, but do not react fully. To account for this imperfect reaction in the short term, we use the elasticities of cost components to demand estimated by Maurin and Pal (2020). The reaction of demand and production to energy costs is estimated for firms from 2000-2019.

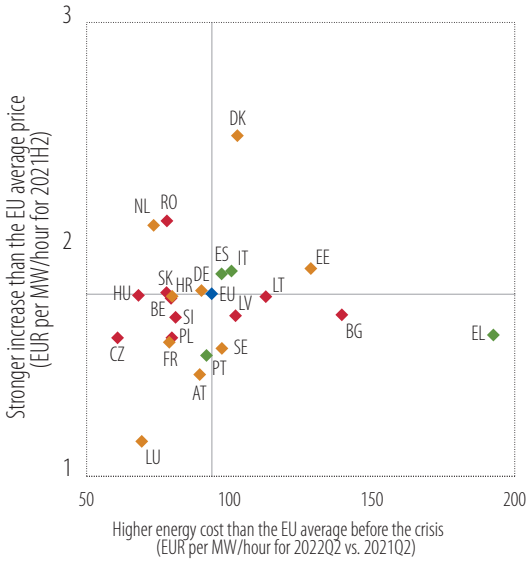
The simulations show that the economic environment hit firms' profits substantially. The consequences of a halt in exports and the increase in the energy prices seen since 2021 are explored in Figure 22.[14] Energy use accounts for 7% of the total output of the EU economy, meaning that the overall energy price increase of 80% will lead to a 6% decline in the value added by firms across the European Union. Figure 22 shows that after the shocks, the impact is substantial and stronger in the "no reaction" case. From 11%, the return on assets of EU firms falls by 3 percentage points for the "adjustment" case and 4 percentage points for the "no reaction" case. The share of firms losing money increases by 7 percentage points in the "no reaction" case, almost doubling compared to normal times, and by 5 percentage points in the "adjustment" case.

The capacity to withstand the adverse environment depends on balance sheet strength. The balance sheet strength of firms before the crisis is then taken into account to estimate changes in solvency and default risk. The change in profits is allocated to either cash holdings or to equity, linking the estimated change in firms' profits to individual financial and balance sheet conditions. Lower profits reduce a firm's ability to repay its debt, and therefore increase its risk of defaulting, especially when it cannot draw from liquid assets to fund its financial expenses. In parallel, higher losses also imply higher insolvency risks, and more firms with depleted capital. Default risk (the proportion of firms unable to pay back their financial expenses from their profits or cash position) rises from 5% to 8% or 9% in the first year and continues to increase the year after, reaching a ratio of up to 11% of firms in the second year in the most adverse situation. Insolvency risk (the proportion of firms with negative equity) also rises by 2 percentage points in the first year, from 4% to 6% (Figure 22). It increases to 7% in the second year. It increases further over time as some firms continue to lose money and deplete their equity.

The result varies among sectors, and it is mainly driven by energy dependence. Figure 23 associates the rise in firms' vulnerability — obtained by averaging the share of firms at risk, the insolvency risk and the default risk by sector, after standardisation. Overall, energy needs are particularly high for chemicals and pharmaceuticals, transportation and raw materials, sectors for which energy dependence is around 12%. These sectors are hit the hardest because of their energy dependence. Conversely, IT and telecommunications, construction, services and trade are less reliant on energy and therefore less affected.

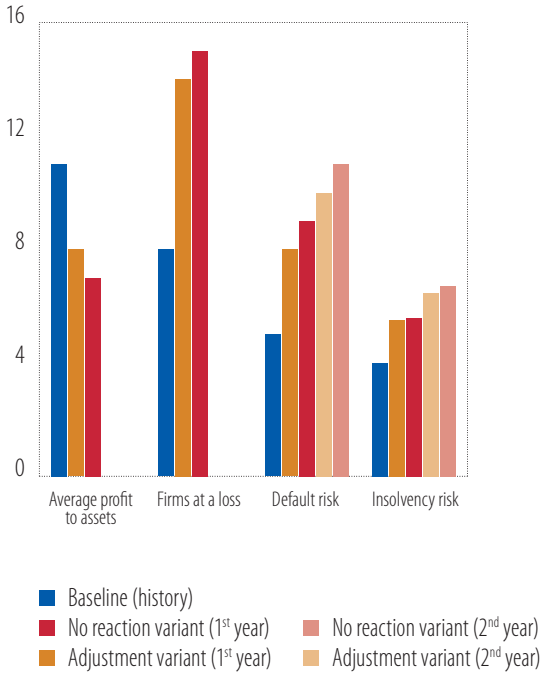
14 The shock is applied to the amount spent on energy overall, regardless of its nature or provenance. The simulations take into account the increase in energy prices at the country level, depicted in Figure 21. See EIB (2022a) for a scenario assuming a doubling of the energy bill for all countries.

Figure 21
Energy prices paid by firms, before the crisis and the change



Source: *EIB staff estimates based on Eurostat, European Commission.*

Figure 22
Overall cost of borrowing and spread
(in basis points)



Source: *EIB staff estimates based on EIBIS-ORBIS historical matched database and Eurostat turnover statistics.*
Note: *See EIB (2022a) and Harasztosi et al. (2022). The plain bars indicate normal times and the shaded bars indicate the value under the scenario.*

Differences in domestic price increases, the composition of EU economies and the initial strength of the corporate sector explain the uneven impact in different countries. In many countries, the share of firms losing money rises well above the usual 8% at the European level. The share increases by more than 8 percentage points in 12 countries. Composition also explains why different EU economies are more or less exposed to rising energy prices. Corporate dependence on energy differs depending on the economy, from a low of 2% of production in Luxembourg to a high of more than 14% in Lithuania, Greece and Croatia, reflecting sector composition and overall energy efficiency.[15] In general, economies in Central and Eastern Europe are more likely to be more dependent on energy. However, the largest EU economy, Germany, could be heavily affected because of its dependence on Russian gas (Bachman et al., 2022; Organisation for Economic Co-operation and Development (OECD), 2022; Deutsche Bundesbank, 2022). Conversely, countries like the Netherlands are less affected (De Nederlandsche Bank (DNB), 2022).

Geographical proximity to Russia and Ukraine appears to have an effect, but is not the only factor. Figure 24 uses colour coding to link the increase in risk in the vulnerability indicator with the location of firms. The vulnerability indicator is obtained by weighting the three risk indicators after they have been standardised. Location is clearly important, and geographical proximity with Ukraine is associated with higher vulnerability. Firms in Hungary, Poland, Latvia and Lithuania, all of which are closer to Ukraine, are more affected. However, firms in Greece, Croatia and Spain are also more affected than other EU peers.

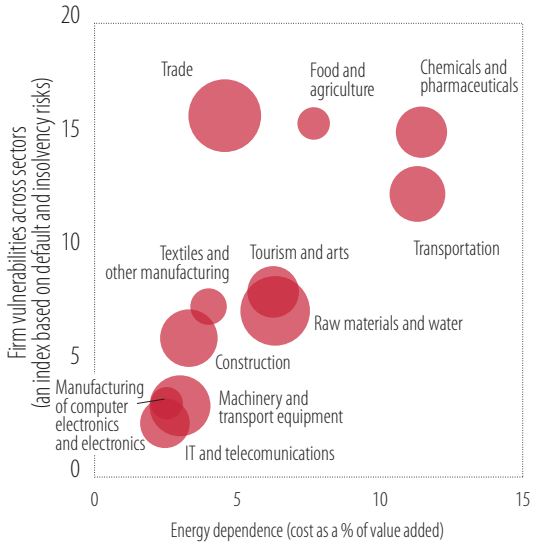
The sectors most distressed by the war differ from those affected by COVID-19. In Figure 24, the same synthetic vulnerability indicator is correlated with the deviation in expected 2023 real GDP as compared

15 We use the OECD (2018) input-output tables that relate to the 27 EU economies.

to European Commission autumn forecasts in 2021 and in 2019. This deviation between the two rounds of GDP projections measures the remaining COVID-19 impact on real GDP after massive policy support deployed during the crisis. In the analysis, the war leads to a slowdown in the recovery and produces new sources of vulnerabilities. Figure 24 shows that, at an EU level, these vulnerabilities are not closely correlated with those caused by COVID-19, but rather are additional weaknesses. This is a particular source of concern for countries approcahing the top-right quadrant of the chart, where economic activity was still well below levels before the COVID-19 crisis when the war broke out. In those economies, the war is heightening vulnerability, bringing it above the EU average.

Figure 23

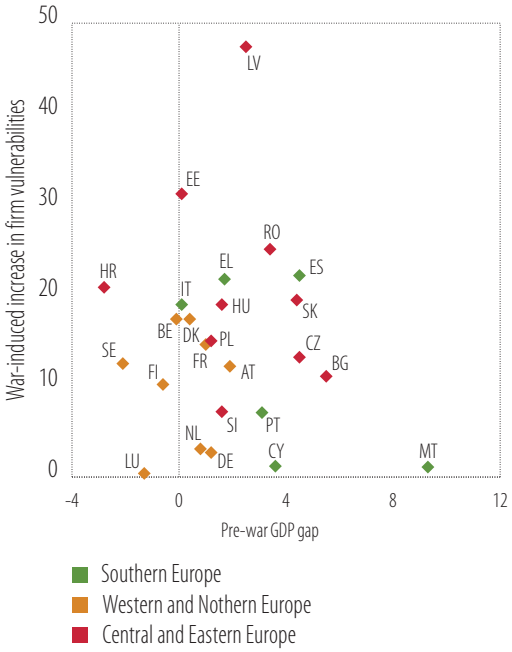
Energy dependence and firms' vulnerability to rising energy prices



Source: *EIB staff estimates.*
Note: *The size of the dot reflects the sector's share in the EU economy.*

Figure 24

GDP gap before the Ukraine war and related increase in vulnerabilities



Source: *EIB staff estimates.*
Note: *X-axis is the gap between real GDP in 2022 expected in the autumn 2019 and autumn 2021 European Commission forecasts. The y-axis reflects the increase in the share of firms at risk of losing money, insolvency or liquidity problems, rescaled by the minimum and the maximum.*

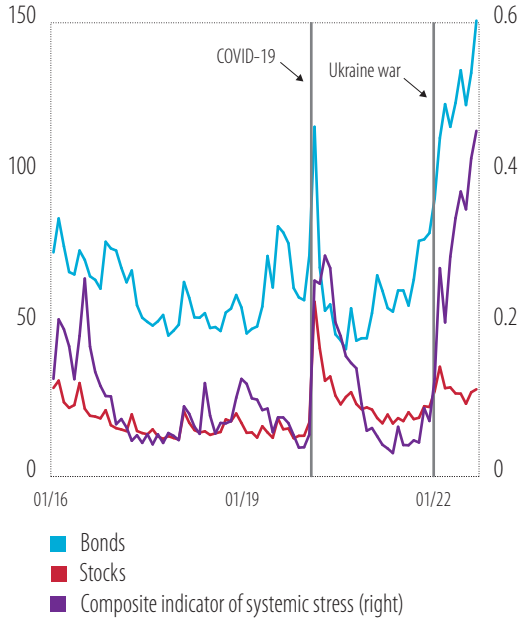
High uncertainty and funding stress could further depress investment

A confidence crisis would exacerbate funding problems, as lenders would avoid risk. The Russian invasion of Ukraine is a major source of uncertainty (Lane, 2022), and investment tends to react negatively to uncertainty (Kumar et al., 2022). Figure 25 shows various indicators of volatility and confidence. Higher uncertainty and the rise in volatility have been associated with a decline in stock prices and a rise in the premium paid for more risky equity investments (Gálvez, 2022). In the interbank market, the interbank spread (the difference between the 3-month Euribor rate and the euro short-term rate (€STR)) has moved upwards since the beginning of the invasion.[16] It rose from 2 basis points at the beginning of 2022 to 65 basis points in September 2022.

16 The €STR reflects the wholesale euro unsecured overnight borrowing costs of banks located in the euro area. It replaced the EONIA on 30 September 2019.

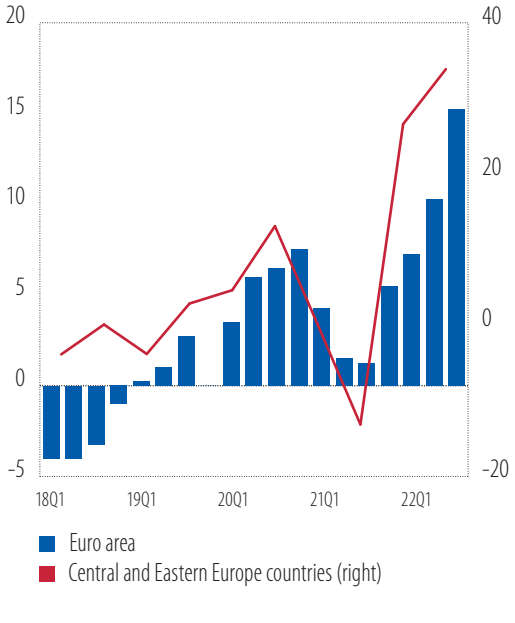
Bank lending surveys indicate a tightening in credit standards in European countries. Since the end of 2021, euro area banks have been reporting a net tightening of credit standards for loans and lines of credit (Figure 26). The net tightening accelerated with the start of the war in Ukraine. Since then, banks have become increasingly concerned about the effect of supply chain disruptions, high energy prices and other input costs, as well as increased credit risks because of firms' exposure to Ukraine, Russia and Belarus. The bank lending survey for Central and Eastern European economies also shows that banks are expecting to tighten credit (EIB, 2022b). Bank expectations in the region are souring, in part because of the market reaction to the crisis (Figure 26). Credit quality is also expected to suffer.

Figure 25
Estimates of implied volatility and the composite indicator of systemic risk



Source: *EIB staff calculations based on ECB and Refinitiv.*
Note: *For the Composite Indicator of Systemic Stress, See Kremer et al. (2012). Last record available October 2022.*

Figure 26
Cumulated net tightening in credit standards on corporate loans (% of banks)



Source: *EIB staff calculations based on ECB data.*
Note: *The fourth quarter of 2019 is used as the comparison point for any tightening. Four-quarter moving averages are reported.*

Increased firm vulnerability will lead to a deterioration in the quality of bank loans and could trigger further tightening. As explained above, the increased costs and reduced demand will affect firm liquidity and solvency differently depending on the sector and EU country. Banks more exposed to hard-hit sectors, such as food and agriculture, chemicals and pharmaceuticals, and machinery and transport, could be more affected. Figure 27 uses an index of bank vulnerability built by looking at banks' total loan exposure to these sectors, showing the results for the 27 EU countries. The banking systems on the right of the chart are more exposed to the deterioration in their loans than those on the left. While European banks have solid buffers to absorb losses, the expected deterioration of their loan book explains the tightening of credit standards.

Table 2
Channels considered in the funding stress scenario

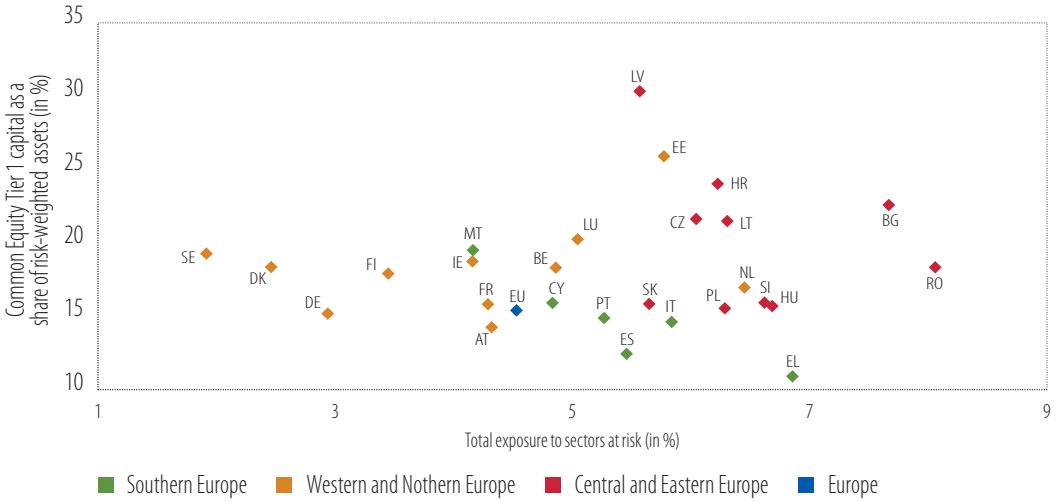
Starting point	We assume that:	
Debt-to-asset and cash-to-asset ratios at the firm level in 2019	• In all countries, short-term debt is not rolled over for finance-constrained firms. • In Central, Eastern and South-Eastern Europe, 20% of net trade credits are not rolled over.	To cover the resulting liquidity needs and finance working capital, firms draw from their cash and liquid assets. • We calculate the cash positions one year later, and the share of firms that are running out of cash.

Source: *EIB.*

The next scenario — the funding stress scenario (Table 2) — illustrates the impact of the crisis on the funding position of EU firms through changes in short-term debt and trade credits. It is assumed that in all countries, short-term debt is not rolled over for finance-constrained firms and that 20% of net trade credits are not financed in Central and Eastern Europe.[17] These two changes increase the cash needed to finance working capital and further deplete cash positions. Figure 28 reports the resulting increase in the share of firms running out of cash, which is well above 8% in seven countries. The simulation shows that increased aversion to risk, if not met with a sufficient policy response, would create further funding stress, potentially fragmenting European markets.

Figure 27

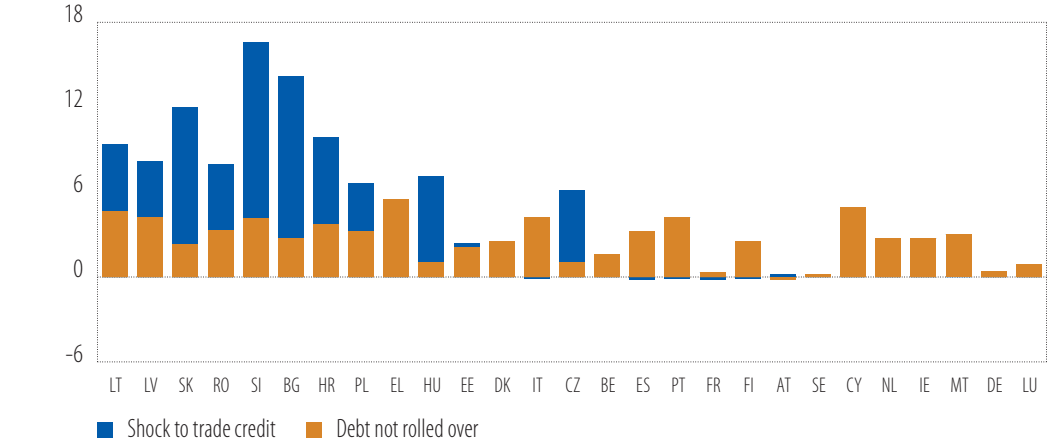
Bank exposure to sectors at risk



Source: *EIB staff estimates. and EBA.*
Note: *Estimates are based on the expected increase in vulnerability across sectors and countries and the loan book composition reported in the EBA Risk Dashboard (2022). The total exposure to sectors at risk calculates Common Equity Tier 1 capital as a share of risk-weighted assets.*

Figure 28

Rise in the share of firms with liquidity problems in the funding stress scenario (in %)



Source: *EIB staff estimates.*
Note: *Short-term debt of finance-constrained firms is not rolled over for all countries. 20% of net trade credits that are no longer financed is not rolled over for Central, Eastern and South-Eastern Europe.*

17 EIBIS waves 2016-2022 are used to distinguish finance-constrained firms. 20% is an estimate of subsidiary dependence from trade credit originating in regions other than Central and Eastern Europe. A shock is only applied to the net trade credit position for net debtor firms in Central and Eastern Europe.

Staying on track for the twin transition

For Europe to meet the sizeable investment needs of the green and digital transition, it must first address some financial weaknesses. First, access to finance is uneven for different countries, types of firms and specific assets. Removing financial bottlenecks could unlock huge investment potential. Second, specific borrowers rely heavily on some types of products or markets. If these are underdeveloped in the European Union, it is important to support them with public policies or instruments. As illustrated below, EIB action can help catalyse private investment. Finally, while cross-border financial flows have withstood the COVID-19 crisis relatively well, the European financial system is not properly integrated. This section illustrates the benefits that further integration would bring.

Some regions or specific investments have difficulty getting finance

More firms are having difficulty accessing credit than before the COVID-19 crisis, and the share of finance-constrained firms is close to a record high since 2016. After rising at the beginning of the crisis, the share of finance-constrained firms fell to a record low of 4.7% in 2021, when policy guarantee programmes supported credit. The share of finance-constrained firms increased substantially, to 6.2% in 2022, when some of these temporary measures were phased out. While the share remains relatively low, it has to be put in historical perspective. Since 2016, the share has vacillated from 4.7% to 6.8%. The level reached in 2022 reflects increased risk aversion and uncertainty, as well as the tightening in credit.

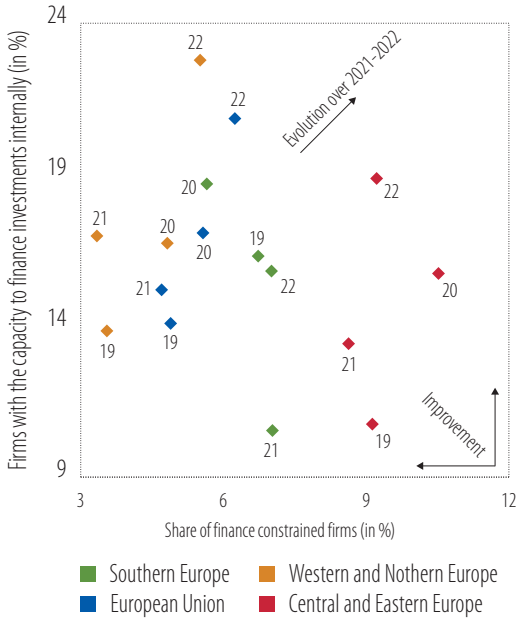
The implications of new financial pressures are unclear, as the share of finance-constrained firms and the share of firms relying on internal finance increased. In Figure 29, we correlate two results from the EIBIS: the financial constraints indicator and the willingness to use internal financing. Financial constraints are likely to affect investment less when firms are not so dependent on outside funds. A move towards the top or left of Figure 29 reflects an improvement in financing conditions. From 2021 to 2022, the willingness to rely on internal financing increased by around 4 percentage points across the board, supported by a strong recovery in profits. In parallel, a substantial increase in the share of finance-constrained firms was recorded. This change mostly originated from Western and Northern Europe, with little change elsewhere. This leaves a mixed overall picture of investment financing conditions.

Access to external finance remains more problematic for some types of firms, and finance-constrained companies have a harder time investing. Figure 30 depicts the share of firms reporting investment gaps over time.[18] It separates finance-constrained firms from non-finance-constrained firms. Overall, investment gaps are more frequently reported when firms are finance-constrained, and the difference tends to be stronger for firms investing heavily in intangible investment. Among these firms, finance-constrained companies reported investment gaps almost three times more in 2022, while firms in general were twice as likely to report gaps.

The following section uses an indicator of structural and cyclical barriers to examine external funding tensions. The share of profitable firms that are finance-constrained is used to reflect investment barriers related to financial sector characteristics and firms' specific features, while the share of firms reporting a worsening of external financing conditions is used to reflect the changes in the financial cycle. Figure 31 shows the substantial variation in the indicator. In EIBIS 2020, the first year of the COVID-19 crisis and before the implementation of the firm-level policy packages, the share of firms reporting external funding difficulties increased from around 10% to 22%. More recently, in 2022, the rise was even more significant. On both occasions, an expected worsening in external financing conditions fuelled the rise. Interestingly, the external funding index tends to be higher for smaller, younger and highly innovative firms.

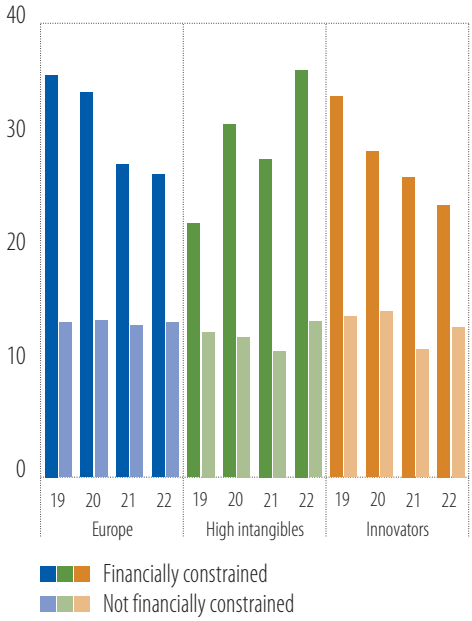
18 Investment gap is constructed from the EIBIS with value 1 if the investment over the last three years was "too little." This is considered as a loss of potential investment or potential growth (the firm might still have positive and increasing investment compared to the previous year).

Figure 29
Financial capacity of firms



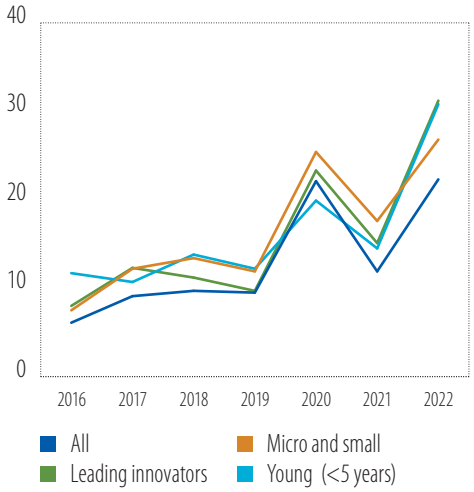
Source: *EIBIS 2019-2022.*
Note: *The numbers next to the diamonds indicate the calendar year.*
Question: *What was your main reason for not applying for external finance for your investment activities? Was happy to use internal finance/didn't need the finance.*

Figure 30
Reported investment gaps, by type of firm (in %)



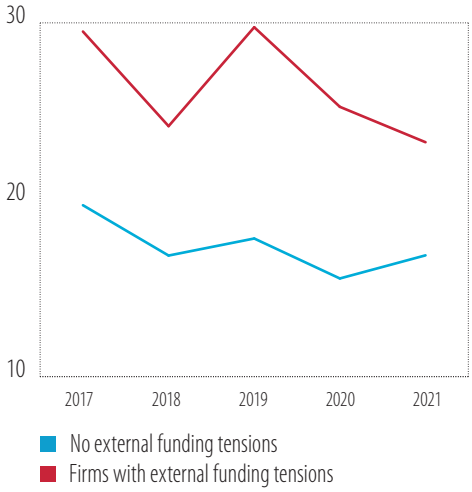
Source: *EIBIS 2019-2022.*
Note: *High intangibles refers to firms allocating more than 50% of their investment to intangible assets.*
Question: *Looking back at your investment over the last three years, was it too much, too little, or about the right amount to ensure the success of your business going forward?*

Figure 31
External funding tension indicator (% of firms)



Source: *EIB staff calculations based on EIBIS 2016-2022.*
Note: *Micro and small firms are those with fewer than ten and 50 employees, respectively. Leading innovators are firms with (substantial) R&D and products new to the country or the global market.*

Figure 32
Proportion of firms reporting investment gap according to external funding tensions

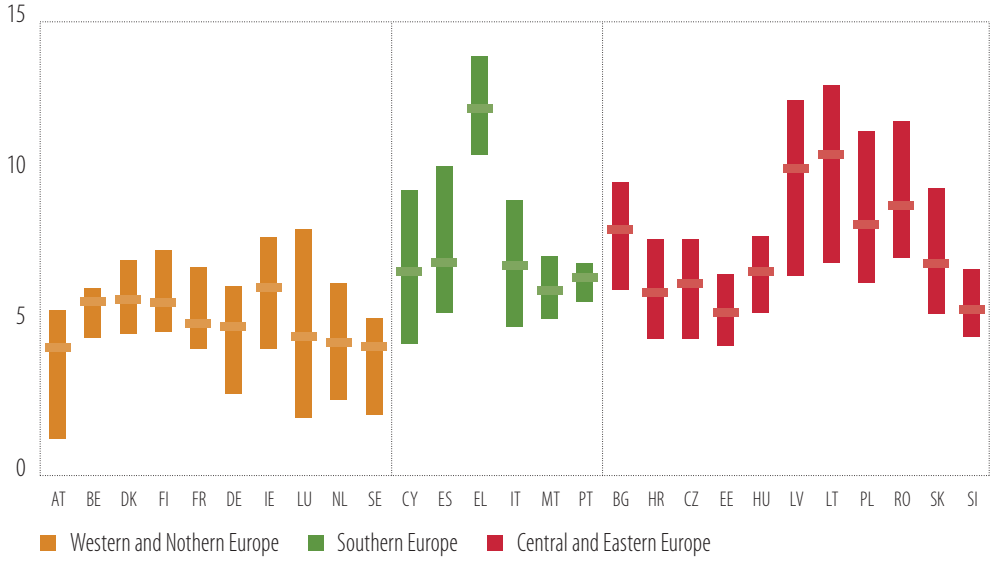


Source: *EIB staff calculations based on the EIBIS.*
Note: *The calculations isolate the causal impact of external funding difficulties on the investment gap.*

The effect of external funding difficulties on potential and realised investment is sizeable. Figure 32 estimates the impact of external funding difficulties on the investment gap[19] over time. On average, firms facing external funding difficulties are 7 percentage points more likely to report an investment gap than those with no external funding difficulties. Similarly, firms reporting external funding difficulties are on average more likely to report an expected drop in planned investments, by 8 percentage points, or to implement investments the year after, by 4 percentage points.

Structurally, the EU economy invests less than the United States in productive assets. Unlocking this financing could raise corporate investment by EUR 120 billion a year. Chapter 2 illustrates the substantial investment gap in the European Union. The literature has deployed various methodologies to estimate this gap (Box B). Correlating the answers received to various EIBIS questions and several more from the ECB Survey on the Access to Finance of Enterprises (SAFE) provides a range of estimates of the investment that would result from reducing financial friction. Figure 33 shows the results, isolating each EU macro-region and each country, averaging over the five years from 2016 to 2021. Overall, the median investment gap ranges from a low of 3% in Austria and Sweden to a high above 10% in Latvia and Lithuania. The average estimate is 6% of EU corporate investment, around EUR 120 billion. The results are comparable to other findings (FICOMPASS, 2019).

Figure 33
Corporate investment potentially lost because of financial bottlenecks
(% of existing corporate investment)



Source: *EIB staff estimates based on EIBIS, SAFE and Eurostat.*
Note: *The vertical bars represent the intervals obtained from several estimates (up to 28, depending on the country). The horizontal bars indicate the median estimates.*

19 We implement average treatment effect techniques and control for firm-level characteristics for size, profitability, liquidity, financial leverage and equity share. We also use sector-country dummies and take into account other investment barriers, such as availability of qualified labour force, uncertainty, demand for products and services and availability of digital infrastructure.

Box B

Estimating investment bottlenecks by looking at credit gaps[20]

A credit gap refers to the difference between the desirable level of credit and the actual level. Measuring credit gaps is an empirical exercise. Broadly speaking, two approaches have been deployed in the literature, namely: (i) a macroeconomic approach; and (ii) methodologies centred on firm-level data. The exercise proposed in this box uses the latter approach to quantify financing gaps in the European Union, based on the latest wave of the World Bank Enterprise Survey. The survey makes it possible to differentiate between firms that obtained credit and credit-constrained firms. Credit-constrained firms either had their loan application rejected or were discouraged from applying for a loan despite needing it.[21] Few studies employ this approach, which reflects a paucity of suitable data.[22] The exercise is conducted to illustrate the factors to be taken into account when assessing credit gaps for firms.

The credit gap proposed here estimates the amount of additional financing required to cover the needs of discouraged firms, taking into account their creditworthiness and adjusting for supply-side elements. The methodology applies a scoring model to assess the creditworthiness of discouraged companies. The financing needs of firms that pass this assessment form the credit gap. By doing so, the method screens out firms that would have been rejected had they applied for loans. It adjusts for observable firm-specific differences in the pool of non-applicants vis-à-vis the pool of applicants, while controlling for unobservable factors common to firms operating in given countries or sectors. The credit allocation rule trades off allocating credit to firms that are not creditworthy vs. denying credit to companies that are. The desired loan volume of discouraged firms is then approximated by the flow of credit to enterprises in the economy, scaled by the total employment of successful applicants.[23] As the size of the discouraged firms is known, the credit gap can be broken down into a small and medium business and corporate credit gap. By adjusting the credit gap for fundamentals, such as institutional quality or banking-sector characteristics, alternative measures can be derived, yielding a range of credit gap estimates.

Discouraged firms are on average less creditworthy than firms that apply for loans. Figure B.1 shows that on average around 1% of the firms have their loan application rejected. The estimated rejection rates for discouraged firms are much higher, except for Western and Northern Europe, and are a multiple of the observed rejection rates. The results suggest that the average quality of the discouraged firms is lower than of the average applicant, so that a significant share of discouraged firms would be denied credit. The share of discouraged firms that would obtain credit is therefore smaller than the share of firms that successfully applied for loans (Figure B.2). Figure B.2 also suggests that financial intermediation is most developed in Western and Northern Europe, which have the highest share of successful applicants, ahead of Southern Europe and Central and Eastern Europe.

Credit gap estimates range from 2.4% to 3.6% of EU GDP, with significant variation across regions. Expressed in euros, this translates to a range of EUR 323 billion to EUR 481 billion. Figure B.3 shows the credit gap ranges for each sub-region as a percentage of GDP. The Central and Eastern European credit gap is estimated at 3.5% to 4.9% of GDP, or EUR 48 billion to EUR 68 billion. The Western and Northern European credit gap ranges from EUR 73 billion to EUR 95 billion, which corresponds to 1.1% of GDP. Southern Europe has the largest credit gap, with estimates ranging from 4.8% to 10.9% of GDP or EUR 160 billion to EUR 360 billion. In the case of Southern Europe, the baseline estimate derived

20 This box is based on a methodology developed in the forthcoming working paper (Akbas et al., 2022).

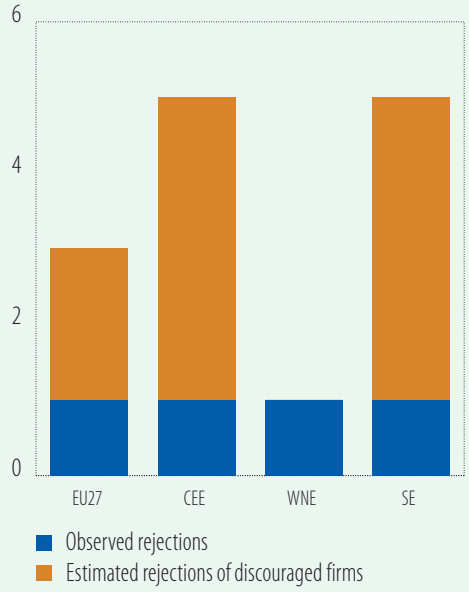
21 Discouraged firms need loans but have refrained from applying because of what they perceive as complex application procedures, unfavourable interest rates, high collateral requirements, insufficient loan amounts and fear of being rejected.

22 International Finance Corp. (2017) also exploits firm-level data and identifies a financing gap for micro, small and medium companies across 128 developing economies of around USD 5.2 trillion, or 19% of GDP on average. See also Lopez de Silanes et al. (2015) who quantify the financing gap for some EU countries making use of micro as well as macro data.

23 Data on outstanding amounts and transaction of credit to non-financial corporations come from the ECB and are adjusted with value-added shares to account for the sectors represented in the Enterprise Survey (such as services, manufacturing and construction). These account for roughly 87% of economic activity on average across EU27 countries. An estimate of the flow of credit is derived from data on the maturity of outstanding amounts.

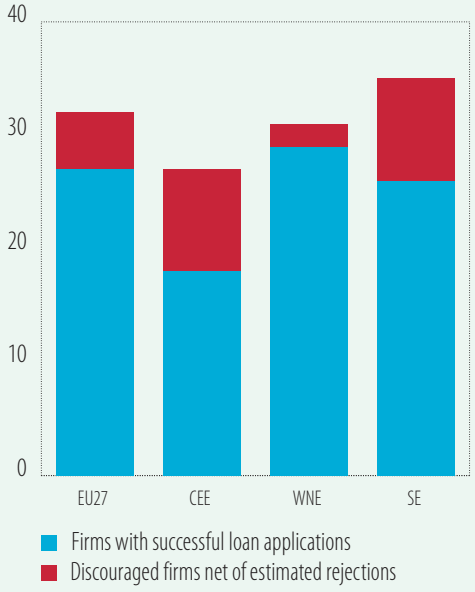
from the survey yields the upper bound, whereas the adjusted credit gap yields the lower bound. The high baseline estimate reflects a high share of discouraged firms in Italy as well as the weight of Italy in the Southern European aggregate.[24] The wide range indicates a high level of uncertainty regarding the estimates. Nonetheless, even the lower bound in Southern Europe indicates greater unmet financing needs than in Central and Eastern Europe and Western and Northern Europe. A limitation of this study is that the surveys in Western and Northern Europe were fielded later than those in Central and Eastern Europe and Southern Europe, and the low credit gap may partly reflect the extraordinary policy response to the coronavirus pandemic.

Figure B.1
Observed rejections and estimated rejections of discouraged firms (in %)



Source: *EIB staff estimates based on the Enterprise Survey.*

Figure B.2
Firms that received loans and "acceptable" discouraged firms (in %)



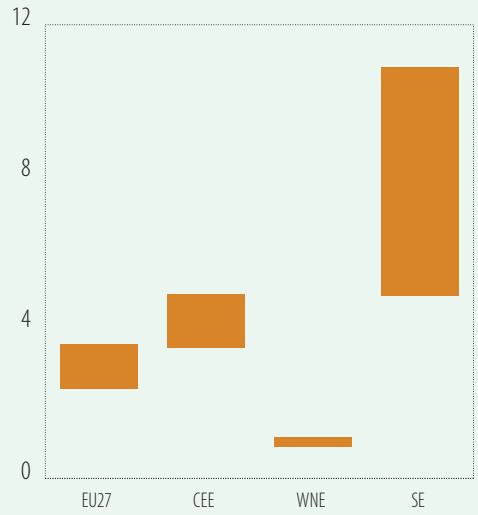
WNE = Western and Northern Europe
SE = Southern Europe
CEE = Central and Eastern Europe

Source: *EIB staff estimates based on the Enterprise Survey.*
Note: *Discouraged firms, after estimating rejections.*

These findings can be broken down further to obtain credit gap measures for small and medium businesses and corporates. Figure B.4 breaks down the baseline estimate into a small and medium business component and a corporate component. The small and medium business credit gap for the European Union is estimated at roughly 2.7% of GDP, or EUR 365 billion. The corporate credit gap, estimated at roughly 1% of GDP, or EUR 116 billion, is significantly smaller than the gap for small and medium businesses. Figure B.4 also shows that the sub-regional variation is driven mainly by the small and medium business segment, with the corporate credit gap ranging from 0.3% of GDP in Western and Northern Europe to 2.2% in Southern Europe. Financing gap estimates suggest that market imperfections are at work. Information is harder to come by in market segments and sub-regions where firms are more opaque. These numbers are not precise estimates. Overall, the methodology implemented in this box illustrates some of the factors that have to be considered when assessing firms access to bank credits.

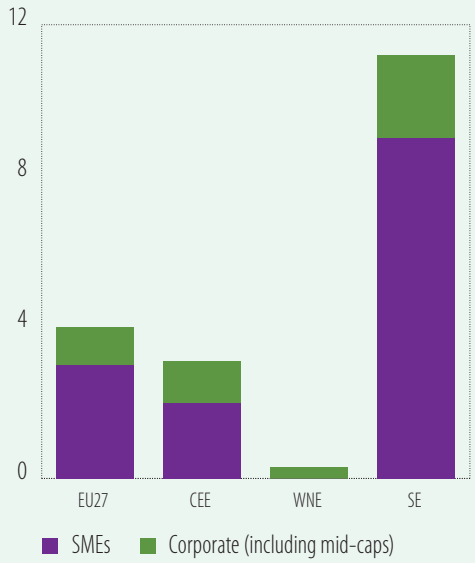
24 It is worth noting that aggregate non-financial corporation (NFC) credit in Italy has been on a declining trend since 2012 — the peak of the European debt crisis, with an average annual growth rate of approximately -3% from 2013 to 2021. By way of comparison, NFC credit has been growing annually by about 3% in Germany and 6% in France over the same period. This could explain the high share of discouraged firms in Italy.

Figure B.3
Credit gaps (% GDP)



Source: *EIB staff calculations.*
Note: *The bars represent a range of estimates. The estimates do not take the macroeconomic environment into account.*

Figure B.4
Credit gap estimates (% GDP)**, by firm size**



WNE = Western and Northern Europe
SE = Southern Europe
CEE = Central and Eastern Europe

Source: *EIB staff estimates.*
Notes: *The figures represent the total credit gap in a given region, and not the average credit gap for the country averages in each region. The estimates do not take the macroeconomic environment into account.*

A lack of access to finance is still an acute problem for small and medium businesses.[25] Financiers are generally more reluctant to extend uncollateralised financing to SMEs, even at high interest rates. As a result, many of these businesses with economically viable projects cannot obtain the necessary financing through usual channels. This phenomenon is often referred to as the SME financing gap, a market failure that results in a lack of market equilibrium. It is rooted in information asymmetry, which leads to credit rationing either through the adverse selection of low-quality borrowers or moral hazard. Figure 34 shows that the share of small and medium companies reporting finance as a highly important issue is on average 5 percentage points higher than for large enterprises. Extensive pandemic liquidity support programmes led to significant improvements in financial conditions during the second half of 2020. The trend reversed course in the second half of 2021, with the phasing out of pandemic support programmes and the outbreak of war in Ukraine. Since then, the share of small and medium companies reporting severe financing issues has increased slightly.

Access to finance by small and medium companies differs markedly from country to country, as shown by the EIF SME Access to Finance Index (ESAF). The results for 2021 are presented in Figure 35.[26] Recent changes in the ESAF have been driven to a great extent by changes in lending conditions. One of the loan sub-index indicators was at a record high in 2020, as small and medium companies relied heavily on

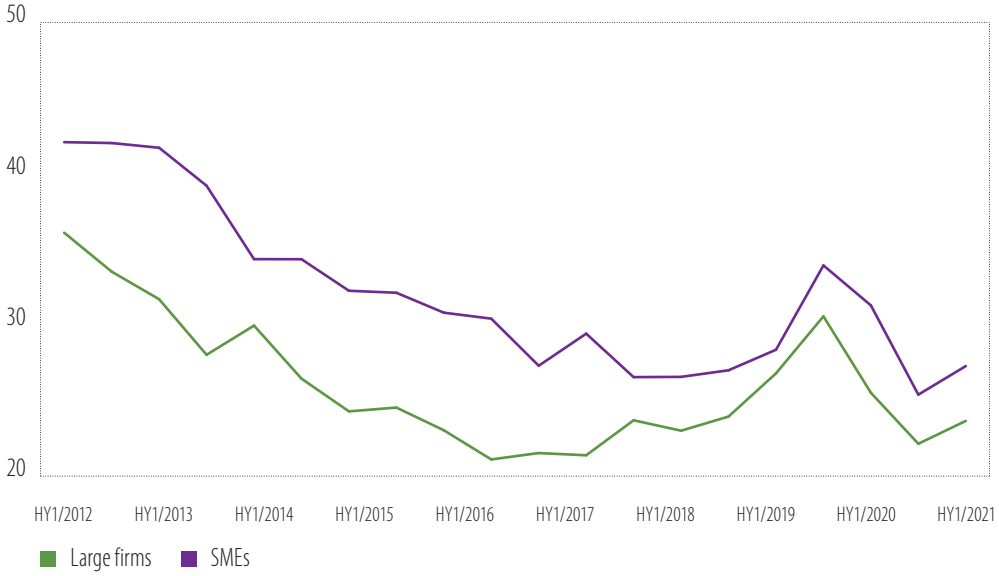
25 Small and medium companies make a massive contribution to job creation and economic growth in Europe (Kraemer-Eis et al., 2022b).

26 The ESAF is a composite indicator that summarises the state of SME financing for each of the EU members and covers different aspects of SME access to finance. It is composed of four sub-indices, three of which cover a specific SME financing instrument. The fourth sub-index covers the general macro-environment (Torfs, 2022).

public support programmes to weather the liquidity issues caused by COVID lockdowns. However, many of those support programmes were phased out during 2021, albeit not at different paces in different countries. This led to changes in the access small and medium businesses had to debt finance, and therefore to changes in the loan sub-index country ranking (Kraemer-Eis et al., 2022b).

Figure 34

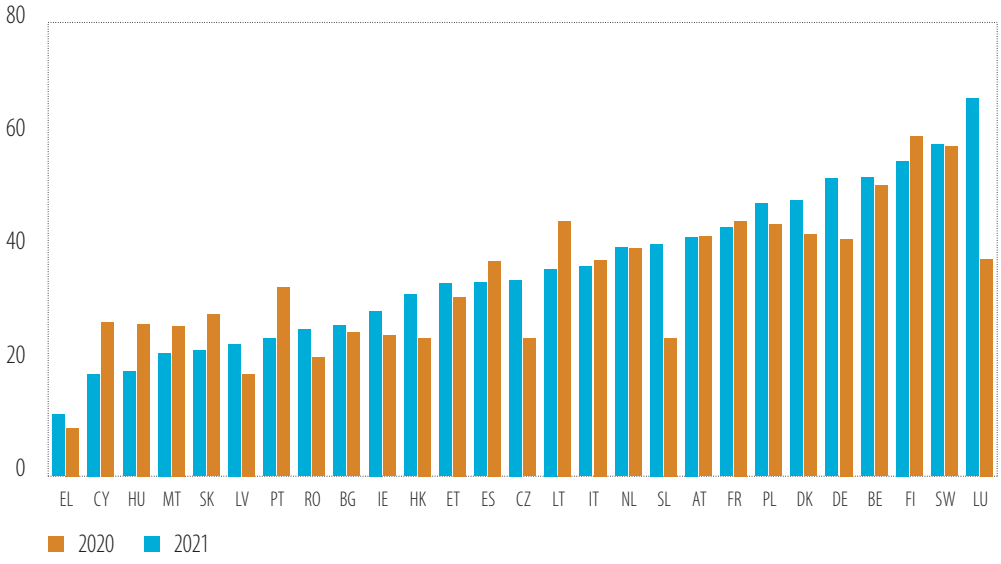
Corporate investment potentially lost because of financial bottlenecks
(% of existing corporate investment)



Source: *The European Investment Fund's European Small Business Finance Outlook (ESBFO) (Kraemer-Eis et al., 2022b).*

Figure 35

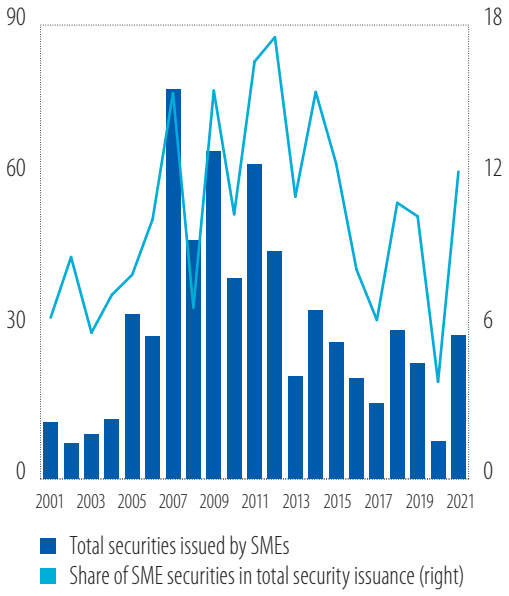
Small firms' access to finance, (in %)



Source: *The EIF SME Access to Finance Index, as published in Torfs (2022).*

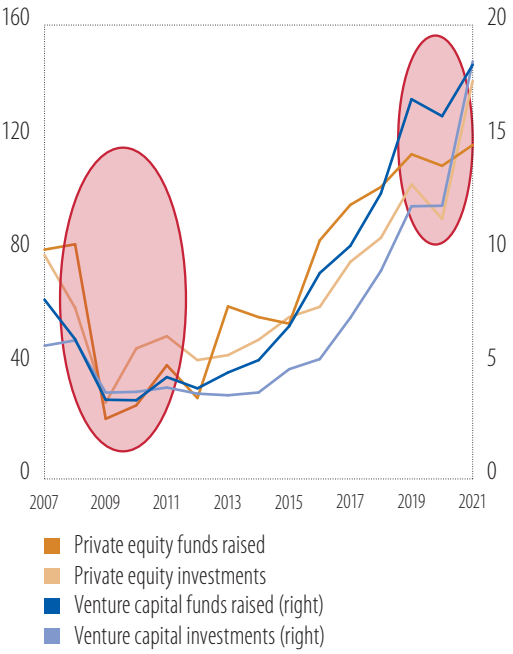
A well-functioning securitisation market can alleviate some of the financial constraints faced by small and medium companies. Securitisation transforms illiquid SME loans into an asset class with adequate market liquidity. SME securitisation, which includes transactions backed by SME loans, leases and other products, can provide indirect access to capital markets for small and medium companies.[27] European SME securitisation activity remains historically subdued (Figure 36). The downward trend that began in the aftermath of the global financial crisis continued until 2017, and volumes have not yet returned to their pre-crisis levels. While SME securitisation declined sharply during the initial phase of the coronavirus pandemic, it increased significantly (by around 270%) thereafter, to the extent that its share of overall securitisation issuance jumped to 12%. This was mostly due to a very large operation that was fully retained. Only a very small fraction of the issuance has been placed with investors (Kraemer-Eis et al., 2022b).

Figure 36
Issuance of small business securities in Europe (left axis: EUR billion; right axis: in %)



Source: *ESBFO (Kraemer-Eis et al., 2022b), based on the Association for Financial Markets in Europe.*
Note: *Last record available is for the first half of 2022. Data is for Europe only.*

Figure 37
Private equity and venture capital activity (EUR billion)**, 2007-2021**



Source: *ESBFO (Kraemer-Eis et al., 2022b) based on data from Invest Europe.*
Note: *Data is only for firms located in Europe.*

Business angels are key financiers for startups and young innovative companies with high growth potential. The latest EIF Business Angels Survey shows that business angel activity fared relatively well in 2021.[28] At the time the European Investment Fund (EIF) conducted the Business Angels Survey, respondents' perception of the environment for business angel investing was back to pre-COVID levels, with half expecting improvements over the following 12 months. In 2021, the majority of business angels (63%) did not expect the pandemic to cause any insolvencies of their portfolio companies. 39% of business angels considered the average impact of the pandemic on performance to be negative — far

27 When analysing SME securitisation, it is important to look not only at bank lending, but also at leasing companies, which form part of the securitisation market (Kraemer-Eis and Lang, 2012). Given that bank financing has been less available for leasing companies since the crisis, securitisation is likely to become even more important for leasing.

28 Botsari et al. (2022). The survey was conducted between 15 November 2021 and 5 March 2022, and therefore does not take into account the challenging environment resulting from the war in Ukraine and the strong acceleration in inflation.

below the 59% in autumn 2020 — and almost half expected a neutral effect on the final performance of their portfolio. Concerning opportunities in the COVID-19 crisis, respondents reported digitalisation, healthcare and sustainable approaches to be the most promising areas for business angel investments.

Companies continue to have difficulty scaling up. The smaller European venture capital industry with its shorter track record (16%) and the underdeveloped initial public offering market (15%) were seen as the key reasons for investment gaps in later stages. Business angels said increased engagement by large institutional investors would be the most effective way to bridge the late-stage financing gap.

The 2022 EIF Venture Capital Survey and the EIF Private Equity Mid-Market Survey show that venture capital sentiment has deteriorated significantly compared to 2021. The fundraising environment deteriorated, and the majority of venture capital firms surveyed expected it to weaken further in the coming year. In addition, venture capital firms are having difficulties finding co-investors. This situation is expected to worsen as well.

The 2022 wave of the EIF Venture Capital Survey indicates that the current crisis is affecting new investments less than the COVID-19 crisis did. Nevertheless, a quarter of venture capital firms expect investments to decrease over the next year (four times as many as in 2021). Investor competition for investee companies has collapsed, and many expect it to further decline. About half of venture capital firms report that entry prices have decreased more than during the COVID-19 crisis and the majority expect them to further decrease next year. In the same vein, high investee company valuations are no longer a significant issue for venture capital firms, despite being seen as the biggest challenge facing the venture capital business in 2021.

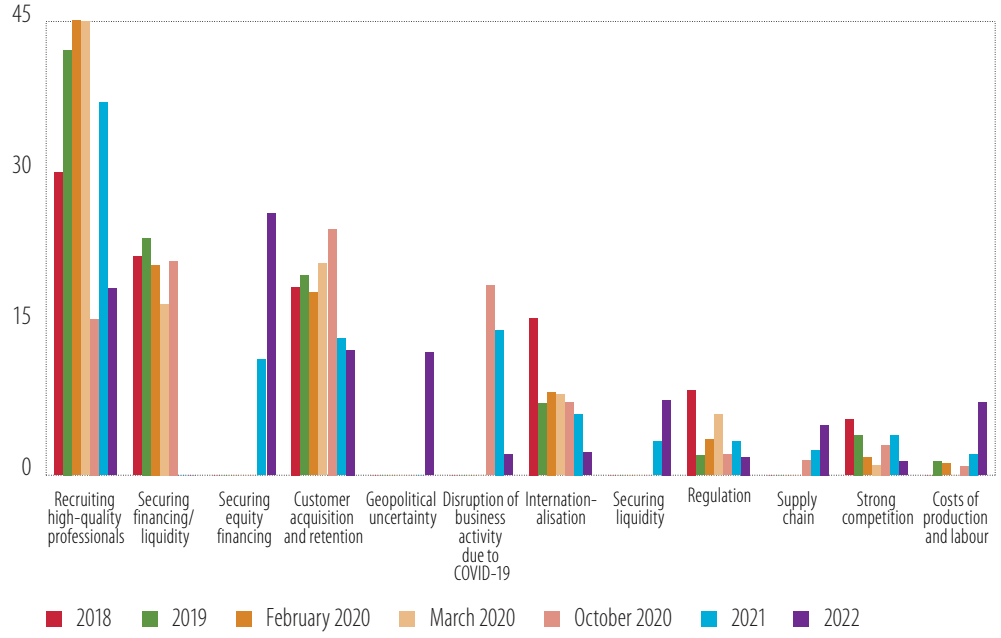
The venture capital exit environment suffered a shock that was in some ways even worse than during the COVID-19 crisis. After the recovery in 2021, half of venture capital firms reported a significant deterioration of the exit environment. Even more expect it to further deteriorate over the next year — twice the share recorded during the COVID-19 crisis. The prices venture capital firms receive when selling their investments decreased during the current crisis. While only 6% of companies expected exit prices to decrease in 2021, this percentage has increased tenfold in 2022 (for the coming year). Key challenges in the exit environment include insufficient demand for initial public offerings and difficulties in finding potential buyers.

Securing equity financing and recruiting high quality professionals are the biggest challenges facing companies in venture capital portfolios (Figure 38). Securing equity financing is threatening the survival of investees at almost one-quarter of venture capital firms. Geopolitical uncertainty and its consequences (including the difficult macroeconomic environment) and the overall weak exit environment are currently the most serious challenges affecting venture capital.

Venture capital firms changed how they selected investments as a response to the current geopolitical and macroeconomic situation. Alongside the management team, scalability potential and technology, financial criteria such as valuation and deal terms, cash-generating capacity and profitability became more important. At the same time, the importance of environmental, social and governance considerations increased considerably, too. Venture capital firms also changed their investment strategy to some extent, emphasising an entrepreneur's experience and the sector or industry.

Venture capital firms also report severe fundraising and operational issues. Great aversion to risk is weighing on venture capital funds, as are investors leaving the market, rising interest rates and rising levels of inflation. Banks, insurance companies, high-net-worth individuals, pension funds, family offices and corporate investors are less willing to invest in venture capital. In contrast, government funds' interest in venture capital has changed only slightly. Venture capital is also facing operational issues, such as the liquidity needs of portfolio companies, reduced divestment and exit opportunities, more regulation and bureaucracy in fund management, and lower performance of portfolio companies.

Figure 38
Biggest challenges faced by venture capital portfolio companies over time (% of respondents)



Source: *ESBFO (Kraemer-Eis et al., 2022b).*

Box C

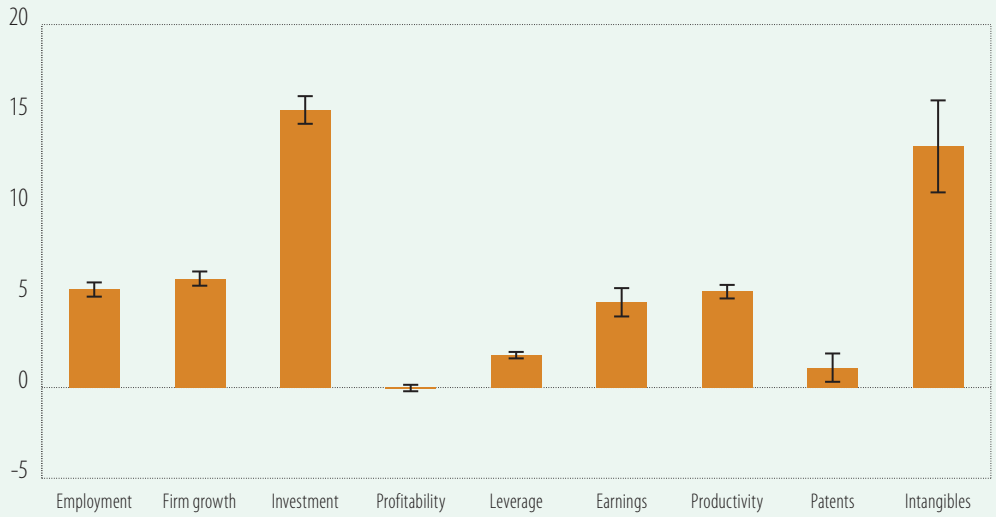
Using public sector financial instruments to crowd in investment in small businesses and mid-caps

Public policies can help deploy a range of financial instruments to support small and medium business and mid-size firms. Financial instruments fall into three categories — loans, guarantees, and equity or quasi-equity — and are then further sorted into instruments that require a financial intermediary. EIB Group activity consists of a mix of loan, guarantee and equity or quasi-equity products being employed in pursuit of several policy goals, including supporting small and medium companies. This approach ensures that products are developed for enterprises of different sizes, with different business models and at different stages of their life cycle, while also providing the flexibility to react to changing economic and financial circumstances and policy imperatives.

The EIB Group supports access to finance for small and medium companies, using commercial banks as intermediaries. The EIB's multibeneficiary intermediated loans require financial intermediaries to pass on some of the advantageous funding terms they receive to borrowers, contributing to better economic performance of small and medium firms. In addition, EIB intermediated loans alleviate the credit constraints these companies face. A number of microeconomic impact assessment studies confirm this (Amamou et al., 2022; Barbera et al., 2022; EIB, 2023). Firms receiving EIB lending increased their employment by an average of 5% relative to comparable peers without EIB financing (Figure C.1). The studies also showed a substantial, positive impact on recipient firms' investment, reaching 15%, indicating that the beneficiaries typically used the loans disbursed for investment purposes. Furthermore, the findings showed that the impact on firm growth tended to be greater for firms that faced financing constraints prior to receiving the loan.

Credit guarantees are another important policy tool that supports credit for small and medium companies, particularly during economic downturns. The EIF, the risk-financing arm of the EIB Group, implements and manages credit guarantee programmes on behalf of the European Union. EIF-guaranteed loans have been shown to have several positive effects (Asdrubali and Signore, 2015; Bertoni et al., 2019; Brault and Signore, 2019), such as increasing beneficiary firms' assets by 7% to 35% and employment by 8% to 30%. Moreover, EIF guarantees caused a decrease in bankruptcy rates by about a third, and by as much as half in some countries. Unsurprisingly, the positive impact of credit guarantees appears to be stronger for younger and smaller firms, which typically experience more severe credit rationing in times of economic stress.

Figure C.1
Estimated impact of EIB intermediated loans (% change)



Source: *EIB staff estimates based on EIB data linked to firms' financial results from the Orbis database.*
Notes: *The bars represent the estimated effect of EIB loans on beneficiaries compared to the firms in the control group in the three years after the loan. The bands show the 95% confidence intervals of the estimates.*

Support for venture capital funds plays an important role in fostering the growth of innovative small businesses in the European Union. Today, the EIF is the largest public investor in European venture capital funds. To examine the impact of EIF-supported venture capital investments on the financial growth and performance of young and innovative firms, researchers have compared venture capital-backed firms with a comparable group of firms with no such backing (Pavlova and Signore, 2019, 2021). The results confirm that EIF-supported venture capital investments have had a positive impact on the growth of startup firms. After five years, supported firms had higher capitalisation, higher revenues and faster job creation. Over the same time, startups backed by EIF venture capital had a 10.3 percentage point higher chance of being acquired and a 1.7 percentage point higher rate of going public than similar firms not backed by venture capital.

To further narrow the scale-up financing gap in Europe, the EIB has recently also created a venture debt product for innovative European small and medium companies in need of more flexible debt products. Lack of sufficient collateral and asymmetric information are among the two biggest market failures preventing young and innovative small and medium companies from accessing traditional bank lending finance. Venture debt is a quasi-equity financing instrument that addresses the funding needs of fast-growing, innovative companies by providing them with greater flexibility and a less constraining repayment structure than more traditional senior debt. The instrument targets firms that have already raised venture capital (mainly later stage series B or C funding) and that want to avoid the ownership dilution associated with additional equity injections.

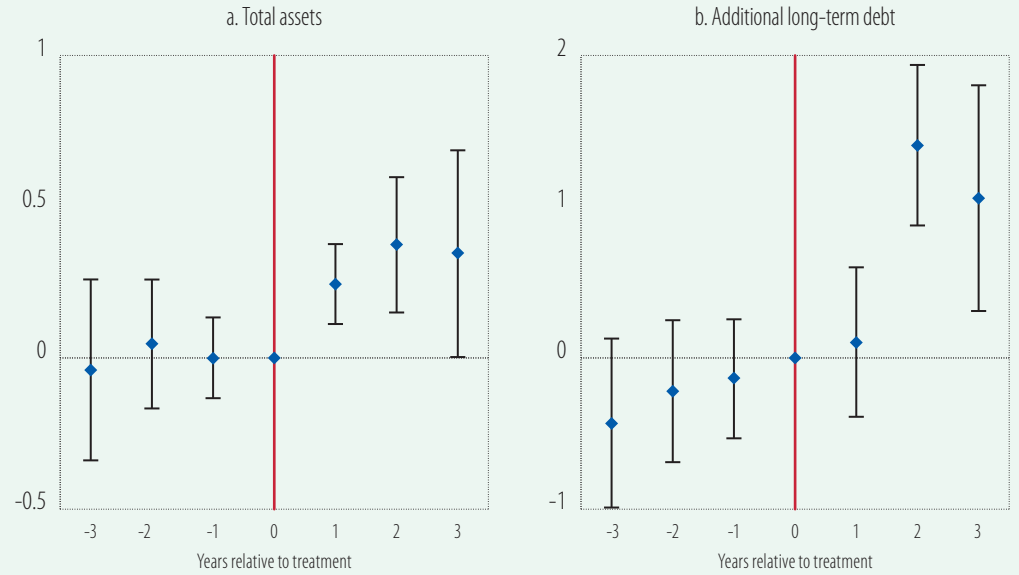
The EIB venture debt programme has been implemented as part of the European Fund for Strategic Investments (EFSI), a partnership between the European Commission and the EIB that offers alternative financing for European small and medium businesses. Rolled out in 2015, the programme saw constant growth over the ensuing years, with the EIB venture debt portfolio reaching a total of EUR 2.65 billion in loans by June 2021. Concerning sector coverage, the EIB venture debt portfolio has a strong focus on investments that benefit society, including health — for example COVID-19 vaccine development — e-mobility and sustainability.

A recent empirical study, one of the first to estimate the effectiveness of venture debt on firms' growth and performance, shows that the EIB's venture debt positively affects beneficiaries (EIB, 2022c).[29] The results in Figure C.2 show a strong and positive impact from EIB venture debt on firm growth. Panel (a) shows that EIB venture debt beneficiaries report one-third more total assets on average compared to firms that did not receive any venture debt. Panel (b) shows that the increase in total assets is partially driven by additional debt funding. Taken together, these results suggest that EIB venture debt beneficiaries experience higher growth due to the crowding-in of additional debt. In addition, EIB venture debt recipients report an average reduction in the cost of debt, defined as the ratio of interest paid over long-term debt, of 14% upon receiving venture debt (a price effect), although this result was not statistically significant.

The analysis also shows positive and significant results for the firms' value added, while results on turnover, employment and innovation are positive but not statistically significant. This likely reflects the small sample size and the recent nature of the programme. Since venture debt is a recent product with data for a limited number of years after signature, the study only considers short-term results (one to three years). Nevertheless, the current study indicates the strong initial value of the EIB's venture debt programme for recipient firms.

Figure C.2

Estimated impact of subscribing to venture debt



Source: *EIB estimates based on EIB allocation data linked to corporates' financials in ORBIS.*
Notes: *Dots represent the estimated effect for EIB beneficiaries compared to the ones in the control group, at each point in time. The effects are normalised to zero in the year prior to loan signature (t=-1) and can thus be interpreted as relative to the year immediately before signing the contract. The bands around the dots show the 90% confidence intervals of the estimates.*

29 The report compares 133 EIB beneficiaries to a control group made of firms that are similar to those that received venture capital, but did not get any venture debt (although these firms may still receive other forms of finance).

Stronger cross-border financial integration would bring benefits to the European Union

Financial integration requires long-term stability, which is hampered by recent political upheaval. During the soverign debt crisis, financial integration receded drastically. EIBIS 2022 shows that the war in Ukraine has increased precisely this kind of uncertainty. Cross-border financing may tighten as a result, especially in countries close to the conflict. The analysis above shows how that tightening would be determinental to the European financial system.

Integrated capital markets facilitate private risk sharing and therefore affect economic stability and resilience. Holding a more geographically diversified portfolio of financial assets provides asset returns that are not only less volatile but also less correlated with domestic income. When a country is hit by an economic shock, cross-border flows enable households and investors to lend or borrow to offset the shock's impact. Improving funding diversification therefore enhances cross-border risk taking and enables capital markets to play a greater role in reducing the domestic impact of a shock.

For economies to be resilient and able to absorb shocks, they require well-functioning risk-sharing arrangements. This is particularly important for countries in a monetary union where specific individual monetary policies cannot be deployed to dampen the shock. In the recent past, European countries have faced large common shocks triggered by the global financial crisis, the sovereign debt crisis and the COVID-19 crisis. Yet the impact of those shocks has varied substantially from country to country, suggesting limited risk sharing. Giovanni et al. (2022) look at public and private risk sharing in the euro area to analyse whether they complement each other or rather can substitute each other. Overall, the authors conclude that public risk sharing and the overall degree of risk sharing among countries are still comparatively low.

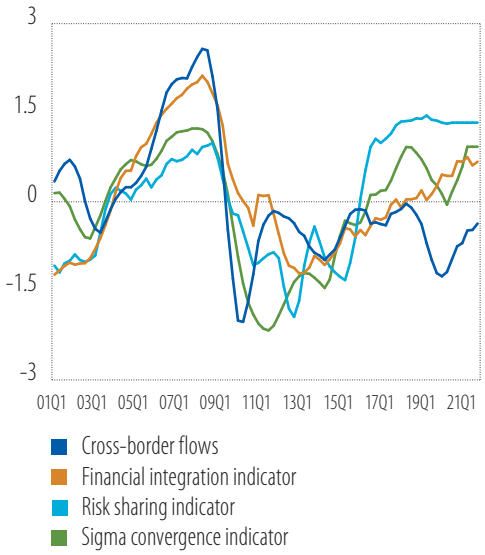
In Europe, cross-border financial integration rebounded following the global financial crisis and sovereign debt crisis and remained resilient during the COVID-19 crisis. Figure 39 shows two measures of financial integration (gross cross-border financial flows and financial integration indicators) together with two indications of the change accompanying integration: sigma convergence and risk sharing.[30] As explained above, greater integration increases risk sharing, and it reduces the correlation between domestic output and consumption. Decreasing sigma convergence indicates a reduction in the dispersion of GDP per capita. To make them comparable, the indicators are all de-meaned and standardised.

The estimated financial integration indicator evolves in a similar way to gross financial flows, while being less volatile. First, a rise in integration is associated with a rise in the intensity of cross-border financial flows. Second, the indicator correlates rather well with the other indicators. It is associated with an increase in risk sharing and in sigma convergence. Third, the indicator is less volatile than cross-border financial flows: The highs and lows were not as extreme. Interestingly, the sharp decline in flows at the beginning of the crisis was not shared by the other indicators, which continued to move upwards.

The indicator shows that financial integration in the European Union at the end of the period is still only around the levels of the mid-2000s. While the four indicators move together, actual cross-border financial flows tend to be more volatile. So far at least, the recovery in financial integration to levels before the COVID-19 crisis has persisted despite the removal of the unprecedented fiscal, monetary and prudential policy support deployed during the crisis. Borgioli et al. (2020) also find that the slump in financial integration after the COVID-19 crisis has been less marked and much shorter than after the global financial crisis or sovereign debt crisis. The substantial variability in the indicator is at odds with the view that financial integration is steadily improving in Europe.

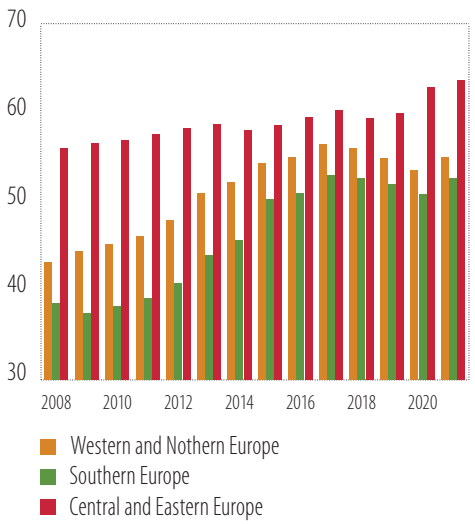
30 As the geographical breakdown of balance of payments is not published for most EU economies, gross flows relate to flows inside and outside the European Union. See Lake et al. (2022) for the construction of the financial integration indicators. The financial integration indicator is built using a Bayesian Factor Vector Autoregressive model (BFAVAR) and auxiliary dataset comprising around 100 series. The risk sharing indicator is obtained by estimating the correlation between GDP growth and aggregate consumption growth for a panel of 12 euro area countries excluding Ireland. The time series is constructed by concatenating panel fixed-effect regression coefficients in a 12-quarter rolling window. Sigma convergence is computed as the coefficient of variation of GDP per capita (the ratio between its weighted standard deviation and its weighted average). A lower value indicates a convergence of GDP per capita across countries. To make series comparable on Figure 38, the indicator is reported in reverse order. An increasing value indicates a reduction in disparities.

Figure 39
Financial integration indicators (de-meaned and standardised)



Source: *EIB staff calculations based on Lake et al. (2022), IMF and Eurostat.*
Note: *Gross capital flows equal the sum of inflows and outflows of direct, portfolio and other investments. Last record is the fourth quarter of 2021. The indicators have been de-meaned and standardised.*

Figure 40
Share of equity in foreign positions (% of external assets and liabilities, average over two years)



Source: *EIB staff calculations based on IMF data.*
Note: *Average share of foreign direct investment and portfolio equity in international holdings. Data is only available until the fourth quarter of 2021.*

Structural and cyclical factors explain movements in cross-border capital flows and in financial indicators. Estimated financial integration increases during upturns and recedes in downturns, and therefore contains a very strong cyclical component. True financial integration must be dissociated from boom-bust cycles (EIB, 2020; Lake et al., 2022). Sign restrictions are implemented in the BFAVAR model to disentangle the boom-bust component from the slow-moving process of true integration. The results show that financial integration was previously overestimated, as a substantial share of the hike was cyclical. Conversely, the drop during the global financial crisis and sovereign debt crisis was overestimated.

The quality of integration has improved in lockstep with the increase in equity's share of financial flows. Cross-border flows consist of foreign direct investment, equity and debt instruments in international portfolios, as well as other investment (encompassing mostly bank flows). Moreover, recent dynamics suggest that the quality of integration is improving much faster than the rebound in cross-border flows. Although all types of flows have been affected by the slowdown, some (foreign direct investment and portfolio equity) have proved more resilient than others (portfolio debt and other investment). This has resulted in a marked change in the composition of financial flows (EIB, 2018). Over time, the share of cross-border flows in foreign direct investment and portfolio equity flows has increased in the European Union as a whole and across the three regions (Figure 40).

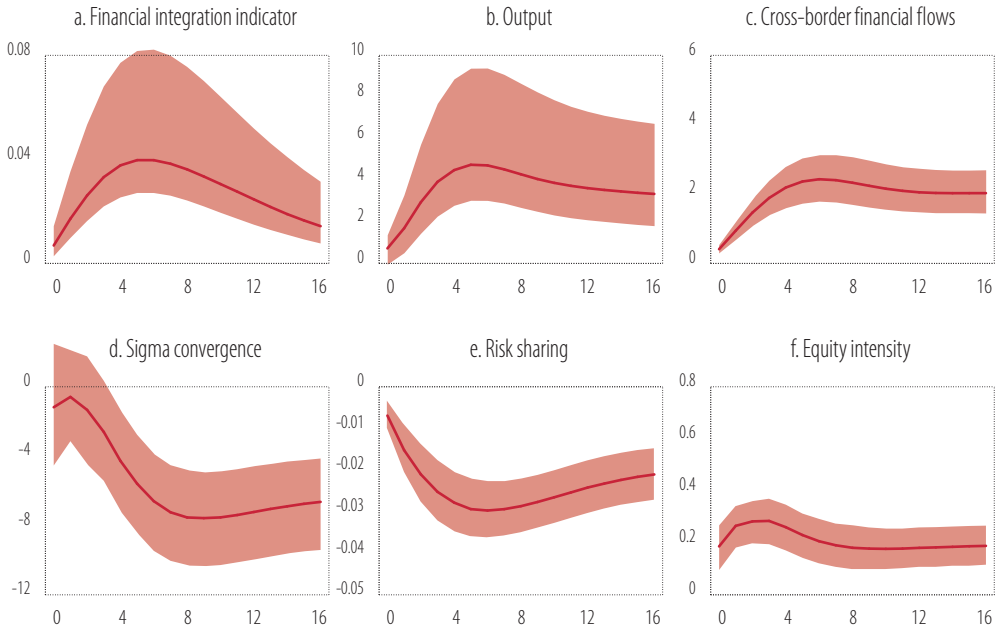
Financial integration raises output and fastens convergence within the European Union.[31] In Figure 41, the financial integration indicator grows more smoothly and peaks at 0.04 after around a year and a half,

31 A structural shock affecting financial integration over the long term and a true integration shock distinguished from a boom-bust shock underpinning the cyclical component are identified here. The financial integration shock is identified by remaining agnostic on the effect of all the variables in the short run, but by imposing sign restrictions in the long run. The shock positively affects the financial integration indicator, cross-border financial flows and equity intensity. Conversely, the last variable is expected to increase in response to a boom-bust shock. Indeed, the equity intensity indicator captures the idea of solid and structural integration. It is reasonable to think of this process as something that reduces financial fragmentation, not by purchasing cross-border debt, but especially by increasing cross-border equity holdings. This shock should also decrease disparities among EU countries and the extent to which they absorb the risk of their common financial market in the long run. Thus, given how the two indicators are built, the shock's impact is negative on both indicators. Lastly, an agnostic approach is applied to the effect of this shock on output, in both the short and the long run.

accounting for around a 13% increase from the last observed value of the series. The response is always positive and significant, and it approaches a steady state only at the end of the horizon period, exhibiting a longer-lasting shock effect. Output behaves in a very similar fashion, peaking at 0.4 percentage points after around five quarters, yet showing much greater persistence. Cross-border financial flows also increase more persistently, with their ratio to GDP peaking at around 2 percentage points around six quarters after the shock. In addition, unlike the previous shock, true integration produces significant responses to the sigma convergence and the risk sharing indicator. The sigma convergence is negative and significant over the long term, indicating a reduction in income disparities, and the risk sharing indicator is also negative and significant for the whole response horizon, showing evidence of risks being better absorbed by cross-border flows. Lastly, equity's share of those flows grows significantly, suggesting strengthened financial integration via increased cross-border equity holdings.

Figure 41

Financial integration benefits (response to an integration shock, percentage point deviation from baseline)



Source: *EIB staff calculations based on Lake et al. (2022).*
Note: *The solid red line is the posterior median response whereas the red shaded area corresponds to the 20% and 80% posterior percentiles.*

Along with the regulatory overhaul and the new institutions created after the global financial crisis and sovereign debt crisis, Europe's financial system was moving decidedly toward integration. Financial integration has increased to a moderate degree since the beginning of the 2000s. Besides enlargement, very little changed in the European Union regarding regulation and access to markets between the beginning of the 2000s and the global financial crisis. Financial integration continued to rise in the early 2000s (mostly following the introduction of the euro), but was not triggered by major changes.

The creation of the EU banking union in 2012, which responded to the sovereign debt crisis, still appears to be the force behind true integration (Coeure, 2013). This call for banking policy integration resulted in the establishment of the Single Supervisory Mechanism and the Single Resolution Mechanism in 2014. The Single Supervisory Mechanism enhances financial stability and integration by implementing common supervisory rules across all EU countries, and the Single Resolution Mechanism, including the Single Resolution Fund, resolves financial transactions for entities under the supervision of the ECB. Also, on the legislative side, the implementation of the Single Rulebook governing EU laws on the financial

sector contributed to integration. The implementation of the Capital Requirements Directive IV (CRD IV) was a critical step, as it implements Basel III. Together with more recent micro and macro policies, CRD IV protects EU financial institutions from systemic risk and financial contagion.

The regulatory overhaul and strengthening of the EU framework conducted since the global financial crisis further pushed European financial integration and helped financial systems withstand the coronavirus pandemic. However, while the banking sector is more resilient, the banking union, a process that is still unfolding, has not fostered much integration or generated gains in cross-border consolidation and portfolio diversification. Some components of the banking union (such as the European Deposit Insurance Scheme) have yet to be agreed. Moreover, progress on the banking union has been dwarfed by other events such as Brexit.

To further integrate the European financial system, policies must be implemented on several fronts. Guindos (2022) summarises the three directions that policymakers should prioritise. First, insolvency rules and withholding tax regimes need to be harmonised. Second, equity and risk capital markets must be supported by reducing European bias for debt-equity and to harmonise the venture capital frameworks of different EU members. Third, a reliable and transparent regulatory framework — such as sustainability disclosures and reliable standards — is needed to ensure faster progress on sustainable finance in the European Union.

Conclusion and policy implications

With the right policies, challenging environments can be transformed into opportunities for change. Empirical analysis shows that the policies and programmes deployed during the COVID-19 crisis have helped increase firms' resilience. Those policies and programmes enabled firms to transform and adapt to the new environment by accelerating digitalisation. Lessons learned during the pandemic could be useful tools for calibrating new policies to address the energy crisis and green transition. The energy crisis and the green transition are emerging as short- and long-term challenges for firms, and targeted support is needed to compensate vulnerable companies in the short term. Credible commitments to the net-zero transition could also serve as a signal to markets and could guide investors, particularly in such uncertain times.

The challenging environment raises the risk of entrepreneurs and investors developing an overly negative outlook. To avoid another decade of sluggish corporate investment, as was seen after the global financial crisis, progress must be made on structural changes to the European financial system. Policies need to focus on the huge challenges of cohesion, digitalisation and the greening of the European economy.

Access to finance might constrain firm development and growth, even when liquidity is abundant. Initial fears of massive bankruptcies during the COVID-19 crisis did not come to fruition, but the war in Ukraine is another shock adding to existing vulnerability. The relatively favourable developments seen so far rely heavily on the massive policy support still partly in place. This support is not tilted towards firms that were already weak before the COVID-19 crisis, but rather to those hardest hit. With monetary policy tightening and costs rising because of the war, how long will the mounting vulnerability take to materialise? Access to finance could (once again) become an issue, especially in Central and Eastern Europe. Firm profits — and therefore cash and solvency positions — will be affected just as banks potentially start to tighten credit.

Targeted financial support for firms has proven to be effective. Analysis of the policies deployed during the COVID-19 crisis broadly confirms that, in net terms, the policy support was highly beneficial to the economic system. In normal times, barring economy-wide shocks to demand, specific types of firms find it difficult to finance their investment plans, even when liquidity is abundant. For these firms, analysis shows that well-targeted financial instruments can help address liquidity issues. New emphasis on venture debt and support for venture capital funds are promising developments.

Faster and more wide-ranging European financial integration is a must. As explained throughout the chapter, many signals indicate that the level of productive investment is below optimum. In normal times, Europe is a net saver. It is therefore important to improve the circulation of private savings across the European Union, so that money can be allocated to projects across countries. Because savings accumulated are not necessarily matched to investment opportunities at the country level, facilitating financial flows is key. For this to happen, work on the Capital Markets Union 2.0 should be a top priority.

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PART II

Resilience and renewal

69% of EU firms **have adopted advanced digital technologies** vs. **70%** in **the United States**

Energy prices have risen between **10%** to **140%** **in various EU countries**

EU consumers in countries with the highest energy prices **pay three times more** than consumers in EU countries with the lowest prices

Productivity is

16%

higher for firms that **invested to become more digital** and operate in regions with fast internet

The share of EU firms seeing **energy costs as a major obstacle to investment** is **27%** higher in **less developed regions** than in **developed ones**

33% of **EU** firms **are pursuing climate change adaptation** vs. **29%** in **the United States**

29% of **EU** firms **view the transition to a greener economy as an opportunity**

88% of EU firms have taken at least **one action to reduce their carbon footprint**

10% of investment by **EU** firms **went to energy efficiency** vs. **6%** for **US** firms

61% of advanced digital firms in the European Union **invested in tackling climate change** vs. **36%** of **non-digital** firms

Chapter 4

Trends in regional and social cohesion

The economic consequences of the war in Ukraine risk exacerbating inequalities. Higher energy and commodity prices hit poorer households particularly hard because they have smaller financial buffers, spend relatively more on energy and food, and have less room to cut discretionary spending. For regions with significant energy-intensive production, the energy shock is accelerating the green transition to a breakneck speed. Regions with tight labour markets, especially in Central and Eastern Europe, stand to benefit from the arrival of highly qualified refugees from Ukraine, but those countries will also need to provide infrastructure to facilitate refugees' integration.

Social cohesion is at risk because the energy crisis has worsened the financial situation of households generally — particularly those that already lost income during the pandemic. Although policy support largely offset the pandemic's social impact, the financial situation of poorer, less skilled and younger households appears to have worsened compared to before the pandemic. Higher energy and commodity prices are now weighing particularly heavily on these groups. One reason is that their consumption spending is tilted towards food and energy. Another is that poorer households rarely own residential property, and therefore have not benefited from the increase in real estate prices. To counteract the effects of the energy price shock, governments have provided extensive support, balancing the need to act quickly with the desire to target the measures to those most in need.

Regional cohesion is at risk because the war in Ukraine places a greater burden on regions that are further east, those that have higher unemployment and those that rely on energy-intensive industries. Geopolitical crises are a source of uncertainty, and uncertainty depresses economic activity. There is tentative evidence that cross-border investment is starting to slow in EU members further east, which tend to be poorer. Within Central and Eastern Europe, it is mostly the richer regions (which offer better employment prospects) that are likely to benefit from the arrival of refugees. Many regions traditionally reliant on coal are also involved in energy-intensive production, and the transition towards a greener economy is being complicated by the energy shock, which is forcing energy-intensive firms to slow production. Authorities and firms in cohesion regions appear to have less capacity to step up and maintain high levels of the transformative investment needed for the green transition.

At times of tight national budgets, policy support should be precisely targeted, focusing on the groups and regions most affected. Even before the war in Ukraine, social and regional cohesion needed to be strengthened. Governments should make it easier for firms to transform, grow and innovate. They should avoid plain vanilla subsidies, and instead focus on supporting innovation and lowering widely recognised investment barriers. Good governance is important for improving the business environment, but it can be lacking in cohesion regions more often than in richer regions. Municipalities frequently cite access to finance as a constraint, particularly in cohesion regions. However, EU funds will provide ample support for improving the conditions for growth and convergence in cohesion regions, and the real challenge will be preparing and successfully implementing projects selected for investment.

Introduction

High inflation, amplified by the food and energy crises, is creating new challenges for social and regional cohesion. The rising cost of living is driving down living standards for all Europeans, but more vulnerable groups risk being hit harder, including those whose financial situation already deteriorated during the pandemic. The different regions of Europe will be affected in different ways — ways that reflect their economic structures and ability to transform. Geopolitical uncertainty might depress investment, particularly in regions closer to the European Union's eastern border. Migration from Ukraine poses challenges, but also brings opportunities, and it will ultimately be most beneficial for the regions that offer better employment prospects. As high energy costs drive the green transition relentlessly forward, regions with legacy industries (especially coal) will have greater difficulty keeping the social costs of transition contained.

This chapter examines the impact of the war in Ukraine on social and regional cohesion in the European Union. It consists of three sections. The first section analyses how social cohesion is affected by rising prices for food and energy against a post-pandemic backdrop. The section contains two boxes: one on how tackling energy poverty can support the green transition, and another on the impact of the energy price shocks on countries and households. The second section analyses the impact of the war on the various regions, focusing on geopolitical uncertainty, how Ukrainian refugees will affect the labour market and the energy price shock. The final section concludes with policy suggestions.

Another blow to social cohesion

Just a year after most pandemic-related restrictions had been lifted, the war in Ukraine has triggered another economic shockwave in the European Union and worldwide. Energy prices have skyrocketed, causing consumer price inflation to reach levels not seen for decades. Inflation has made everyone in the European Union poorer. Higher oil and gas prices have transferred wealth equal to about 3.5% of EU gross domestic product (GDP) to the countries that deliver fossil fuels to the European Union. And like with any inflation shock, poorer households are bearing the brunt. As a result, governments have once again moved to support households financially.

This section reviews the primary impact of the pandemic and the subsequent period of high inflation on the distribution of income and wealth, and it describes the main types of policies used to counter the regressive effects of these events.

Despite massive policy support, the pandemic may have left scars

The pandemic hit poorer households more severely than richer ones. Poorer households tend to work in professions less suitable for remote working, and under non-standard employment contracts that offer less protection against job losses. Eurostat (2020) estimates that compared to the previous year, aggregate income from employment in the second quarter of 2020 fell by about 7.5% for low-income earners and just over 5% for medium-income earners, but by less than 4% for high-income earners.[1] For all income groups, most of this income loss was due to work absences. It is only for the lowest income group that unemployment accounted for a substantial proportion (almost 2 percentage points) of the overall loss in income.

1 The lowest income group combines the bottom three deciles of the income distribution, while the highest combines the top three deciles.

Early studies suggest that policy support offset the regressive impact of the pandemic in the short run (see for example Palomino et al. (2020); Almeida et al. (2020) or Clark et al. (2020)).[2] The share of people at risk of poverty or social exclusion in the European Union increased, but not by much: from 21.1% in 2019 to 21.7% in 2021, with some variation across countries.[3] Job retention schemes prevented job losses of most underoccupied employees.[4] Clark et al. (2020) show that in Germany, Spain, France, Italy and Sweden, inequality (as measured by the shares of income going to different income groups) first widened from January to May 2020, and then decreased back to pre-crisis levels by September 2020.[5]

However, some evidence shows that the financial situation of poorer households deteriorated more drastically. The European Commission's consumer survey provides rich evidence about how the pandemic affected different segments of society.[6] The financial situation of many low-income households deteriorated more than that of high-income households (Figure 1, blue bars). Furthermore, while the share of low-income households with a financial surplus in March 2021 had not changed since the start of the pandemic, that of high-income households had increased (Figure 2, blue bars). This may be because high-income households typically buy more discretionary items, which they could consume less of during the pandemic. The observation that high-income households cut their spending more during the pandemic is also supported for the United Kingdom by Hacıoğlu-Hoke, Känzig and Surico (2021) based on transaction data from a large personal financial manager. Across the European Union, the differences between low- and high-income households are also reflected in those between households with lower and higher levels of education, arguably because higher education is typically associated with higher income.

The financial situation of younger households also appears to have deteriorated more than that of older households. The financial situation of younger households worsened during the pandemic, which may well reflect an initial reduction in employment (shown below). By contrast, there is almost no change in the financial situation of older households from February 2020 to March 2021 compared to the 12 months leading up to the pandemic. In addition, while the share of younger households with a financial surplus in March 2021 was only moderately higher than in February 2020, a sharper improvement was seen among older households. The smaller impact on older households is not surprising because their income consists largely of pensions, which were unaffected by the pandemic.

Scarring effects, which could have hit poorer and younger households relatively hard, appeared largely contained by the speed of the 2021 economic recovery. During the pandemic, employment rates tended to fall more for young people, those without higher education and immigrants from outside the European Union, all of whom tend to earn less money. Had their spells without employment lasted longer, these groups might have lost some of the skills needed to become re-employed. The rapid economic recovery certainly facilitated their re-employment. On average in 2021, the employment rates of some groups were still below pre-pandemic levels. For example, the share of young people from 15 to 29 years of age who were not in employment, education or training exceeded 2019 levels. The same was true for people not native to their EU country of residence (Figure 3). In contrast, the employment rates for people with lower secondary education or below returned approximately to their pre-pandemic levels, just as they did for those with higher education.

2 Stantcheva (2022) provides a detailed literature overview of the distributional impact of the pandemic.

3 There is a break in the Eurostat data measuring the share of persons at risk of poverty in 2020 for many EU countries, including Germany and France. Among the countries without a break in the data, Spain stands out with an increase of 0.9 percentage points from 2020 to 2021 for persons at risk, as does Greece with a decrease of 1.6 percentage points.

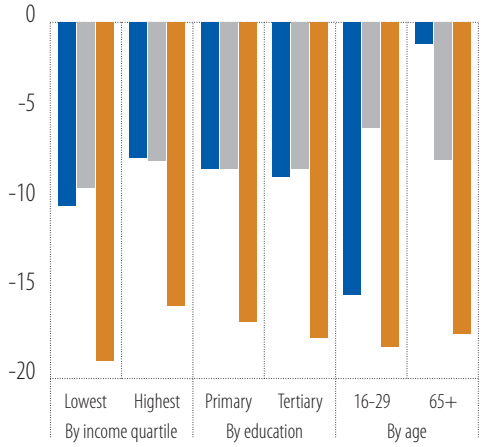
4 See for example Müller et al. (2022) for a discussion of the characteristics of job retention schemes across different EU countries.

5 Eurostat (2020).

6 We interpret the confidence scores relative to their pre-pandemic values, which is an attempt to abstract from changes in the composition of the different income groups.

Figure 1

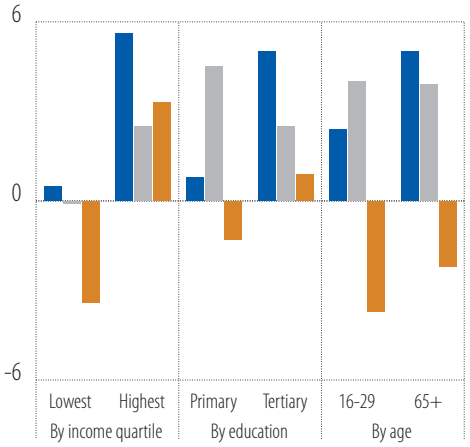
Effect of the pandemic and the war in the Ukraine on households' financial situation during the preceding 12 months (index points, changes vs. February 2020)



Source: *EIB staff estimates based on Eurostat data.*
Note: *The bars show the change in an index of households' financial situation relative to February 2020. The index quantifies households' qualitative assessments of their financial situation, from "Our financial situation has considerably deteriorated over the past twelve months" to "Our financial situation has considerably improved over the past twelve months."*

Figure 2

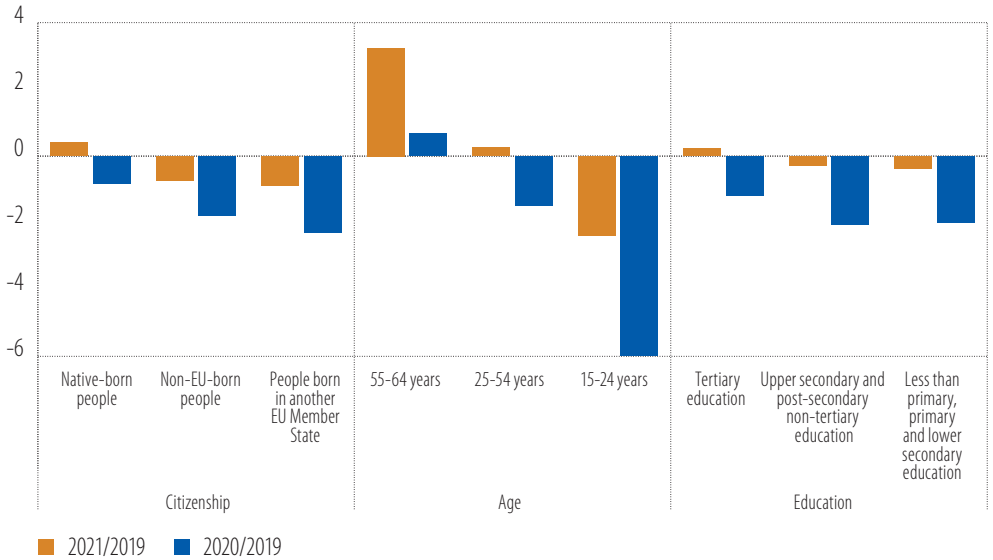
Effect of the pandemic and the war in the Ukraine on households' financial surplus (index points, changes vs. February 2020)



Source: *EIB staff estimates based on Eurostat data.*
Note: *The bars show the change in an index of households' financial surplus relative to February 2020. The index quantifies households' qualitative assessments of their financial situation, from "We are taking on debt" to "We are saving a lot."*

Figure 3

Change in employment rates since 2019 (percentage points)**, by education, age, and citizenship**



Source: *EIB staff estimates based on Eurostat data.*
Note: *There is a break in the time-series data for non-EU-born people from 2020 to 2021.*

In the longer run, increasing remote work might widen the gap between higher and lower incomes. Remote work is incompatible with many lower-income jobs (Sostero et al., 2020) but it tends to increase the productivity of higher-income workers. Based on a representative survey on self-reported productivity conducted in June 2020 in the United Kingdom, Etheridge et al. (2020) show that low-income workers report being less productive than a year before the pandemic, in contrast to workers with higher incomes. Differences also exist between sectors. Workers in the education, administrative, entertainment and accommodation sectors report significant decreases in productivity, while those in the financial, insurance and information technology sectors report increases in productivity.

The energy crisis weighs more heavily on poorer households than richer ones

The energy crisis triggered by the war in Ukraine worsened the financial situation of all households, and it seems to have degraded the finances of poorer and older households more severely. In March 2022, high- and low-income households judged the evolution of their financial situation (Figure 1, grey bars) to be equal to that of March 2021 (Figure 1, blue bars). At the end of the first nine months of the war in Ukraine, all households reported that their financial situation had deteriorated further (Figure 1, orange bars). At the same time, low-income households were much more likely to have to take on debt than high-income households, most of whom continued to save (Figure 2, orange bars). Energy poverty, already an issue before the energy crisis (Box A), is likely to have worsened during the pandemic.

Box A

Energy poverty at the outset of the Ukraine crisis

Energy poverty is a persistent problem for many households across the European Union, and it has been aggravated by increasing prices. From 2019 to 2022, spending on energy increased by more than one-third on average across EU members. In some countries, it almost doubled. High and rising prices and a weakening economic climate increase the risk that even more households will no longer be able to pay their bills (Halkos and Gkampoura, 2021; European Commission, 2022a).

Energy is vital for good living conditions. Energy poverty can negatively affect living and health conditions (Thomson et al., 2017). Different indicators are used to measure and track energy poverty across the European Union (Thema and Vondung, 2020). These include expenditures (for example, comparing the energy costs of households against predefined thresholds), self-reported assessments and direct comparisons (like tracking energy consumption, such as heating in homes, against a standard). We compile such indicators using data from the EU Statistics on Income and Living Conditions (EU-SILC) to measure energy poverty.

While the share of households affected by energy poverty has been shrinking in recent years, the recent spike in prices could reverse that trend. Past shocks and crises like the European sovereign debt crisis and the COVID-19 crisis were associated with increases in the share of people experiencing energy poverty across the European Union. In fact, periods of crisis have been found to result in energy poverty, through changes in household income, austerity measures and high energy prices (Halkos and Gkampoura, 2021).

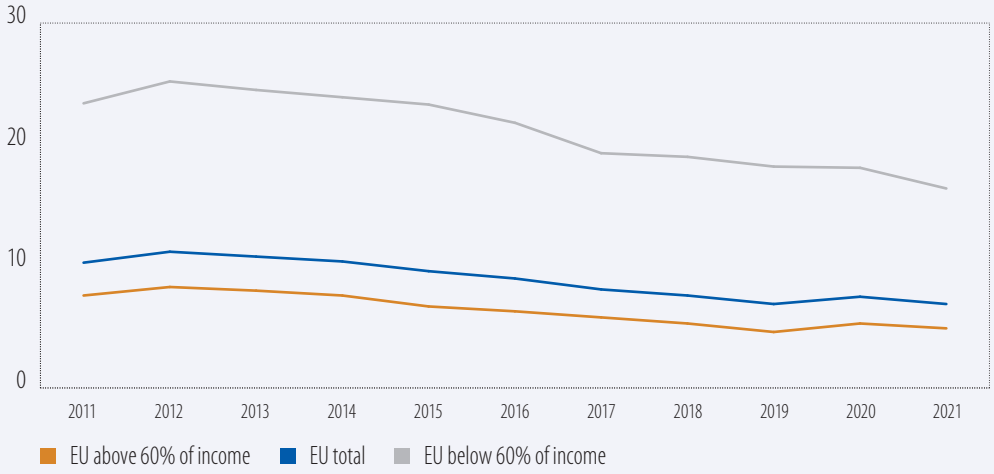
While the share of energy poor households has decreased across income levels, poorer households remain more than three times as likely to experience energy poverty compared to more affluent ones. Differences among income levels persist (Figure A.1).

Household characteristics influence energy poverty. While income is a key driver, household size, type of employment contract and building quality also have an impact. In the European Union, households in rural areas report energy poverty more often. In addition, older people, single-person households

with dependent children, and those with three or more children are more often affected (Figure A.2). Analyses also suggest that the least energy-efficient households (those in poorly insulated dwellings) are more likely to be energy poor.

Figure A.1

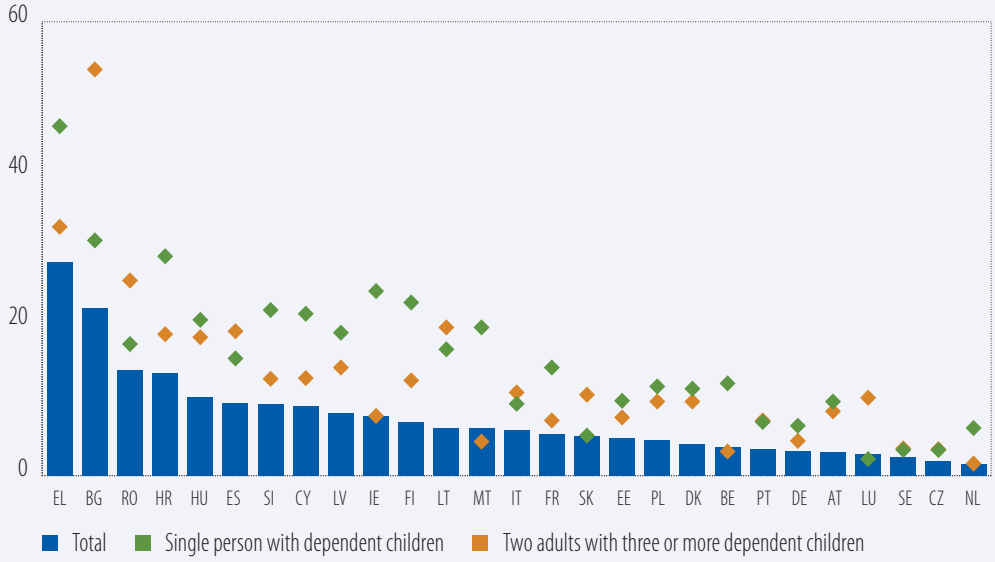
Share of people in the European Union (in %) **that cannot keep their home adequately warm, by income**



Source: *European Union Statistics on Income and Living Conditions (EU-SILC).*

Figure A.2

Households (in %) **in arrears with utility bills in 2020, by household type**



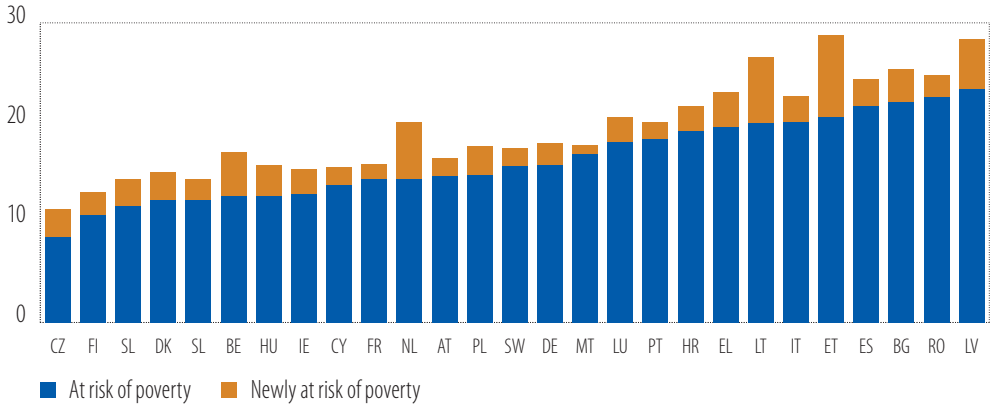
Source: *EU-SILC.*

Tackling energy poverty has three dimensions: social, energy supply and infrastructure. For fragile social groups, income support for vulnerable households and measures to facilitate labour market participation can help reduce energy poverty. Energy policies also play a crucial role, by ensuring a supply of energy at affordable prices. Finally, investment in infrastructure such as energy generation and networks, but also in housing that is energy efficient and affordable, can reduce energy poverty levels and increase households' ability to withstand further energy shocks.

One reason for the greater impact of inflation on households with lower incomes is that their spending is tilted towards food and energy. Inflation has risen since Russia's invasion of Ukraine — most dramatically for energy and food, on which poorer households tend to spend a greater share of their income. From August 2020 to August 2021, the price of the consumption basket of the poorest 20% of households in the European Union increased by 11.4%, about 3 percentage points more than the consumption basket of the richest 20% of households. Soaring inflation is likely to push more people in the European Union into poverty (Figure 4), and more so in countries with an already unequal distribution of income (Figure 5). Box B provides details.

Figure 4

Share of the population (in %) **at risk of poverty because of rising prices**



Source: *EIB staff estimates based on Eurostat and the European Commission 2022.*
Note: *Blue bars indicate existing shares (end of 2021). Orange bars show estimated increases. See Box B for details on computation.*

Figure 5

Increase in the share of the population at risk of poverty vs. income inequality, by region

Source: *EIB staff estimates based on Eurostat.*
Note: *See the annex for details on computation for share of people newly at risk of poverty as a result of recent price increases. The GINI coefficient (X-axis) measures inequality among values of the income distribution with higher values indicating greater inequality.*

Box B

The impact of energy price shocks on countries and households

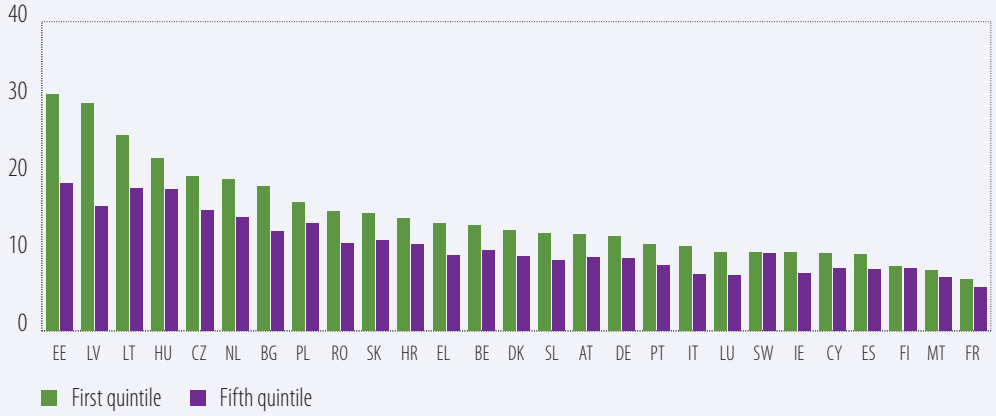
This box explains how we derived the impact of the higher food and energy prices on households' real disposable income, and consequently their risk of falling into poverty (Figure 4 and Figure 5 in the main text). We follow Eurostat in defining households "at risk of poverty" as those with disposable income (including transfers) below 60% of the median. The estimation depends on three factors: the size of the price shock, consumption patterns at different points of the income distribution, and the shape of the income distribution itself, because it determines the threshold for poverty.

The price shock tends to be larger in countries with lower per-capita income (such as countries in Central and Eastern Europe). We define the shock as the change in the contribution of energy and food prices to headline inflation relative to a calm period: January 2003 to June 2007. In this period, headline annual inflation averaged 2.1% in the euro area, to which food contributed 0.5% and energy 0.6% (a total of 1.1%). During 2022, the combined contribution of food and energy to headline inflation was about 5.9%.[7] Our estimate of the energy and food price shock (that is, the abnormal contribution of energy and food prices to inflation) is therefore (after rounding) 4.7%. The size of the shock differs substantially across countries because the weights of food and energy in the national consumption basket differ[8], because of measurement issues and different market structures of these goods in each country. The shock ranges from 0.9% in Malta and 2.7% in France, to 12% in Lithuania and 14.8% in Estonia.

The impact of higher food and energy prices is larger for poorer households, which spend more of their income on food and energy. The weights of food and energy in the consumption basket differ not only across countries, but also across households within a country. They are provided in the EU-SILC database by quintile of the income distribution. The consumption basket of households with lower income contains a larger share of food and energy. The price of the consumption basket of low-income households is therefore rising more steeply than that of high-income households. The differences tend to be bigger in countries where income is less equally distributed, and particularly large in the Baltic states and Greece (Figure B.1).

Figure B.1

Estimated increase (in %) **in prices from August 2022 to August 2021, by country and income quintiles**



Source: *EIB staff estimates using Eurostat and EU-SILC data.*

7 At the time of writing, figures were available only until August 2022. We assume that for the remainder of the year, annual food and energy price inflation remained at their August 2022 levels.

8 The weights in the Harmonised Indices of Consumer Prices (HICP) for Member States are different and based on each national consumption basket (see Box B in Chapter 1).

Rising food and energy prices shift all real incomes down, although the effect is bigger for lower-income households. The price shock causes the entire distribution of real disposable income to shift down. Several assumptions must be made to approximate the increase in the share of households below the poverty line because the details of the income distribution are not known. (Consumption basket weights are only available by quintile, but Eurostat publishes household income data by decile.) We assume that the consumption basket weights are identical for all households within a quintile, and that the incomes are identical within each decile. We also hold constant the real value of the poverty threshold, with households below it assumed to be at risk of poverty.

Estimates find that around 11 million people may fall into poverty in the European Union. The price shock exacerbates poverty to a greater degree in countries that have higher inequality and experience a larger shock. The countries tend to be in Central and Eastern Europe. In the Baltics, the effect is particularly pronounced. A comparatively large share of households was just above the poverty line, and rising energy prices has pushed that share below the poverty line. There are exceptions to this pattern, however. Countries experiencing a relatively contained price shock but that have an uneven income distribution — like Greece or Italy — could potentially have a large increase in the number of people at risk of poverty.

Inflation also lowers the wealth of poor households more because they have not benefited from the increase in real estate prices. The net wealth of richer individuals rose from 2019 to 2021, but for the poorest wealth decile it declined (Figure 6). Over the past two years, the composition of financial assets has had relatively little influence on the cumulative real return of households' portfolio (Figure 7). The real value of equity shares, which comprise a much smaller share of poorer households' portfolios, did not resist inflation better than bank deposits because the pandemic and the energy shock lowered corporate earnings. However, poorer households are less likely to own residential property, for which prices have increased rapidly since the start of the pandemic. Of the poorest one-fifth of households, only 7.2% own any real assets, compared with 94% of the richest one-fifth.[9] Households in the middle of the wealth distribution, which tend to have more debt than poorer households, may ultimately benefit from the declining real value of their mortgages.

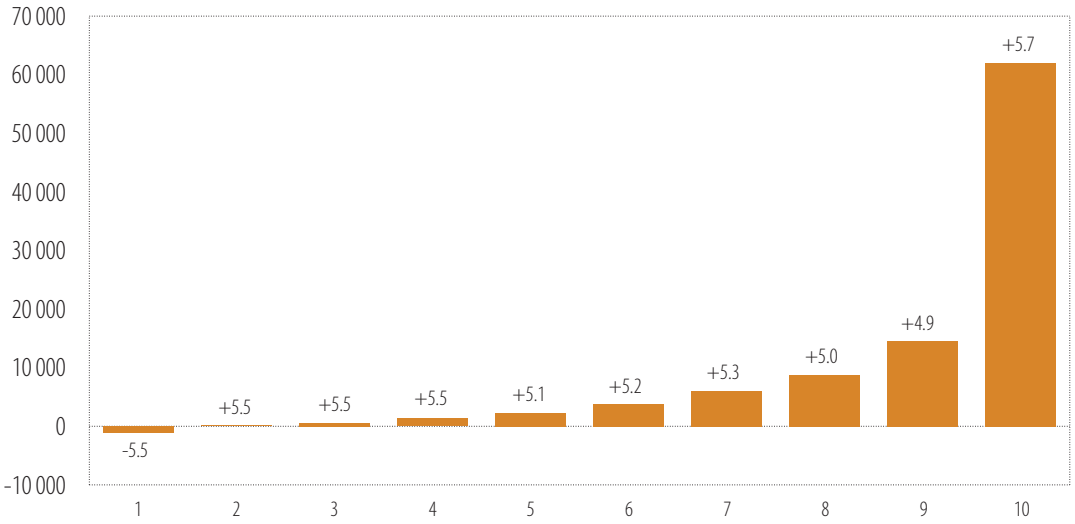
Low competition for bank deposits means that poorer households are unlikely to benefit immediately from higher central bank policy rates. By mid-2022, all EU central banks had increased their policy rates to fight inflation — some by over 5 percentage points (see Chapter 1). All households benefit from lower inflation, in particular poor households, for the reasons discussed in this section. However, the transmission of monetary policy to deposit rates has been much slower than to lending rates (see Figure 8 for the euro area; the effect is more pronounced in some non-euro EU countries whose central banks increased interest rates more). Loan rates are rising rapidly, which puts pressure also on households in the middle of the wealth distribution whose mortgage payments become more expensive.

Households whose financial situation is deteriorating are less confident about their ability to withstand inflation. Households facing financial difficulties have less resources to deal with higher prices (Figure 9). One reason is that poorer households, by definition, have smaller financial buffers. Another reason is that poorer households often have fewer options for adapting their spending, which is more focused on necessities. Already in 2017, regular expenses were eating up more or all of the income of three-quarters of households in the bottom wealth quintile, where median annual gross income was EUR 17 900. People in households already stumbling from higher prices caused by the Ukraine war reported more frequently that they were feeling uncertain and helpless.[10]

9 Real assets consist of real estate, vehicles and, for the self-employed, businesses. For the average household, by far the largest share of real assets is in real estate.
10 European Commission (2022), Question 10.

Figure 6

Net personal wealth per adult in the European Union (in EUR, purchasing power parity)**, by wealth deciles**



Source: *World Inequality Database.*
Note: *The height of the columns shows the absolute growth in net wealth. The numbers over the bars indicate the change. Household wealth is defined as the sum of financial assets (such as deposits, stocks, bonds, equity) and non-financial assets (such as housing, business), net of debts, owned by individuals. The purchasing power parity is based on 2021 prices.*

Figure 7

Real value of shares, bank deposits, and residential property, euro area (2019Q4=1)

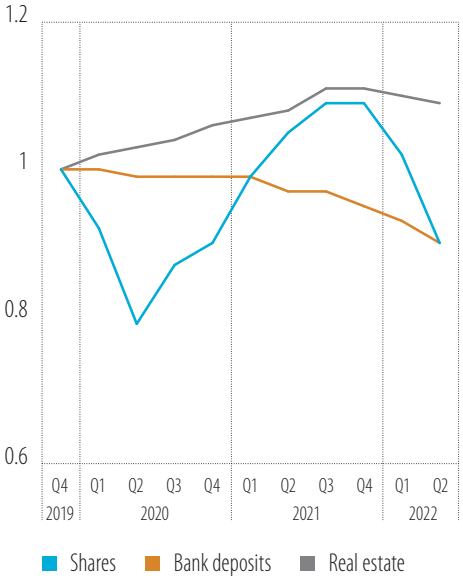
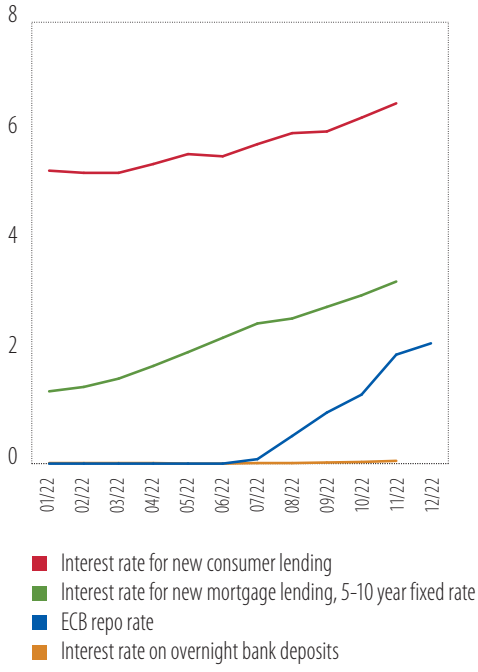


Figure 8

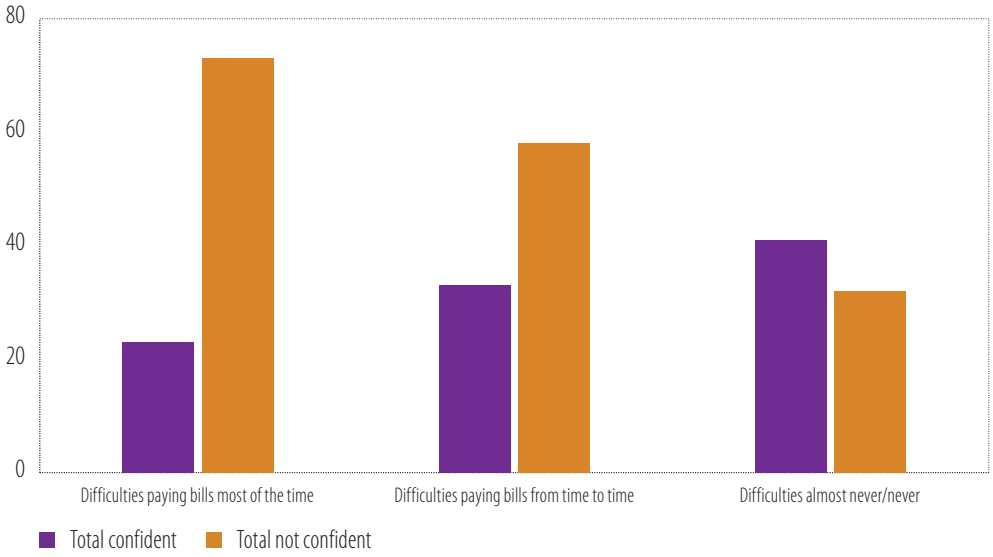
European Central Bank policy rate and selected euro area bank interest rates (in %)



Source: *EIB staff estimates based on European Central Bank (ECB) data.*

Figure 9

Individuals' confidence that the Ukraine conflict will not affect them personally (in %)**, by financial situation**



Source: *European Commission 2022, EIB staff estimates.*
Note: *Interviews for the special Spring Eurobarometer commissioned by the European Parliament took place in April and May 2022.*
Question: *Thinking about the war in Ukraine and its potential consequences on your life, how confident do you feel that your life will continue unchanged?*

Governments provided massive support to soften the impact of the energy price shock. For most EU countries, governments announced measures for households and firms worth 2% to 5% of GDP from September 2021 to October 2022 (see Chapter 1). The support is equal to about half of the support that EU countries provided for the pandemic from January 2020 to October 2021.[11]

The support measures aimed to quickly help those most in need while encouraging energy savings. Meeting both objectives simultaneously proved difficult, in part because of the time it takes to develop well-designed policies and because of technical constraints, such as the availability of data on household wealth. Instead, most governments initiated a range of support measures, some of which were available quickly, while others were more targeted and took longer to implement or retained more of an incentive to save energy. As of November 2022, all EU countries lowered retail prices of energy by reducing taxes, regulating prices, or instructing state-owned energy companies to lower their prices. Depending on the design, richer and poorer households benefited. Most countries supplemented these measures with transfers to vulnerable groups like poorer households and families (Sgaravatti et al., 2021).

The future financial situation of poorer households also depends on how the energy crisis affects the labour market. At the time of writing, labour markets have proved resilient to the energy price shock. In the third quarter of 2022, 3.2% of jobs in the European Union were vacant, more than during the same quarter in 2019. In that quarter, average EU vacancy rates were higher in all sectors than before the pandemic, and were particularly high in accommodation and food services, as well as construction. More detailed information is available for some EU members. In Germany, for example, low-skilled jobs that were filled in November 2022 had been open for an average of 161 days — more than a month longer than a year earlier, and not far below the time it took to fill vacancies for professionals (175 days). Nevertheless, some national labour markets appeared to cool, and the risk of bankruptcies was rising (see Chapter 3).

11 IMF (2021) estimated in November 2021 that the value of "above the line measures" by EU countries and the European Union was 11.4% of EU GDP.

The war in Ukraine endangers regional cohesion, with Central and Eastern Europe most at risk

The invasion of Ukraine has sent shockwaves throughout the European Union, but its effects appear concentrated in Central and Eastern Europe. This section discusses three main ways in which the war in Ukraine could hamper regional cohesion in Europe. First, geopolitical uncertainty could shift investments away from regions close to the conflict area. Second, immigration from Ukraine is likely to contribute more to the growth of richer regions where employment prospects are better. Third, the energy crisis, which is accelerating the green transition, will burden regions that were already struggling with the transition.

Geopolitical risks facing Central and Eastern Europe could slow cohesion

Geopolitical crises are a source of uncertainty, and uncertainty depresses economic activity. The war in Ukraine creates uncertainty around energy security and raises the risk of violent conflicts in Europe. It is well known that uncertainty hampers economic activity (Chapters 1–3). Hoping for uncertainty to be resolved over time, firms tend to postpone investment decisions and to hire less (Caldara et al., 2022). Moreover, households delay spending on larger items or on consumer durable goods (Coibion et al., 2021). As geopolitical uncertainty adds to other sources of uncertainty, it depresses economic growth. This section tries to identify the impact geopolitical uncertainty has on investment. It finds clear signs that geopolitical uncertainty has increased, and that it is affecting public investment. There is also some tentative evidence that corporate investment is responding as well.

Russia's invasion of Eastern Ukraine amplified geopolitical risks — particularly in Eastern Europe, where it triggered higher military spending. News reports related to the geopolitical risks became more frequent around the Russian invasion (see for example Caldara et al., 2022). For many European countries, this surge of concern and commentary is the highest increase in decades. People in countries further east in the European Union are more likely to believe that the invasion in February 2022 poses a threat to their country's security (Figure 10). However, concerns about geopolitical risk pre-date the Ukraine invasion and have prompted countries to invest in their military capacities. Since the Russian invasion of Crimea in 2014, the easternmost NATO countries in the European Union have increased military spending by more than those further west (Figure 11).

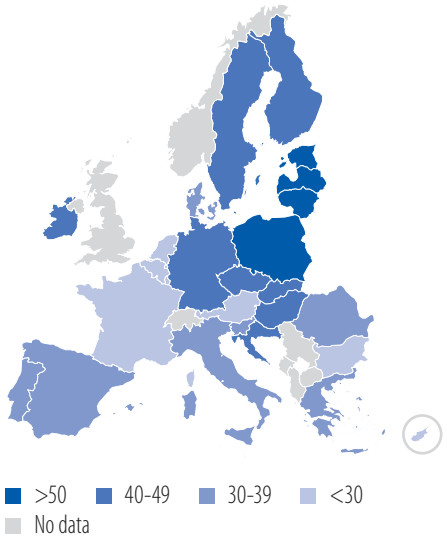
If higher geopolitical uncertainty in Eastern Europe depresses investment, it could slow cohesion. Regions further east in the European Union tend to have lower GDP per capita compared to the EU average and to the country in which they are located. Most of the regions are cohesion regions, which tend to be less developed and have per-capita income that is below 75% of the EU average.

We compare the geographical pattern of geopolitical uncertainty with that of corporate investment to see whether uncertainty might have caused investment to decline. We compare the evolution of two variables across EU regions since February 2022: the importance of uncertainty as an obstacle to corporate investment, and the number of merger and acquisition (M&A) announcements. We observe that uncertainty obstructed investment more in Central and Eastern Europe, and that the number of M&A announcements with targets further east fell by more than those with targets in the rest of the European Union, and tentatively attribute this to geopolitical uncertainty.

Uncertainty appears to be hindering investment further east in Central and Eastern Europe, but the role of geopolitical risk is unclear. The EIB Investment Survey (EIBIS) measures the importance of uncertainty about the future as an obstacle to corporate investment — without, however, specifically identifying the sources of uncertainty. The answers collected in the second quarter of 2022 show that uncertainty increased since 2021, and that it is a bigger investment obstacle for countries in Central and Eastern Europe, plus Finland (Figure 12). These results are obtained when controlling for firm-specific characteristics (sector, size, age, sales growth, profitability and activity in trade) and the importance of other investment obstacles (lack of demand, lack of skilled staff, high energy costs, inadequate digital

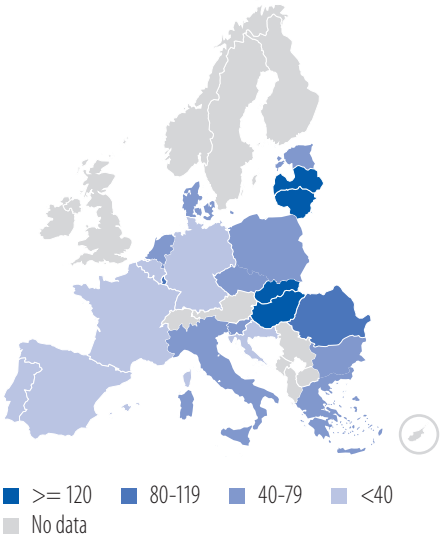
or transport infrastructure, labour or business regulations, and access to finance). However, the results only indicate the impact of geopolitical uncertainty on investment, because not all uncertainty can be attributed to the geopolitical crisis.

Figure 10
Share of respondents (in %) **who believe the Ukraine war is a threat to their country's security**



Source: *European Commission 2022.*
Question: *Please tell to what extent you agree or disagree with each of the following statement: "The invasion in Ukraine is a threat to the security of our country." The map shows the share of respondents who "totally agree" with the statement. (The other options were "Tend to agree," "Tend to disagree," and "Totally disagree").*

Figure 11
Increase in military expenditure from 2014 to 2022 for EU NATO members (in %)**, inflation adjusted**

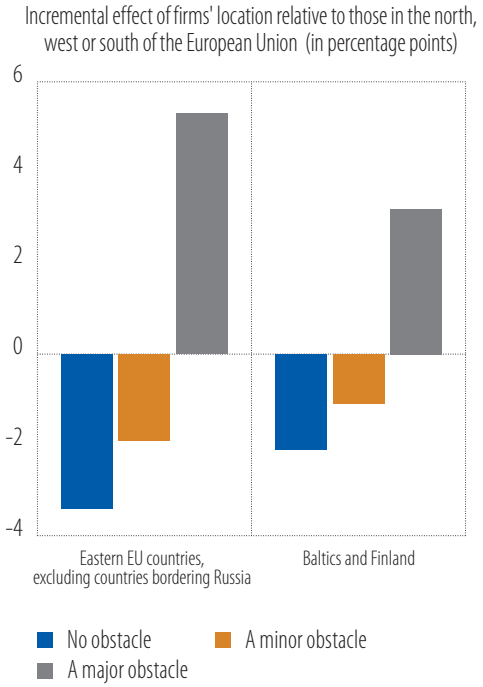


Source: *NATO 2022.*
Note: *Figures for 2022 are estimates.*

There are some early signs that geopolitical risk may dampen cross-border investment in Central and Eastern Europe. Cross-border M&A activity typically responds to political uncertainty in developing and emerging markets (Cezar et al., 2020). M&A announcements with targets in Ukraine collapsed after the country was invaded, compared to the same period in 2021.[12] To see whether the war might already have influenced the location of M&A targets in the European Union, we regress the region in which cross-border M&A targets are located on factors that might determine the location of the acquiring firm's investment. We look at whether the transaction was announced after the war broke out (24 February 2022 to 11 December 2022) or during the corresponding period in 2021; the sector in which the target firm is operating; and, as a proxy of the acquirer's funding costs, whether at least one of the acquiring firms is located in the euro area. The marginal effects of the time of announcement are small but significant (Figure 13). The likelihood that the target firm is located in EU countries bordering Russia was 1.4 percentage points lower from 24 February 2022 to 11 December 2022, compared to the same period a year earlier. For target firms located in Western and Northern Europe or in Southern Europe, the likelihood is 1.7 percentage points higher.

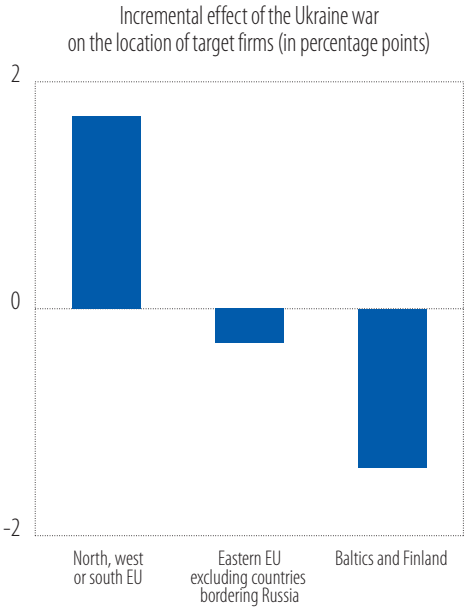
12 According to the Bureau Van Dijk's ORBIS database, five M&A announcements were made from 24 February 2022 to 11 December 2022, compared with 73 announcements concerning minority stakes, capital increases or acquisitions during the same period in 2021.

Figure 12
Likelihood that uncertainty is an obstacle to investment, by firm location



Source: *EIBIS 2022, EIB staff estimates.*
Note: *The bars show how a firm's location influences the likelihood that it will report uncertainty is an obstacle to investment. For example, in the EU countries bordering Russia, the likelihood that a firm reports uncertainty is a major obstacle to its investment is 3.2 percentage points higher than for firms in northern, western and southern EU countries. Estimates are derived from an ordered logit regression that takes the importance of uncertainty as an investment obstacle as a dependent variable. Controls are described in the main text.*

Figure 13
Likelihood of merger and acquisition announcements, by target location



Source: *ORBIS M&A 2022, EIB staff estimates.*
Note: *The bars show how the date when a cross-border M&A transaction is announced influences where the target firm is located. For example, the likelihood that the target firm is located in the EU countries bordering Russia was 1.4 percentage points lower from 24 February 2022 to 11 December 2022 than during the corresponding period a year earlier. Estimates are derived from a multinomial logit regression that takes the location of the target firm as a dependent variable. Controls are described in the main text.*

So far, the estimated impact of geopolitical uncertainty on investment appears to be small, and it remains tentative. Geopolitical uncertainty is only one determinant for investment decisions, alongside skills and labour costs, government subsidies, infrastructure, good governance and a predictable regulatory environment. Also, cross-border mergers and acquisitions can take many months, if not years, to prepare. While announcements are timely signals of M&A activity, they may not yet have responded to the increase in geopolitical risk.

Migration from Ukraine is alleviating labour shortages in Central and Eastern Europe, while weighing on some municipalities' social infrastructure

The invasion of Ukraine triggered the largest displacement of people in Europe since World War II. The conflict displaced about one-third of Ukraine's population of over 40 million, most within Ukraine (United Nations High Commissioner for Refugees (UNHCR), 2022a). As of early December 2022, about 7.9 million Ukrainians had resettled across Europe, with almost 4.8 million registered for the European

Union's "Temporary Protection" or similar schemes (see below and UNHCR, 2022b). Most Ukrainians sought refuge in Central and Eastern Europe. Poland, Slovakia, Hungary, Romania and Germany received the largest number of refugees (UNHCR, 2022a). Refugees appear to have headed mostly for more densely populated, richer areas where employment prospects are better (Mulvik and Siarova, 2022).[13]

Regions that successfully integrate refugees into their labour market will benefit more from their arrival. The existing evidence suggests that migrants can help to ease labour shortages, moving to industries and occupations where their labour is most needed. Their impact on wages is relatively small (Kahanec and Zimmermann, 2016; Kahanec and Guzi, 2017; Kahanec and Pytlikova, 2016). Broadly speaking, however, refugees find it more difficult to enter the labour market compared to other migrants (Organisation for Economic Co-operation and Development (OECD), 2016). Health, language skills and social networks present particular challenges for the integration of refugees. Constructing policies that take these challenges into account may therefore help ease the integration of refugees into the workforce and society as a whole (Brell et al., 2020).

Some EU countries have benefited substantially from earlier immigration from Ukraine. Here, Poland stands out for the size of its Ukrainian immigration since Russia's occupation of Crimea in 2014. In 2021 alone, Poland issued around 325 000 work permits for immigrants from Ukraine.[14] In contrast to earlier years, when most migrants from Ukraine sought employment as temporary workers in the agricultural sector, immigrants since 2014 predominantly settled in cities and sought work across a broad spectrum of economic sectors (Strzelecki et al., 2020). Strzelecki et al. estimate that this immigration increased Polish GDP by about 0.5% per year, accounting for over one-tenth of Polish GDP growth from 2013 to 2018.

Ongoing immigration from Ukraine is likely to increase the labour supply significantly in the Czech Republic, Poland and Estonia, and throughout the EU primarily in the services sector. Based on the size of the refugee population relative to their host countries, as well as the historical activity and historical employment rates for refugees, the OECD (2022) estimates that refugees from Ukraine are likely to increase the EU labour supply by 0.5% by the end of 2022, with larger increases expected in Poland (+2.1%), the Czech Republic (+2.2%) and Estonia (+1.9%). Most adult refugees are women. Refugees are highly qualified. According to UNHCR (2022b), which surveyed 4 900 refugees between mid-May and mid-June 2022, half are university-educated (vs. 29.5% of adults in the European Union), and an additional one-quarter of refugees have technical or vocational education. Three-quarters were working before they left Ukraine, primarily in education, trade and healthcare.

Refugees are providing a welcome injection of new workers into the labour market. In several European countries close to the conflict area, labour markets were very tight when the conflict erupted. Throughout much of the region, unemployment was extremely low. For example, only 2.4% of people aged 15 to 74 were unemployed in the Czech Republic, 2.9% in Germany and 3% in Poland. In Slovakia, migrants are filling jobs in trade and services that would otherwise have remained unoccupied (National Bank of Slovakia, 2022). In Poland, one-fifth of refugees were already working in April/May 2022, and another 10% had been offered employment (National Bank of Poland, 2022). In Germany, where Ukrainian refugees tend to encounter higher language barriers than in Eastern European countries, many refugees have joined language and integration courses. In the early autumn 2022, 17% of working-age Ukrainian refugees were already employed (Institute for Employment Research (IAB), 2022).

EU rules on working and residence permits make it easier for Ukrainian refugees to integrate into the labour market. Unlike in previous periods in which many refugees arrived in Europe (fleeing conflict in Syria, for example), Ukrainian refugees can apply for temporary protection in an EU country of their choice.[15] The measure provides migrants with a residence permit for at least a year, a work permit and access to housing, education, welfare and medical care. The residence permit provides a degree of stability — not only for the refugees, but also for potential employers wishing to absorb hiring costs. The ability to choose the host

13 See also European Observation Network for Territorial Development and Cohesion (ESPON) (2019) for evidence on earlier migrations.

14 Department of Labour Market, Ministry of Family and Social Policy, Poland.

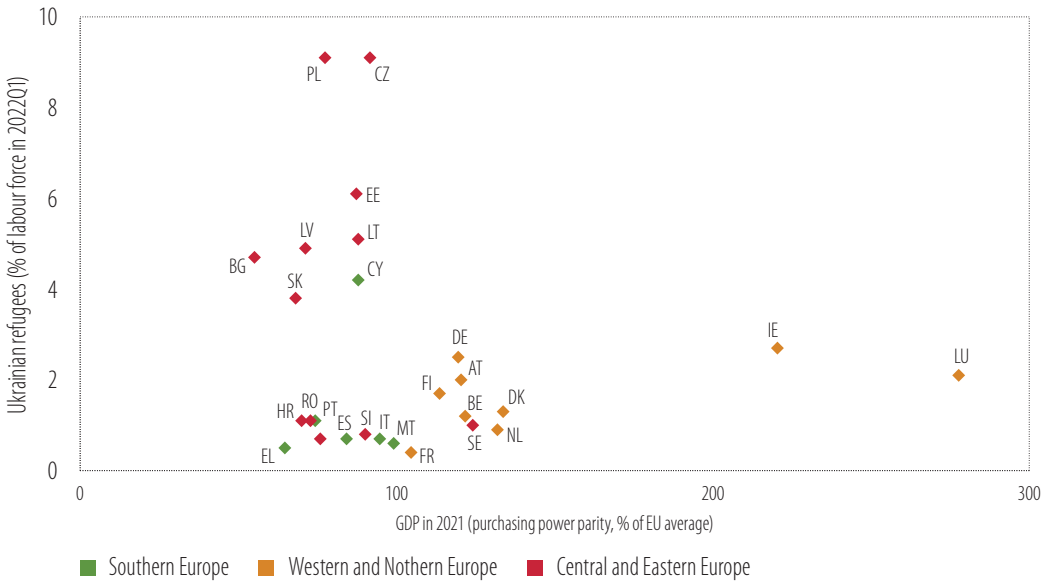
15 EU members have activated the Temporary Protection Directive, a legal instrument put in place in 2001, for the first time for Ukrainian refugees. See European Commission / DG Home for further information.

country should facilitate the matching of job-seeking refugees with jobs: Next to safety and family ties, employment prospects were the key reason refugees selected a particular host country (UNHCR, 2022b).

That said, refugees will need additional support to better integrate into local labour markets. Language courses and swift recognition of qualifications could further improve refugees' labour market prospects and enable them to move to more productive and better-paid employment. While high education levels could facilitate their integration into the labour market, the fact that many refugees from Ukraine are women with children suggests that additional investments in social infrastructure, in particular childcare and afternoon school facilities, might be needed to allow more refugees with young children to enter the labour market successfully (see for example Hauptmann et al., 2022). Ultimately, this support will benefit the host regions.

While the integration of refugees is likely to spur growth, whether it will benefit regional cohesion is less clear. On the one hand, refugee inflows are large relative to the labour force in countries whose GDP per capita is below the EU average (Figure 14).[16] In that sense, integrating refugees would appear to benefit cohesion. However, within a given country, refugees are likely to move to the economically stronger regions with better employment prospects. These regions can be much wealthier than the EU average. For example, adjusting for purchasing power, the GDP per capita of the region including Warsaw is two-thirds higher than the EU average.

Figure 14
Ukrainian refugees with temporary protection status and GDP per capita, by host country



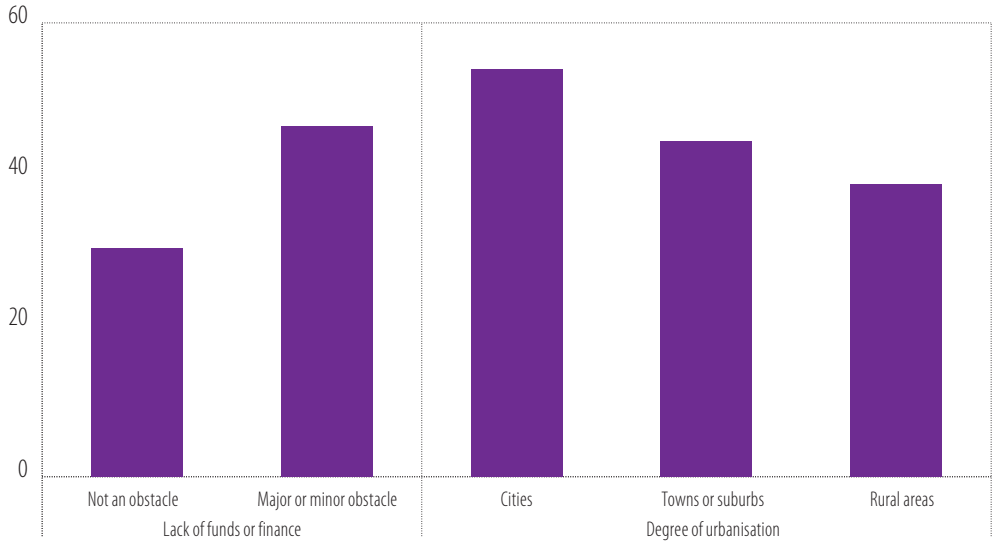
Source: *Eurostat, UNHCR, EIB staff estimates.*
Note: *Temporary protection is a legal status afforded refugees in the European Union.*

In the short run, migration is putting pressure on the social infrastructure of some municipalities. As refugees arrive, municipalities need to provide schools, medical treatment, education and housing. Municipalities that reported being more challenged by the migration are more likely to report that financial constraints present an obstacle to their investments (Figure 15). Rural areas are less likely to report challenges than more densely populated areas. Presumably, this is because these areas have received fewer refugees relative to their population.

16 The likely increase in the labour force would be much smaller, mainly because of the large share of children in the refugee population, according to the estimates in the OECD (2022) publication quoted above.

Figure 15

Factors determining the probability that a municipality reports crisis-related migration as a challenge (probability in %)



Source: *EIB staff estimates based on EIBIS Municipality Survey 2022, Eurostat and UNHCR 2022.*
Note: *The bars represent the probability of reporting crisis-related migration as a challenge, estimated from logistic regressions. The regressions control for municipality size, cohesion status, purchasing power of the region, number of doctors and hospital beds in the region, unemployment in the region, number of refugees in the country, healthcare, and education spending of the country.*

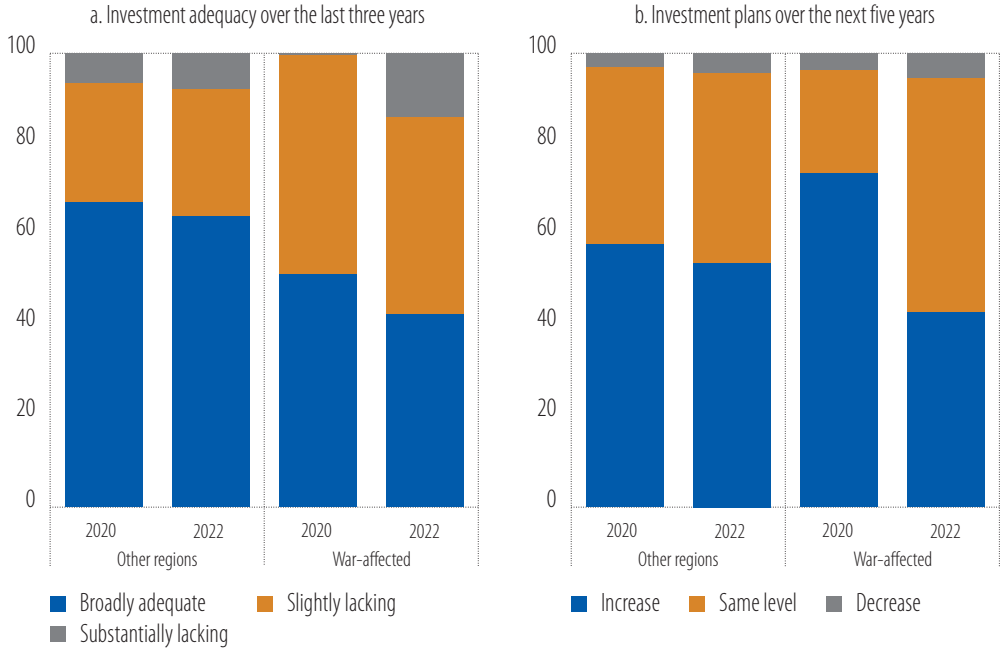
Municipalities bordering Ukraine or Belarus report more often than elsewhere that their investment in social infrastructure is inadequate. To some extent, this difference already existed in 2020, but a lower share of municipalities bordering on Ukraine and Belarus reported adequate investment in 2022 than previously (Figure 16a). This pattern also holds in Hungary, Romania, Slovakia and Poland, where the share of municipalities disclosing a substantial lack of social infrastructure investments rose from 4% to 15% from 2020 to 2022.

Nevertheless, these concerns do not seem to translate into plans to increase investment in social infrastructure (Figure 16b). One reason might be funding, which these regions report as a barrier to investment more frequently than other regions. Another might be that these regions are more than twice as likely to receive transfers from the central government. Less local autonomy could make it more difficult to rapidly increase investment. Finally, investment might be crowded out by the need to increase spending on other immediate needs, such as energy and refugee expenses.

A variety of EU programmes are available to fund the reception and integration of refugees from Ukraine. Local and regional authorities report that access to funding is a key challenge when receiving refugees and helping them to integrate (Dobiás and Homem, 2022). Various EU-level funding programmes are available for support. In particular, EU members can use cohesion funding from the previous budget period (2014-2020) to meet the basic needs of people fleeing the Russian invasion of Ukraine, to enhance the administrative capacity of EU members to cater for refugees' needs and to develop tailor-made solutions for their long-term integration. These resources complement support from the Asylum, Migration and Integration Fund, and other funding sources.

Figure 16

Adequacy of municipalities' investment in social infrastructure (% of respondents), **by survey wave and proximity to Ukraine/Belarus border**



Source: *EIB Municipality Survey 2020/2022 and EIB staff estimates.*
Question: *In the last three years, would you say that within your municipality or city the level of investment in infrastructure projects was broadly adequate, slightly lacking or substantially lacking in each of the following areas?*

Source: *EIB Municipality Survey 2020/2022 and EIB staff estimates.*
Question: *For each of the following areas, if you compare the average annual infrastructure investment you are planning for the next five years vs. the average annual infrastructure investment recorded in in the last three years, does your municipality or city expect to increase, decrease, or have around the same level of spending on infrastructure investment?*

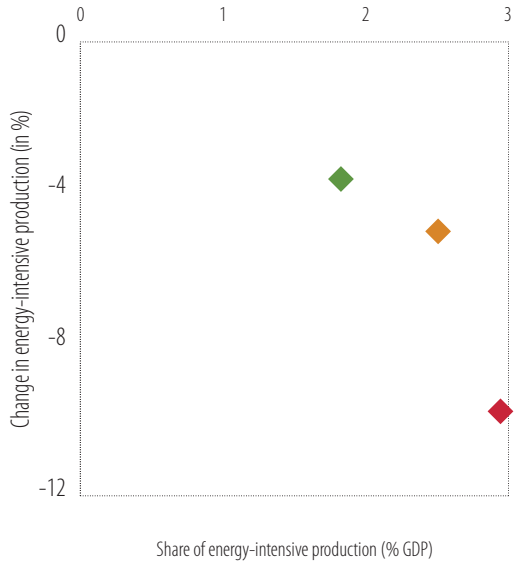
The energy crisis is putting particular pressure on Central and Eastern Europe

The energy crisis is rapidly accelerating the green transition for energy-intensive firms. These firms already faced intense global competition from non-EU countries that have lower energy prices and environmental standards. Skyrocketing energy prices prompted energy-intensive firms[17] in the European Union to scale back production by 5% from January to September 2022, while overall manufacturing output increased by 3%.

Like geopolitical uncertainty and migration, the energy shock tends to affect Central and Eastern Europe more than other EU regions. The amount of energy used relative to GDP tends to be higher in Central and Eastern Europe. For example, the energy intensity of the Czech Republic's output was twice that of Germany in 2019, and Bulgaria's was more than four times that of Italy. In part, this reflects the region's specialisation in energy-intensive production. In addition, production and buildings in these areas are less energy efficient.[18] Energy-intensive industrial production declined by more in Central and Eastern Europe from January to September 2022 than in the rest of the European Union (Figure 17).

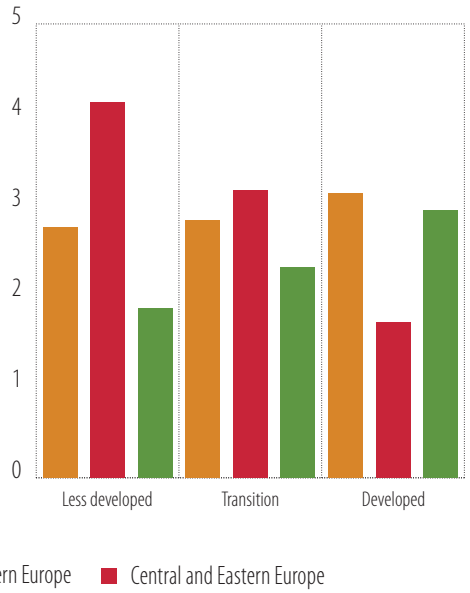
17 Energy-intensive sectors are defined in this section as paper, coke and refineries, chemicals, non-metallic minerals and basic metals.
18 European Commission (2022b).

Figure 17
Decline in production of energy-intensive sectors from January to September 2022 and share of energy-intensive production in GDP, by region



Source: *Eurostat.*
Note: *Changes in energy-intensive production are aggregated by country using as weights the value added of energy-intensive sectors. The chart shows for each region simple averages of the country aggregates. Data on the share of energy-intensive production in GDP is from 2019.*

Figure 18
Employment in energy-intense sectors (% of private sector employment), **by region and development status**



Source: *Eurostat, EIB staff estimates.*
Note: *Data is from 2019. Shown are simple averages of the NUTS2-level data.*

Within Central and Eastern Europe, the energy shock poses a risk not only to growth, but also to cohesion. Energy-intensive production is clustered throughout the European Union, in richer and poorer regions alike. Some energy-intensive clusters lie in regions that are rich and well diversified, such as southwest Germany. Other clusters, however, are located in less developed or transition regions that face convergence and transition challenges, such as ending coal mining or coal-based energy production. In Central and Eastern Europe, employment in energy-intensive sectors is greater in less developed regions (Figure 18), where just over 4% of employees work in those sectors.[19] The opposite holds true in Southern Europe, where the share of employment in energy-intensive industries tends to be higher in more developed regions.

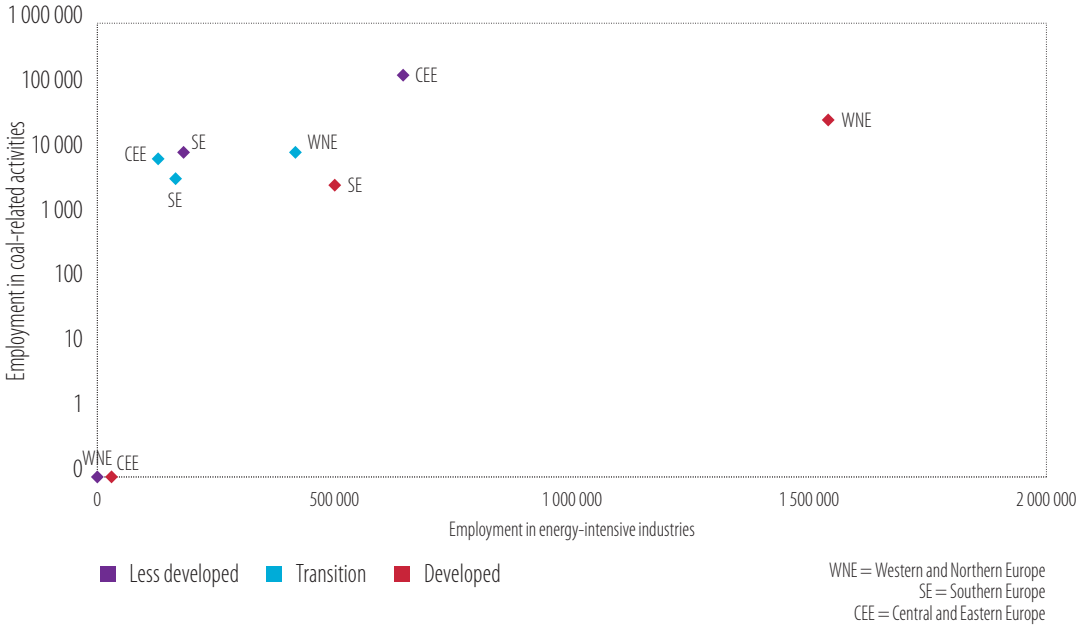
The energy shock amplifies the challenges posed by the green transition, particularly in regions with substantial coal activities. As energy-intensive firms are scaling down production far sooner than planned, the energy shock is accelerating the industrial changes required for the green transition. This transition tends to be particularly difficult in regions with extensive mining activities and coal-based electricity generation. Coal has historically been used to power energy-intensive industrial activities.[20] As a result, regions in which a large number of people are employed in coal-related activities also tend to also have high employment in energy-intensive industries. This is particularly true in less developed regions in Central and Eastern Europe, making cohesion particularly vulnerable to the energy crisis (Figure 19). Experience shows that employees in coal activities cannot easily find alternative employment because

19 Simple average across countries.
20 Regions such as Silesia, the Ruhr area in Germany or Asturias in Spain are examples.

they lack the required skills or because of a lack of suitable jobs in their home regions. Studies using labour-accounting methodologies find no sizeable change in unemployment, but instead document an increase in emigration and in the number of economically inactive people in coal regions (see for example Beatty and Fothergill, 1996; and Fieldhouse and Hollywood, 1999).

Figure 19

Employment in coal-related activities and in energy-intensive industries, by development and region



Source: *Alves Dias et al. (2018), Eurostat, EIB staff estimates.*

Note: *Changes in energy-intensive production are aggregated by country using as weights the value added of the energy-intensive sectors. The graph shows for each region simple averages of the country aggregates. Shares of energy-intensive production in GDP are from 2019. Employment in coal-related activities was available from 2018 (see Alves Dias et al. (2018), Annex 5).*

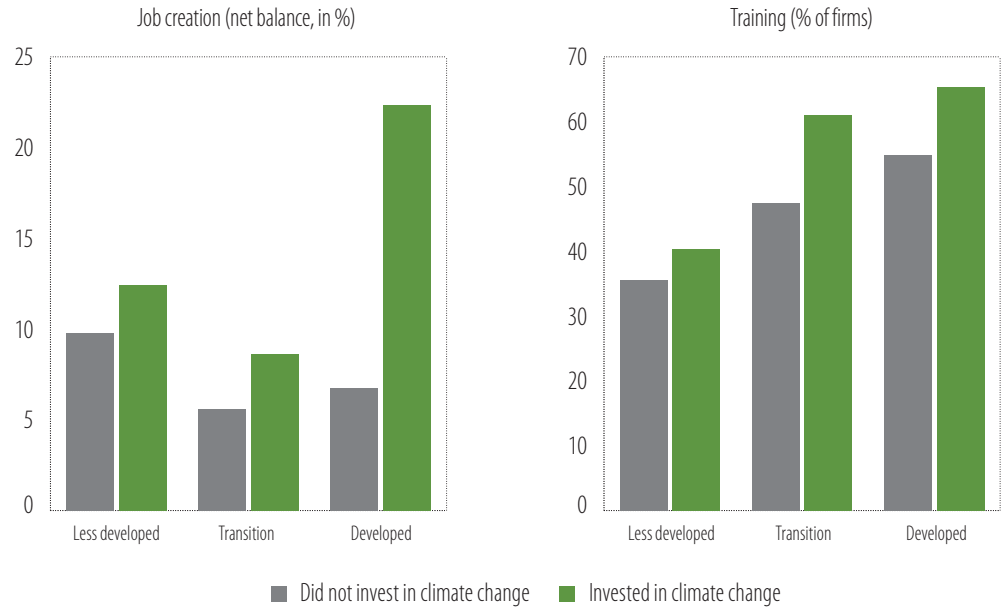
The green transition has created new jobs, but less so in cohesion regions. Firms that are implementing digital technologies are more likely to add jobs compared to their non-digital peers (EIB, 2022). Similarly, firms investing in the green transformation have been more likely to add jobs and, in the process, have invested more in training (Figure 20). However, it appears that while green and digital firms in cohesion regions do increase employment, they do so to a lesser extent than firms in developed regions.

To offset the negative impact of the energy crisis on cohesion, governments in poorer regions need to improve the business environment and lower well-known barriers to investment. Barriers to investment tend to be higher in cohesion regions than elsewhere. For example, in the EIB Investment Survey, a larger share of firms in cohesion regions than in developed regions reports that finance, regulations and energy cost are major obstacles to investment (Figure 21). Access to finance is particularly a problem for small and medium-sized enterprises (SMEs) in cohesion regions (30% of small and medium firms in less developed regions cite the availability of finance as a major obstacle, compared with 17% of such businesses in more developed regions). Addressing this barrier can help firms in cohesion regions to grow and add new local jobs (Box C).[21] There is also evidence that the quality of government is lower in cohesion regions (Figure 22). Corruption is also known to reduce growth and increase inequality. Corruption distorts incentives, acts as an inefficient tax on business and reduces the quality of investments (Mauro, 1995).

21 Perhaps surprisingly, poor digital infrastructure and a lack of skilled staff appear to be less of an issue in cohesion regions. However, this difference is likely to reflect the current level of development, rather than more availability of skilled staff and better digital infrastructure in absolute terms. Firms in cohesion regions tend to direct a smaller share of their investment to training than those in developed regions (EIBIS, 2020–22).

Figure 20

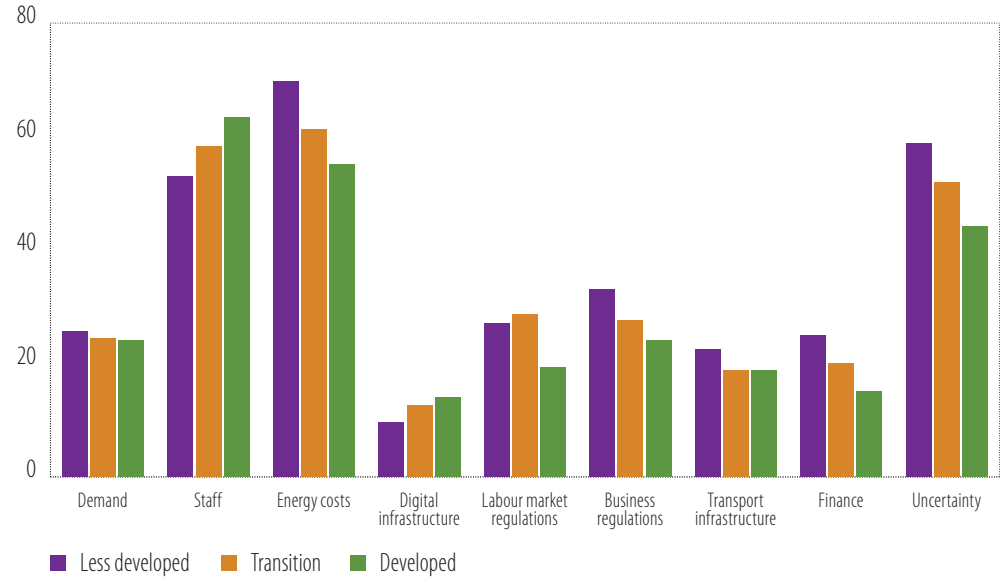
Net job creation and firms investing in training, by level of regional development



Source: *EIBIS 2022.*
Note: *Net balance refers to share of firms that increased employment minus share of firms that decreased employment. Share of firms investing in training shows the percentage of firms that spend more than EUR 50 per employee for training.*

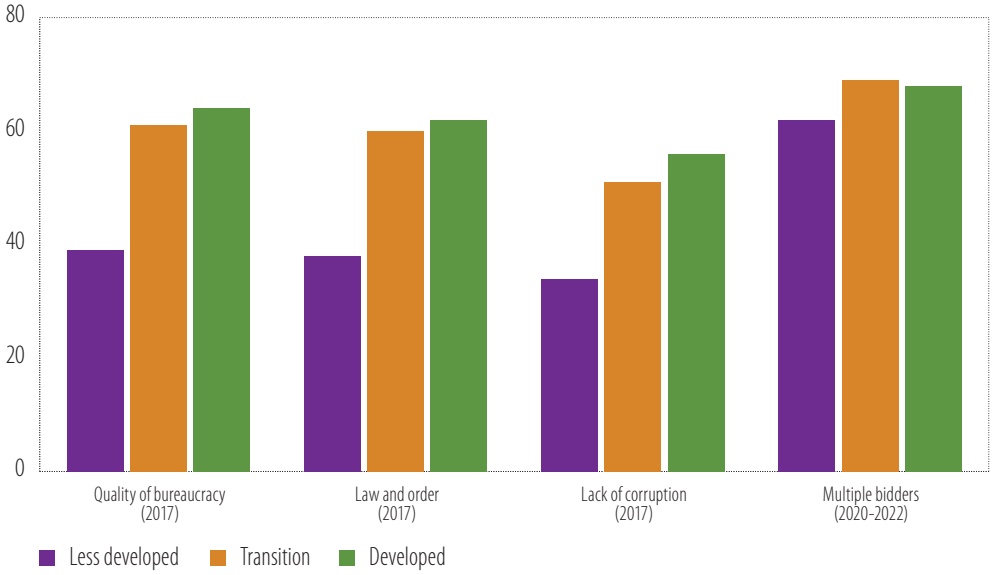
Figure 21

Major investment obstacles (% of firms), **by regional development**



Source: *EIBIS 2022.*
Question: *Thinking about your investment activities, to what extent is each of the following a major obstacle?*

Figure 22
Indicators for quality of government (index)**, by regional development**



Source: *University of Gothenburg (Quality of Government Institute), EIB staff estimates.*
Note: *The first three indicators are aggregated using NUTS2-level regional data in Charron et al (2020). They are the components of their overall quality score and date from 2017. As a partial update of the work of Charron et al, the "multiple bidders" indicator is based on European public procurement contracts (https://ted.europa.eu/TED/main/HomePage.do) awarded January 2020 to June 2022. For this indicator, the bars show the marginal effect of the development of the region in which the awarding authority is located in a regression explaining whether only one bidder submitted a bid for the awarded contract. A large share of single-bidder auctions is typically interpreted as a warning sign for corruption. The other explanatory variables in the regression are the type of good, service, or work procured, a dummy for EU-funded contracts, the type of awarding authority, and whether the authority acted as a central purchasing authority.*

Box C
Impact of EIB intermediated lending across cohesion regions[22]

A number of studies have shown that the European structural and investment funds had a positive and significant effect on regional economic growth (see for example Dall'erba (2005); Esposti and Bussoletti (2008), Becker et al. (2012), Pellegrini et al. (2013), Cerqua and Pellegrini (2018), Coelho (2019) and Barbero et al. (2023)). Some studies, however, found more conditional support for the effectiveness of these funds, depending on regional development (Cappelen et al., 2003), institutional quality (Ederveen et al., 2006; Arbolino et al., 2020) and human capital (Becker et al., 2013; San Juan Mesonada and Sunyer Manteiga, 2021). It appears that studies focusing on more recent years find a larger impact made by the funds, suggesting that the way of allocating and using them has become more efficient over time (Dall'erba and Fang, 2017).

Firm-level evidence, including from EIB lending, supports these results. Micro-studies have found that support from EU cohesion policy promotes firms' growth, employment and productivity (Benkovskis et al., 2019; Bachtrögler et al., 2020). Furthermore, recent evidence culled from impact studies of EIB-intermediated lending to small businesses and mid-size firms, or mid-caps, shows that the added impact of the loans is significantly larger for companies in less developed regions.[23]

22 Based on EIB (2023).
23 EIB, "Impact Assessment of EIB intermediated lending," Economics – Impact Studies Series (forthcoming).

Figure C.1 shows the average impact for EIB beneficiaries in the three years after receiving the loan, using the 2021-2027 Cohesion Policy classification of EU regions. Whereas the baseline analysis finds an overall increase in employment, firm growth and innovativeness for EIB beneficiaries relative to their peers, the results also show a significantly larger effect in less developed regions relative to developed ones. The impact on firms' employment and asset growth in the three years following the loan is approximately 3% higher in less developed regions. Similarly, less developed regions see an 8% higher impact on firms' innovation. Both results support the idea that the loans result in added benefits to less developed regions, which meet the EIB's goals of economic and social cohesion.

Figure C.1
Impact of EIB intermediated lending (in %)

Source: *EIB staff estimates based on allocations of EIB Multiple Beneficiary Intermediated Loans over 2008-2017 linked to firms' financial figures reflected in the Bureau van Dijk's ORBIS database.*
Note: *Firm growth is measured by the percentage change in firms' total assets. Innovativeness is measured by the percentage change in firms' intangible fixed assets.*

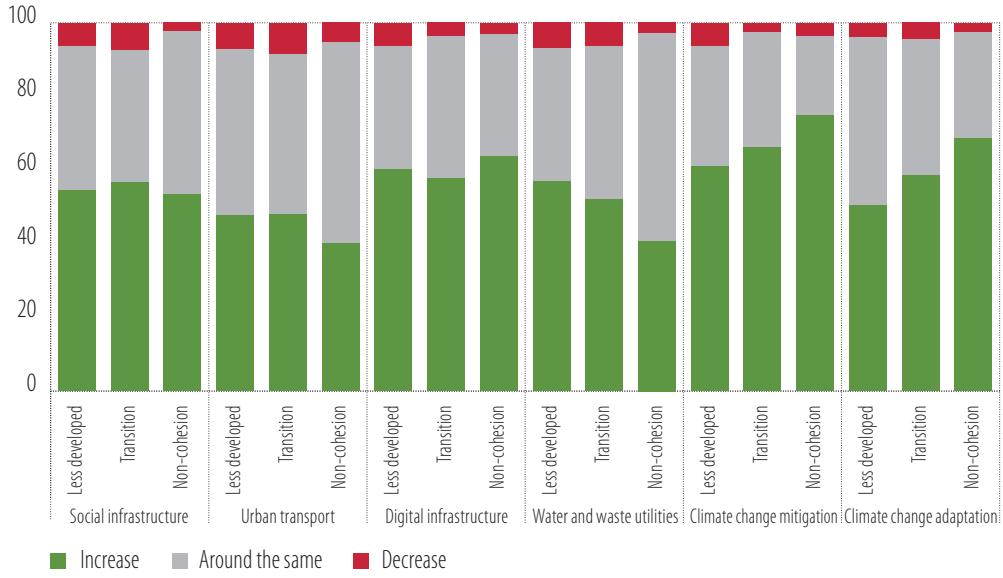
Municipalities can play a role in reducing these obstacles, including through investments in local infrastructure. Municipalities conduct around one-third of all public investment in economic activity in the European Union.[24] According to the 2022 EIB Municipality Survey, municipalities are planning to increase investment in the digital and green transformations (Figure 23). However, the share of municipalities planning to increase investment is lower in less developed regions, perhaps because they first need to fill gaps in public infrastructure. In general, a larger share of municipalities in less developed regions report that insufficient finance and access to skills hold back their investment.

EU cohesion policy should continue to help municipalities build the administrative capabilities they need to design and implement investment plans. Municipalities in less developed regions tend to lack the skills needed to implement green projects than more developed regions (Figure 24, green bars). The lack of these capacities can act as a break on investment plans, which could further hinder municipalities' ability to receive financial support from the European Union. However, municipalities in less developed regions typically have ambitious investment plans — plans that would push their green transition to the same level as developed regions (Figure 24, blue diamonds). A big obstacle to delivering those investment plans, however, is access to the expert knowledge needed to implement green projects. This tends to be more prevalent for municipalities in less developed regions (Figure 25). A range of EU programmes are available to support regions' ability to build the skills and technical expertise required to design and implement investment plans, including programmes managed by the European Investment Bank.

24 From Eurostat, general government expenditure by function, 2020. For a detailed discussion of local investment in infrastructure, see EIB (2020).

Figure 23

Municipal investment plans (in %)**, by regional development**

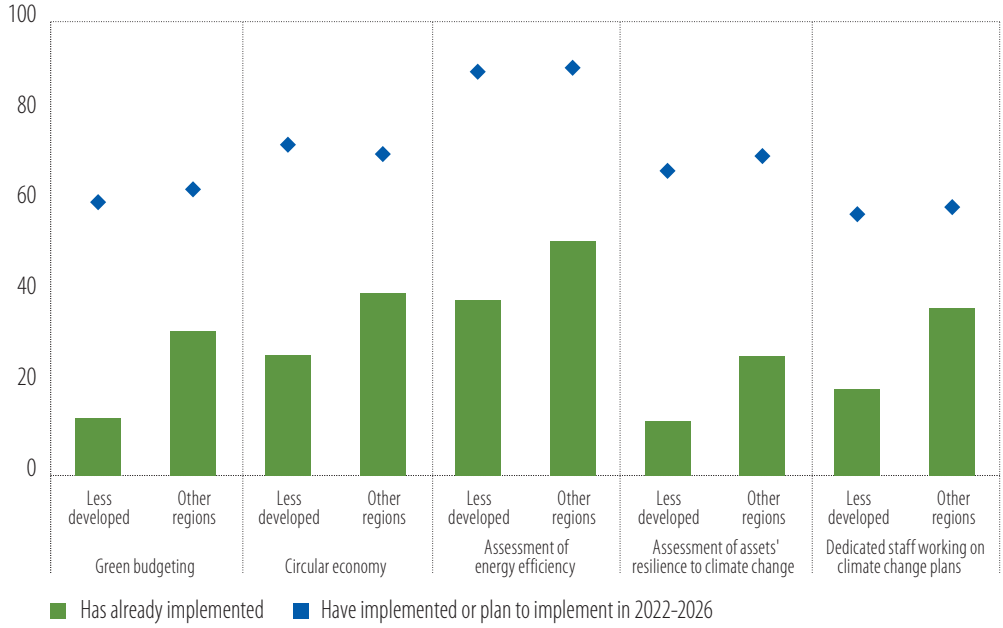


Source: *EIB Municipality Survey 2022.*

Question: *For each of the following areas, if you compare the average annual infrastructure investment you are planning for the 2022-2026 period vs. the average annual infrastructure investment recorded in 2019-2021, does your municipality expect to increase, decrease, or have around the same level of spending on infrastructure investment?*

Figure 24

Municipalities' green capacities and sophistication (% of respondents)**, by regional development**

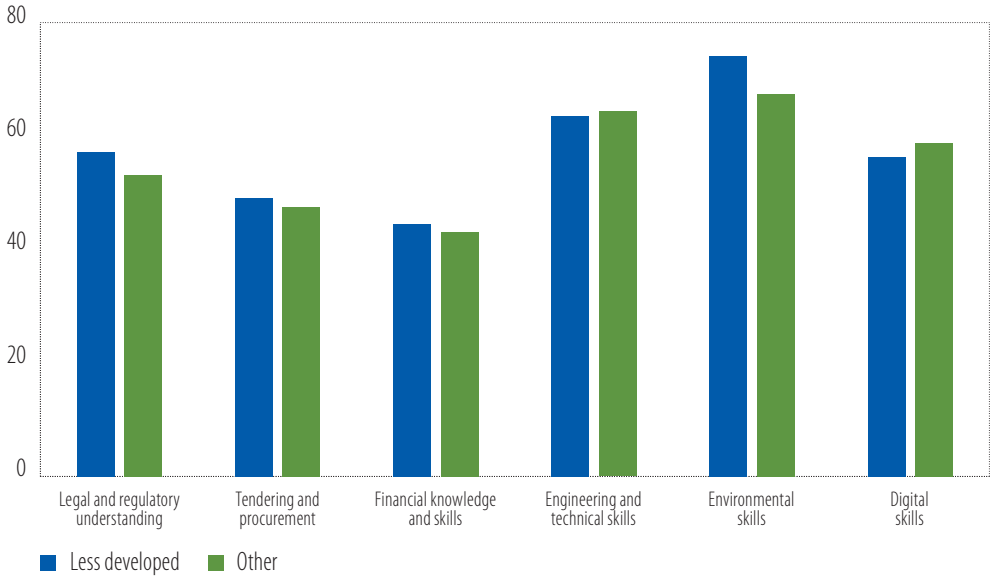


Source: *EIBIS Municipality Survey 2022.*

Question: *Thinking about climate change and environment sustainability. For each of the following please tell me whether your municipality has already implemented, has plans to implement in the 2022-2026 period or has no plans to implement in the 2022-2026 period?*

Figure 25

Share of municipalities reporting that insufficient access to experts is an obstacle to investment (in %)**, by regional development**



Source: *EIB Municipality Survey 2022.*
Question: *For each of the following areas, if you compare the average annual infrastructure investment you are planning for the 2022-2026 period vs. the average annual infrastructure investment recorded in 2019-2021, does your municipality expect to increase, decrease, or have around the same level of spending on infrastructure investment?*

Conclusion and policy recommendations

The war in Ukraine risks exacerbating the cohesion challenges Europe already faced across social groups and regions. The energy crisis triggered by the war has further worsened the financial situation of all households — arguably to an even greater degree for poorer and older households. Regional cohesion is likely to suffer from geopolitical uncertainty, the arrival of refugees and the energy shock.

Efforts must be made to strengthen social and regional cohesion, regardless of the Ukraine war. All regions will need to transform in the coming decades to reach EU climate goals. Without this broad-based transformation, Europe will not be able to reduce its dependence on fossil fuels (particularly from Russia) in the medium term, or to reach carbon neutrality in the longer term. The pandemic and the surge in energy prices show that shocks can accelerate economic shifts. Fast transformation requires flexibility, new ideas and investment by public and private stakeholders.

Social and regional funding is available through the EU Cohesion Fund and the Recovery and Resilience Facility. For the 2021–2027 budget period, the EU plans to contribute EUR 244 billion to support cohesion through the Cohesion Fund. In addition, out of the investments to be funded by the Recovery and Resilience Facility from 2021 to 2026, EUR 193 billion will contribute to social and territorial cohesion. Relative to GDP, most of the funds will flow to Central and Eastern Europe.[25]

Public policy needs to combine public investments with reducing administrative and regulatory investment barriers, which will encourage firms to invest and innovate. As with any economic transformation, corporate investment and innovation are necessary for the green and digital transformation. Investment and innovation can only flourish if they are fostered by an appropriate regulatory environment, sufficient public capital and high-quality public services. Programmes intended to encourage growth and transform the EU economy, such as the Juncker Plan in 2014 and NextGenerationEU in 2020, effectively combined public investments with regulatory and policy reforms.

To promote cohesion, public investment should boost social, transport, green and digital infrastructure and continue to improve workers' skills. Public investment in social infrastructure and mobility, such as affordable housing and transport, facilitates social cohesion, and it is especially needed in regions that are accommodating a large number of refugees. Investments in energy-efficient, affordable housing and clean transport would help integrate refugees while simultaneously advancing the green transition. Policy should also continue to address the shortage of skilled labour, which consistently tops the list of investment barriers reported by firms throughout the European Union.

Policy support should focus on the most severely affected groups and regions. Fiscal support for the energy crisis should focus on transfers to the most vulnerable groups while keeping incentives to save energy intact. This means avoiding policies that reduce the price of energy for all groups.

25 For 2021–2027, the EU Cohesion Fund allocates an average of 12.7% of 2021 GDP to countries in Central and Eastern Europe, versus 0.4% for countries in Western and Northern Europe and 6.4% for countries in Southern Europe.

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Chapter 5

Progress on digital transformation

The European Union is closing the digital adoption gap with the United States. More than half of EU firms responded to the pandemic by investing in digitalisation, and they are rapidly catching up with their US peers in implementing advanced digital technologies. Despite this, Europe is not well positioned in digital innovation, and is at risk of developing dependencies in several critical technologies.

Digitalisation drives firms' resilience to economic disruption and climate change, and it has helped European firms adjust at a time of repeated shocks. Digital companies displayed more resilience to the economic and trade disruptions unleashed by the COVID-19 crisis and the war in Ukraine, suggesting that they found more efficient ways of working. Digital firms generally perform better than non-digital firms, tending to be more innovative and productive. They are also more likely to engage in international trade and invest in addressing the physical and transition risks of climate change. Digital technologies will be key to meeting the ambitious goals of the European Green Deal.

Successfully managing the digital transition and taking advantage of its long-term benefits goes beyond technology adoption. The digital transformation is a societal change. Striking the right technological balance is a complex process for the European Union, which is caught between global players that are defining the cutting edge of digital innovation, national preferences and societal and regulatory patterns that set boundaries on the use of digital technologies. To make the most of the digital transformation, the European Union will need to position itself well in the global environment, creating better internal conditions for innovation in technologies that are crucial to European interests and taking full advantage of the benefits of digitalisation, while staying within the boundaries of the European economic model.

Firms' digitalisation depends on external and internal factors. These include adequate digital infrastructure and competition-friendly regulation, as well as management decisions on investment in employee training and trade with firms in innovative sectors, which accelerates the spread of digital technologies. A coordinated policy framework is crucial for addressing infrastructure gaps, improving digital skills, developing the innovation environment and regulating efficiently. Governments and municipalities also need to embrace digitalisation themselves. For many regions, this implies a coherent approach to digital governance, guided by the needs of people and firms. The right balance is especially important for businesses that are not using cutting-edge digital technologies, as recent crises — the coronavirus pandemic and the war in Ukraine — are likely to exacerbate the digital divide between more and less tech-savvy companies.

Introduction

According to the results of the EIB Investment Survey (EIBIS), more than half of companies in the European Union responded to the pandemic by investing in digitalisation. European firms are also rapidly catching up with their US peers in the implementation of advanced digital technologies. Europe continues to lag behind other global players in digital innovation, however, and it is at risk of developing dependencies in several critical technologies. The European Union needs to focus on critical factors such as digital infrastructure, regulation and digital skills, and it must further strengthen and defend its ability to innovate in strategic technologies. At a time of repeated shocks and structural transformation, digitalisation drives resilience and adaptation, and it enables firms and societies to prosper.

This chapter is split into five sections. The first assesses the current trends in technological adoption and looks at how the pandemic accelerated digitalisation, while highlighting the risk that some firms may be left behind. The second section focuses on external enablers of digitalisation and stresses the importance of adequate digital infrastructure and regulation. The third section discusses how firms' internal workings, such as investment in employee training to improve digital skills and engagement with innovative sectors, influence digitalisation, and looks at the factors affecting whether firms take advantage of digitalisation. The fourth section explores digitalisation as a driver of firms' resilience and their ability to transform to address trade shocks and structural changes being caused by the green transition. The last section presents policy implications and conclusions.

Adoption, innovation and risks of polarisation

The pandemic has accelerated digitalisation

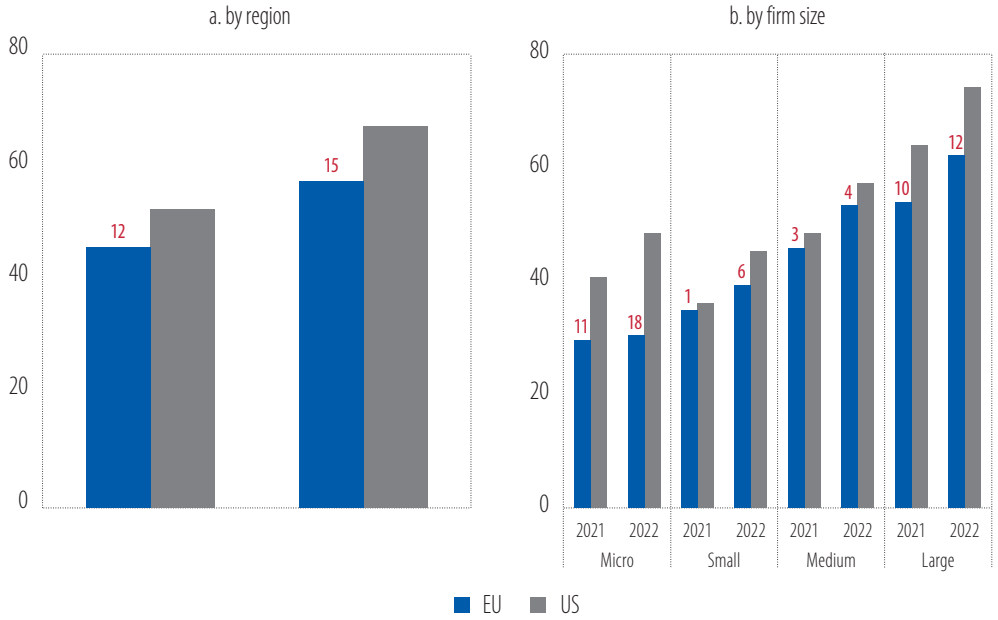
More than half of firms invested in digitalisation in response to the COVID-19 crisis. In the European Union, 53% of firms report taking action to become more digital — for example by providing services online — according to the results of the EIBIS conducted from April to July 2022. However, significant differences exist between countries and firm sizes.[1] Also, the share of firms that invested in digitalisation as a response to COVID-19 is higher in the United States than in the European Union, and this gap increased from 2021 to 2022 (Figure 1a). Micro and small firms are lagging medium-sized and large firms. In the European Union, only 30% of microenterprises stated that they took steps to improve digitalisation in 2022, compared with 63% of large firms (Figure 1b). European micro and small firms are also less likely than their US peers to report having invested in becoming more digital.

In addition to moving ahead with basic digitalisation, European firms are accelerating the adoption of new, advanced digital technologies after putting these processes on hold in the first year of the pandemic. The European Union has been closing its digital adoption gap with the United States over the past four years. But implementing advanced digital technologies requires more significant investment than simple digitalisation activities such as providing services online. Beyond the short-term response to COVID-19 and the war in Ukraine, the digital transformation of the EU economy will require the adoption of more advanced digital technologies, such as 3-D printing, advanced robotics, the internet of things, big data analytics and artificial intelligence, drones, online platforms and augmented reality. The share of EU firms implementing advanced digital technologies increased from 2021 to 2022, reaching 69%, compared with 71% in the United States (Figure 2).

1 All the associations discussed in the analysis using EIBIS data — such as the links between digitalisation and firm size, firm productivity, internet speed or digital skills — also hold in multivariate regression analysis controlling for other potential factors that may influence the analysis, such as firm age, sector and country.

Figure 1

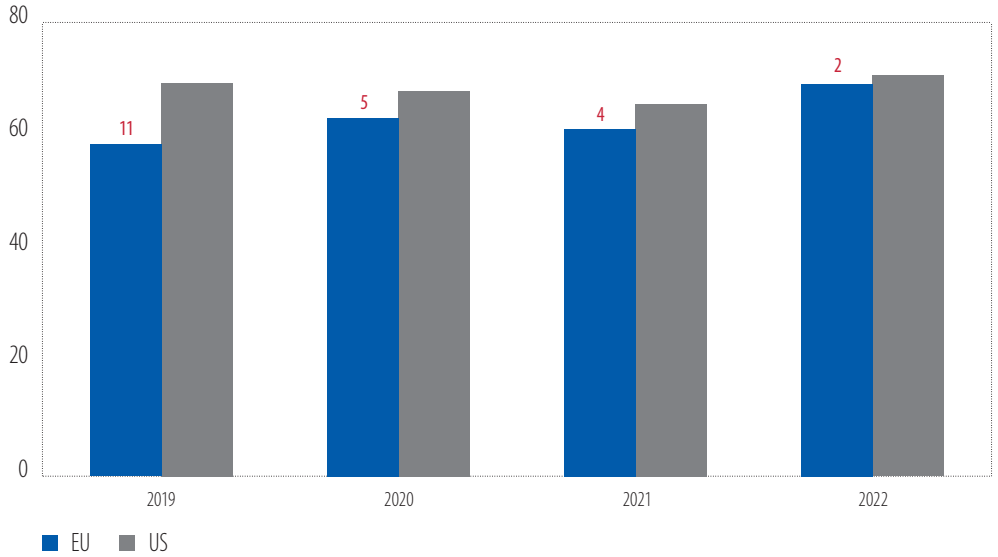
Investment in digitalisation as a response to COVID-19 (% of firms)



Source: *EIBIS 2021-2022.*
Note: *The numbers over the bars indicate differences in percentage points between the United States and the European Union.*
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 2

Adoption of advanced digital technologies (% of firms)



Source: *EIBIS 2019-2022.*
Note: *The numbers over the bars indicate differences in percentage points between the United States and the European Union. 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.*
Question: (2019-2021) *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 3 for the definitions of digital technologies).*
Question: (2022) *To what extent, if at all, are each of the following digital technologies used within your business? Not used in the business; used in parts of the business; entire business is organised around this technology.*

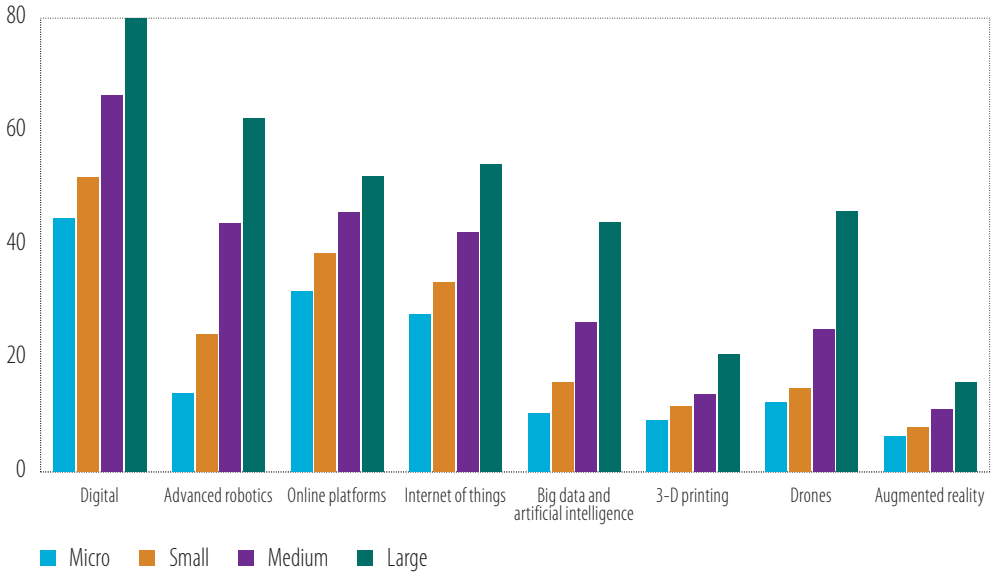
Advanced robotics and online platforms remain the most widespread digital technologies. The implementation of most advanced digital technologies has progressed over the past four years (Figure 3a). The gap in the adoption of internet of things technologies between the European Union and the United States has narrowed in the last year. The gap was 12 percentage points in 2022 (Figure 3b), compared with 18 percentage points in 2021.

Figure 3
Adoption of specific digital technologies (% of firms)

Source: *EIBIS 2019-2022.*
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 and artificial intelligence" refers to cognitive technologies, such as big data analytics and artificial intelligence (manufacturing, services, infrastructure). "Drones" are unmanned aerial vehicles (construction). "Augmented reality" refers to augmented or virtual reality, such as presenting information integrated with real-world objects using a head-mounted display (construction, services). "Online platforms" refers to a platform that connects customers with businesses or customers with other customers (services and infrastructure).*
Question: *See questions for Figure 2 for the exact wording.*

Firm size plays a key role in the adoption of advanced digital technologies. 80% of firms with more than 250 employees use advanced digital technologies, compared with around 45% of firms with fewer than ten employees (Figure 4). This disparity is likely to slow the digital transformation in Europe (Revoltella, Rückert and Weiss, 2020). The difference in adoption rates is particularly pronounced for advanced robotics, which supports the idea that certain technologies involve major integration costs, and that large firms are more likely to adopt these technologies (Acemoglu et al., 2022).

Figure 4
Probability of adopting advanced digital technologies (in %)**, by firm size**



Source: *EIBIS 2022.*
Note: *The bars represent the probability of digital technology use by firm size class, estimated from logistic regressions. The regressions control for firm country and sector fixed effects (27 EU countries and 12 sectors).*

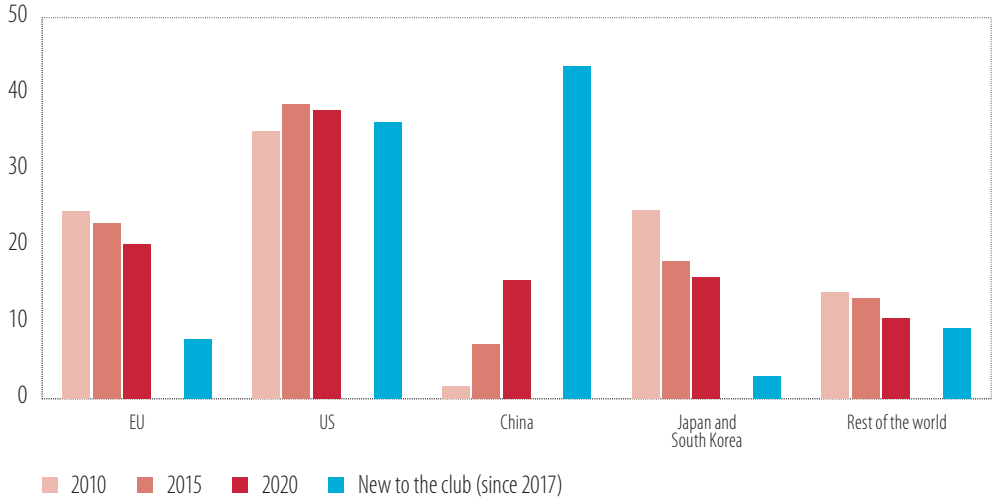
Europe's digital innovation delay

While Europe is catching up when it comes to the adoption of advanced digital technologies, it is at risk of being overtaken in digital innovation. R&D investment and patenting activities are highly concentrated among a small number of companies, sectors and countries. The world's top 2 500 R&D investors account for close to 90% of global business R&D expenditure and 60% of patent filings for all technologies (Amoroso et al., 2021). This concentration of innovation is particularly pronounced in high-tech sectors such as software and computer services, pharmaceuticals and biotechnology, and technology hardware manufacturing, but it also exists in traditional industries such as the automotive sector.[2] Compared to sales or employment, R&D investment and patenting activities are more concentrated in a small number of incumbent firms that have grown bigger over time.

The European Union remains a major global player in R&D and innovation, but the share of EU firms in the top 2 500 R&D investors has fallen over time. The share of firms from the European Union and Japan on the list of the top 2 500 R&D investors decreased from 2010 to 2020 (Figure 5). This decline can be largely attributed to the emergence of Chinese firms. While the United States remains an innovation leader, the number of Chinese companies included on the list of big R&D spenders has risen fast.

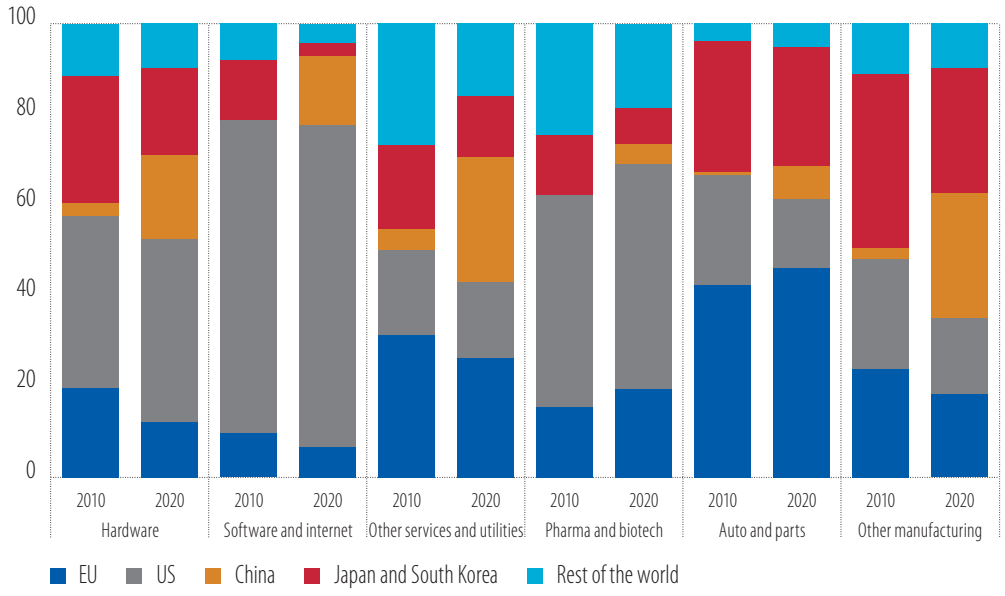
2 Eurostat classifies motor vehicle manufacturing as a medium-high-tech sector, whereas pharmaceuticals, computer, electronic and optical products, and computer programming and related activities are considered high-tech sectors.

Figure 5
Share of top global R&D companies (in %)**, by region**



Source: *EIB staff calculations based on EU Industrial R&D Investment Scoreboard.*
Note: *"New to the club" refers to firms that entered the list of top global R&D investors after 2017.*

Figure 6
Share of R&D expenditure in 2010 and 2020 (in %)**, by sector**



Source: *EIB staff calculations based on EU Industrial R&D Investment Scoreboard.*
Note: *Share of R&D expenditure by the top R&D investors, by sector and country.* Hardware*: electronic and electrical equipment, technology hardware and equipment.* Software and internet: *software and computer services.* Other services and utilities: *fixed-line telecommunications, mobile telecommunications, food and drug retailers, general retailers, industrial transportation, travel and leisure media, banks, equity investment instruments, life insurance, non-equity investment instruments, non-life insurance, real estate investment and services, support services, alternative energy, electricity, gas, water and multiple utilities, industrial metals and mining, oil and gas producers, oil equipment, services and distribution.* Pharma and biotech: *pharmaceuticals and biotechnology, healthcare equipment and services.* Auto and parts: *aerospace and defence, automobile and parts.* Other manufacturing: *beverages, food producers, tobacco, chemicals, construction and materials, forestry and paper, general industrials, industrial engineering, household goods and home construction, leisure goods, personal goods.*

The global R&D landscape has changed rapidly over the past decade as the digital economy increased in importance and as the European Union specialised less in software and computer services than the United States and China. Among the leading companies in software and internet, EU firms only represent 7% of R&D expenditure, compared with 71% for the United States, 15% for China and 3% for Japan and South Korea (Figure 6). Similarly, the European Union accounts for 12% of R&D expenditure among leading companies producing technology hardware and electronic equipment, compared with 40% for the United States, 19% for Japan and South Korea, and 19% for China. European policymakers need to continue to stress the importance of digitalisation, or EU firms could fall into a dependency trap for a few rare and strategic technologies (see Box A). The European Union and the United States should also cooperate on technology and trade matters, following the approval of the US Inflation Reduction Act, which calls for massive investment in clean energy and climate change (von der Leyen, 2022).

Box A

EU technological leadership and vulnerabilities[3]

The coronavirus pandemic and a fast-changing geopolitical landscape has revealed EU dependencies in several strategic sectors and value chains — such as batteries, clean energy, processors and semiconductor technologies, and raw materials — confirming the need to further accelerate Europe's economic and industrial transformation (European Commission, 2022a; Ravet et al., 2022). Rising environmental, geopolitical, economic and social instability across the world increases the likelihood of extreme and disruptive events. It also draws more attention to the technological capacities of major economic players, such as the European Union, the United States and China (Crespi et al., 2021).

For Europe to remain a global economic power, it must lead on green and digital solutions. The European Union is falling far behind the United States and China in many digital technologies, such as nanotechnologies, artificial intelligence and big data (European Commission, 2022b). China has moved to the forefront of digital technology over the last decade, confirming not only its rise as an economic player on the international stage, but also the importance of its research and innovation efforts for future digital technologies.

Europe needs to maintain its strategic autonomy, or the ability to act autonomously and strategically on the geopolitical scene, without jeopardising its open economic model. The European Union has nothing to gain from heeding domestic interest groups and protecting its market under the pretext of technology sovereignty. Open and fair trade has already helped its societies to prosper. Not being able to access technologies critical for implementing the European Union's main policy priorities, however, could have severe repercussions for its ability to compete freely on the global market.

The European Union has already presented major initiatives supporting its strategic autonomy. It has responded to European hardship caused by the energy market crisis and Russia's invasion of Ukraine with REPowerEU, an initiative to replace fossil fuels with more sustainable sources. The European Green Deal is also a key example of EU efforts to create autonomy without sacrificing the drive towards sustainability. Preserving the strategic autonomy of the European Union also means looking strategically at which technologies to focus on. For example, the European Chips Act will mobilise EUR 43 billion in public and private investments to strengthen the semiconductor industry, with the goal of increasing Europe's share of global chip production from 10% currently to at least 20% by 2030.

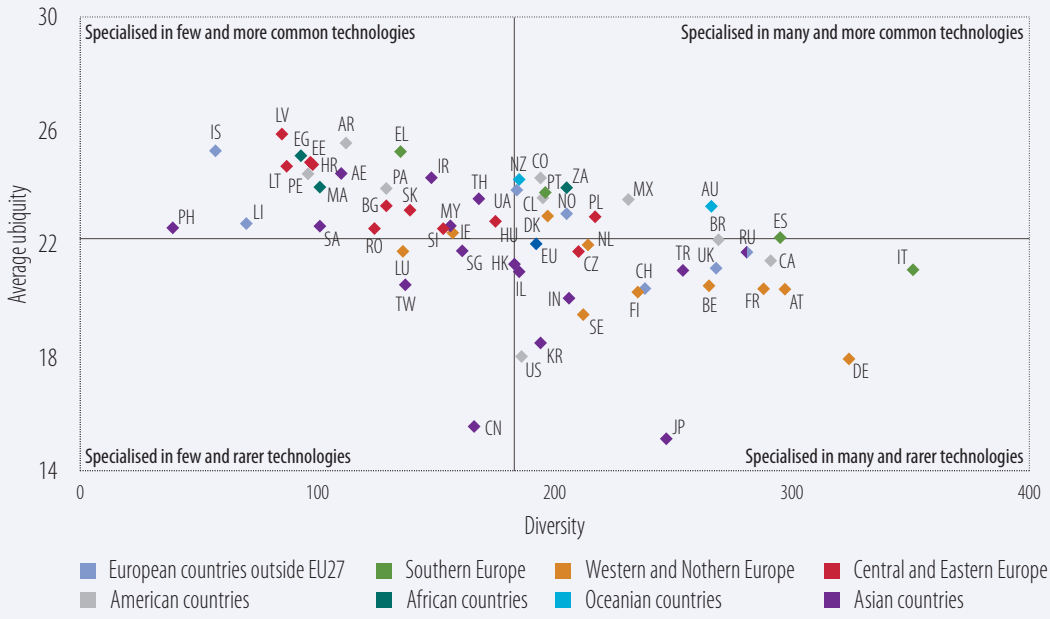
If the European Union is to compete internationally in strategic technological fields, it needs to assess the technological capabilities that influence innovation. This will highlight gaps in strategic technologies and indicate how EU policies can best address those gaps. More complex technologies are more likely to remain in the countries or regions that already use them, which creates a competitive advantage for these areas (Balland et al., 2019).

3 This box was prepared by Valentina Di Girolamo and Alessio Mitra (European Commission, Directorate-General for Research and Innovation).

Using patent data retrieved from the Organisation for Economic Co-operation and Development (OECD) database, the research (European Commission – DG Research and Innovation, 2022) factors in the heterogeneity in technology complexity and assess EU technological capabilities compared to other international economies. The research does this by looking at the relationship between a country's technology diversity (the number of different technology specialisations) and a technology's average ubiquity (the average number of countries specialised in the same technologies as the country in question).

China is less diversified than the European Union, the United States, Japan and South Korea (Figure A.1). Nevertheless, it specialises in technologies that are also quite rare (low ubiquity), placing it in the bottom-left quadrant and making it an emerging innovation leader. The United States and South Korea are slightly more diversified than the average, while their ubiquity remains low, signalling an overall ability to specialise in rarer technologies. Japan is also in the bottom-right quadrant. It is highly diversified yet specialises in relatively rare technologies.

Figure A.1
Technology diversity and average ubiquity in 2016-2020, by country



Source: *Authors' calculations based on an OECD database with a sample of 645 technologies at the 4-digit level according to the International Patent Classification system, using patent fractional counting.*

Note: *Technological diversity provides information on how many different technology specialisations are in the basket of each country. Average ubiquity instead captures the average rareness of the technologies a country is specialised in, providing information on how many other countries are specialised in the same technology fields. The vertical line and the horizontal line denote the mean diversity and the mean average ubiquity, respectively. Data for the European Union are calculated as the mean of EU Member States.*

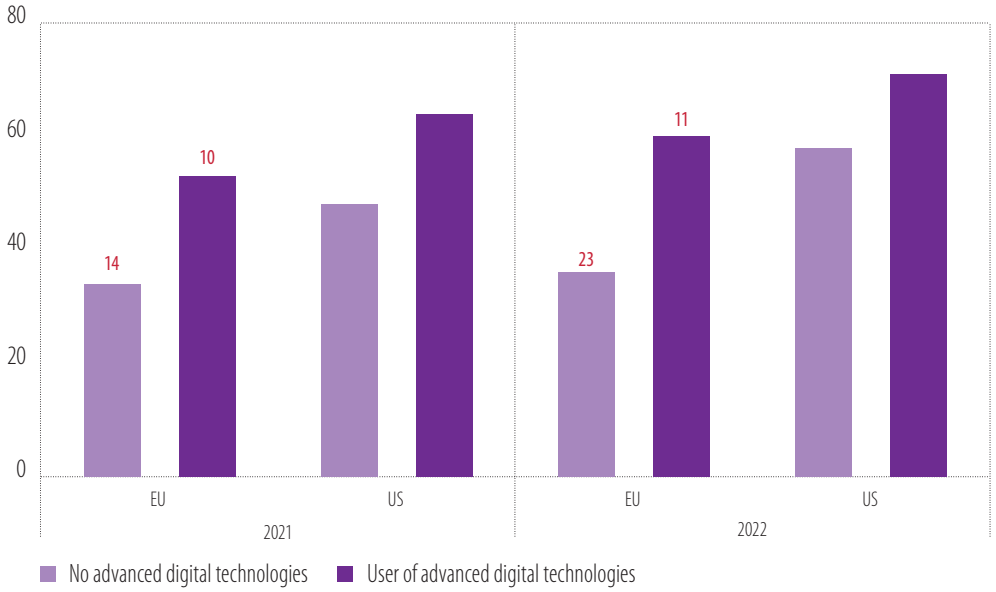
Overall, the analysis shows that the European Union is more diversified than other main international innovation leaders — notably the United States and China. It tends to specialise, however, in technologies that are relatively common (higher than average ubiquity). This suggests that the European Union should increase its innovative efforts in more sophisticated technologies, supported by innovation policies in line with EU policy priorities. This would also strengthen the European Union's strategic autonomy, as it would make it less dependent on other countries in these more sophisticated technological fields.

Digital divides between European firms

Companies that were already digital before the pandemic are more likely to have invested further in digitalisation in response to COVID-19. The crisis may have further deepened the digital divide, as leading firms have accelerated digitalisation, while laggard firms fell further behind (Rückert et al., 2021). Only 36% of non-digital firms in Europe have used the crisis as an opportunity to begin investing in their digital transformation, while 60% of firms that had already adopted advanced digital technologies invested in becoming more digital in 2022 (Figure 7). Importantly, the share of European firms that started investing in digitalisation is significantly lower than in the United States, where 58% of non-digital firms invested in becoming more digital in 2022.

Figure 7

Investment in digitalisation as a response to COVID-19 (% of firms)**, by prior adoption of advanced digital technologies**



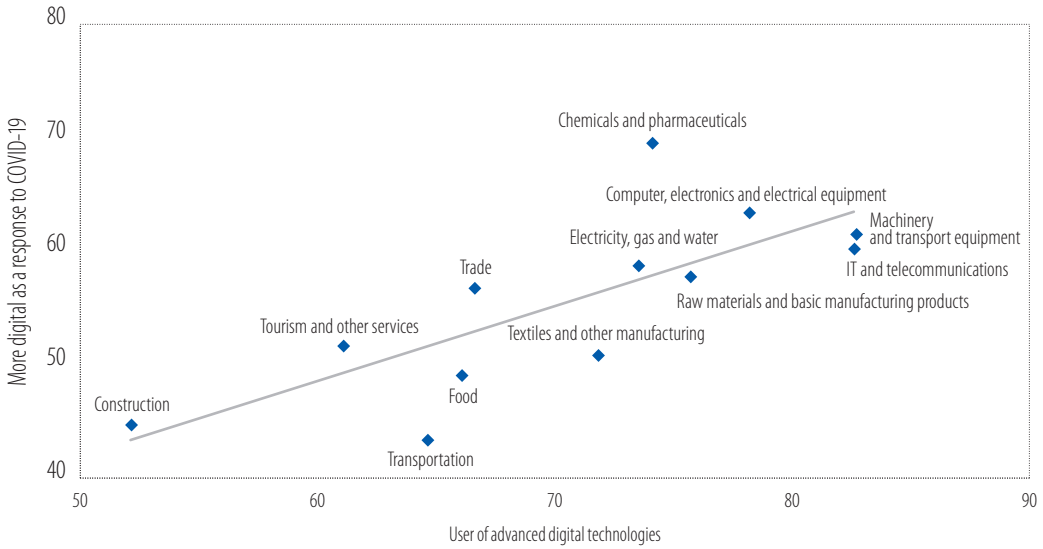
Source: *EIBIS 2021-2022.*
Note: *The numbers over the bars indicate differences in percentage points between the United States and the European Union.*
Question: *As a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital (e.g. moving to online service provision)? See note to Figure 2 for the definition of the adoption of advanced digital technologies.*

Digitalisation varies widely among economic sectors. For example, 83% of firms in the machinery and transport equipment sector use advanced digital technologies, far more than in the construction sector (52%). One explanation for differing levels of digitalisation is that industries produce different products, and that only certain tasks can be performed using advanced digital technologies. There is also a strong correlation in all industries between the use of advanced technologies and digital uptake during the pandemic (Figure 8).

Firms have been grouped into four different digitalisation profiles to better determine whether gaps are emerging. The four categories — neither, basic, advanced and both — are based on companies' implementation of advanced digital technologies, and the steps they took to become more digital as a response to the COVID-19 crisis (Figure 9). "Neither" refers to firms that have not implemeted any advanced digital technolgies, while "basic" means 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. "Advanced" refers to firm that have invested in advanced digital technologies but have not taken action to become more digital as a response to COVID-19, while "both" means firms that have implemented advanced digital technologies and have also invested further in digitalisation as a response to COVID-19.

Figure 8

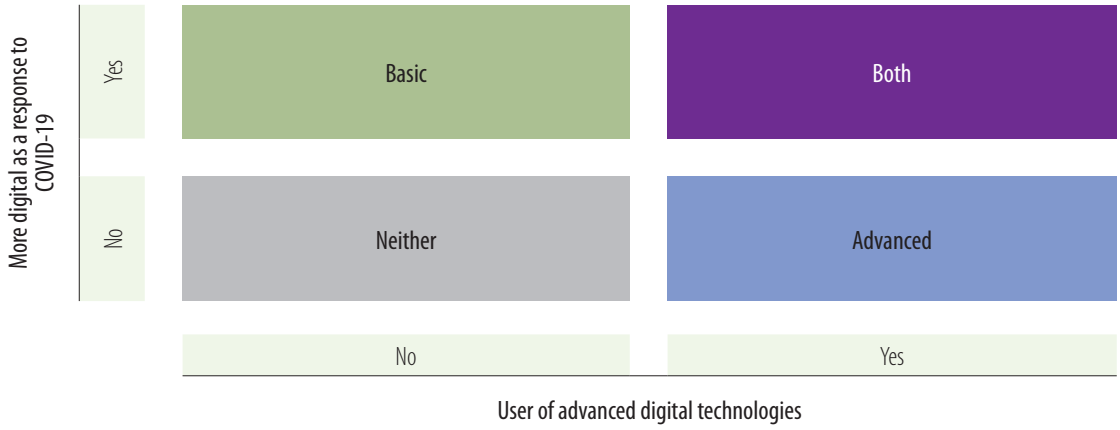
Investment in digitalisation as a response to COVID-19 and advanced digital technologies (% of firms)**, by sector**



Source: *EIBIS 2022.*
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 2 for the definition of the adoption of advanced digital technologies.*

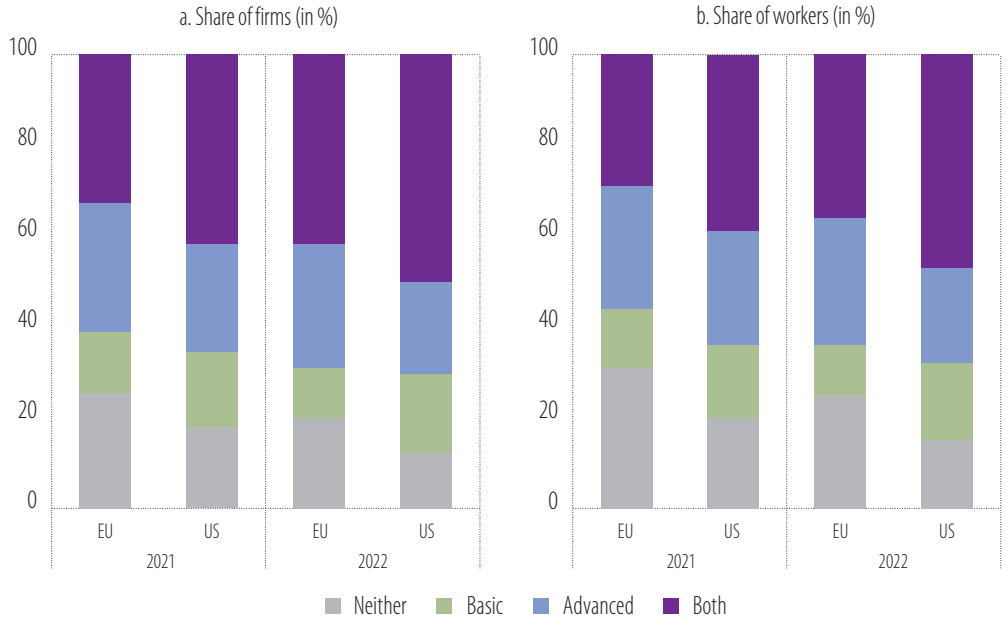
Figure 9

Corporate digital divide profiles



The share of EU firms that did not invest in digitalisation decreased in the second year of the pandemic. One-fifth of EU firms did not invest in digital transformation in 2022, down from 26% in 2021 (Figure 10). The share of workers at firms that fell in the "neither" category decreased to 25% in 2022 from 31% in 2021, but this share remains significantly higher than in the United States (15%). It is encouraging to see that, over time, fewer firms and workers fall into this category. However, firms in the "neither" category may need stronger or more specific policy support to prevent them from falling behind.

Figure 10
Corporate digital divide profiles



Source: *EIBIS 2021-2022.*
Note: *See Figure 9 for the definition of digital profiles.*

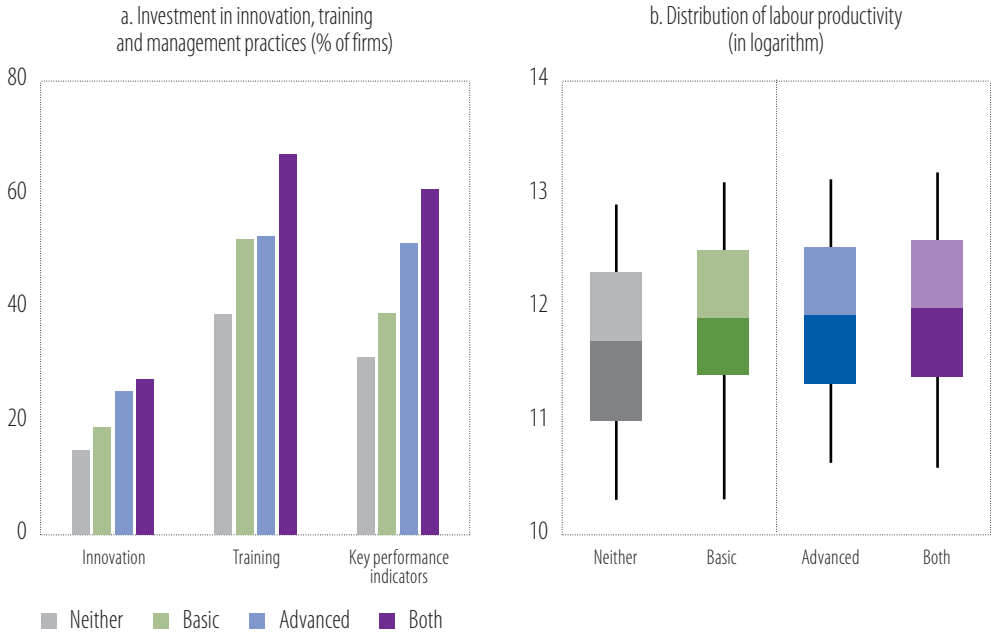
Source: *EIB staff calculations based on EIBIS 2022, Eurostat and the US Census.*

A non-negligible share of firms used the crisis to start the digitalisation process. These companies have not yet implemented any advanced digital technology in their business, but they have taken action to become more digital as a response to COVID-19 — for example, by providing services online — and their digitalisation is categorised as "basic." In the European Union, 13% of firms fall into this category, and the share has remained stable over time.

At the other end of the spectrum, 69% of EU firms have already adopted advanced digital technologies. Among firms that have implemented advanced digital technologies, some did not invest in increasing their digitalisation activities during the pandemic. These companies are categorised as "advanced." Finally, firms that use digital technologies and that have also invested in further digitalisation as a response to the pandemic are categorised as "both" because they have fully embraced the digital transformation. 42% of European businesses fell into the "both" category in 2022 (a 9 percentage-point increase compared with 2021), while one-half of US firms fits in the "both" category.

The digital divide between firms may continue to grow over time. Most companies that cite developing or introducing new products, processes or services as their main investment priority over the next three years are already more digitally advanced (Figure 11a, Innovation). On the other hand, non-digital firms are more likely to say replacing capacity is their investment priority. In addition, about 20% of non-digital firms report not having any investment plans, compared with 6% of the most digitally advanced firms. Digital companies are more likely to report investing in employee training and using strategic business monitoring systems that compare current performance to a series of strategic key performance indicators (KPIs), which indicates advanced management practices. Digitalisation is also associated with higher labour productivity (Gál et al., 2019; Cathles, Nayyar, and Rückert, 2020). Digital firms that fall into the "both" category tend to have the highest levels of labour productivity (Figure 11b). These differences in investment priorities risk exacerbating the digital divide.

Figure 11
Firm performance, by digital profile



Source: *EIBIS 2022.*
Note: *See Figure 9 for the definition of digital profiles.*
Question: *Looking ahead to the next three years, is the development or introduction of new products, processes or services your main investment priority? In the 2021 financial year, did your business invest in the training of employees? Does your company use a formal strategic business monitoring system that compares the firm's current performance against a series of strategic key performance indicators (KPI)?*

Source: *EIBIS 2022.*
Note: *See Figure 9 for the definition of digital profiles. Labour productivity is defined as sales per employee. Figure 11 shows the 10th, 25th, 50th, 75th and 90th percentiles of the distribution of labour productivity, by digital profile.*

External factors enabling digitalisation: Digital infrastructure and product market regulation

The external environment in which firms operate contributes significantly to their digitalisation efforts. Digital infrastructure, regulation and market concentration can all limit or enhance digital adoption. In these areas, a coherent set of public policies can make a major difference. The analysis presented in this section shows how firms' operating environment can enable digitalisation and maximise returns from digitalisation investments.

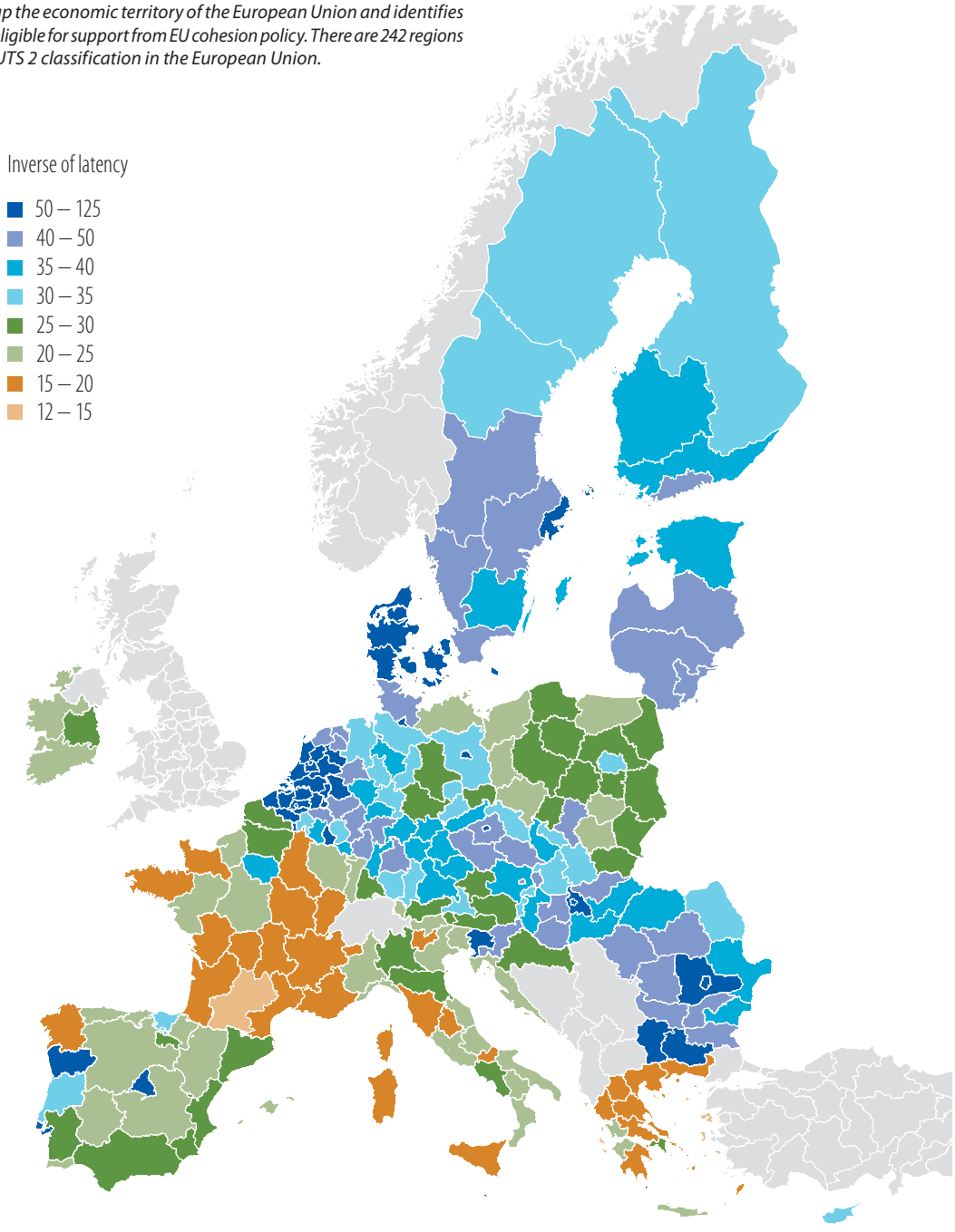
Digital infrastructure as an enabler of firm digitalisation

Digital infrastructure played a critical role during the COVID-19 crisis. 14% of EU firms surveyed in the latest EIBIS consider access to digital infrastructure to be a major obstacle to investment. A key consideration is internet access and speed. Using data on internet speeds, Figure 12 shows that significant differences exist in the quality of digital infrastructure between EU regions and countries.

Figure 12

Internet speed estimates at the NUTS 2* level in the European Union, in 2019

** The Nomenclature of Territorial Units for Statistics (NUTS) classification divides up the economic territory of the European Union and identifies regions eligible for support from EU cohesion policy. There are 242 regions in the NUTS 2 classification in the European Union.*

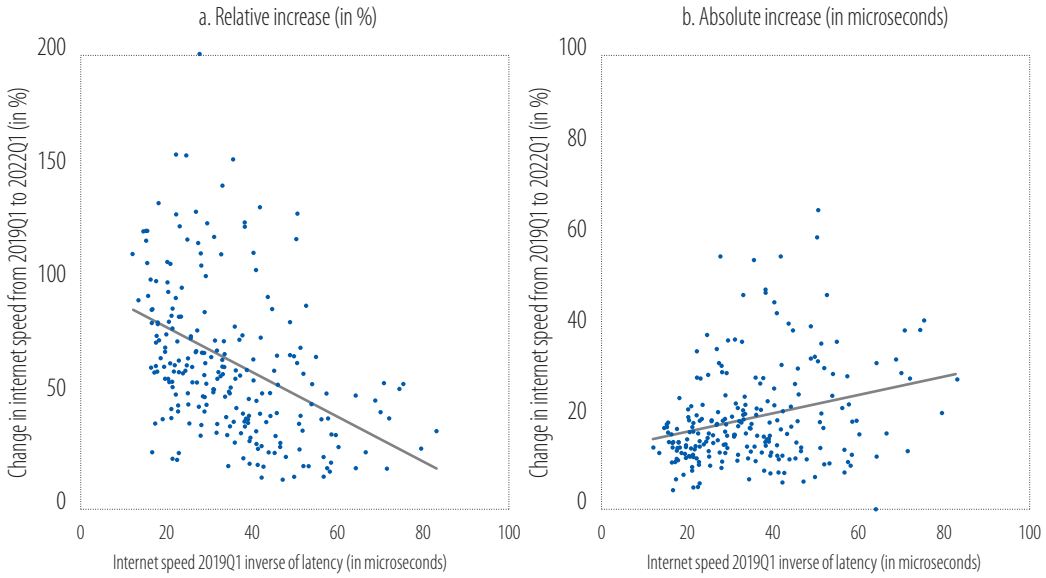


Source: *Authors' calculations based on Ookla.*

Note: *The figure shows data from the first quarter of 2019 and is based on more than 11 million internet speed tests during this period. Internet speed is proxied by the measure of average latency during internet speed tests performed using the website Speedtest.net. Latency is the time it takes for data to be transferred between its original source and its destination, measured in microseconds. The measure is transformed as the inverse of latency (one over latency) to show a positive increase when internet speed is higher. The original data is provided at the level of mercator tiles (approximately 610.8 metres by 610.8 metres at the equator), which is aggregated to NUTS 2 level averages, using the number of tests as weights.*

Persistent and major differences in access to digital infrastructure continue to exist between EU regions. While internet speed has increased throughout the European Union, regions that previously had poor internet access have experienced the greatest relative improvement recently (Figure 13a). Internet speed more than doubled from 2019 to 2021 in some EU regions — primarily in France, Poland and Romania. However, the improvement in digital access has not been sufficient to close regional gaps. Instead, regions that already had better digital infrastructure have increased internet speed more quickly in absolute terms (in microseconds) (Figure 13b). This suggests that digital infrastructure gaps between regions have been widening over time.

Figure 13
Change in internet speed in European regions, 2019-2021



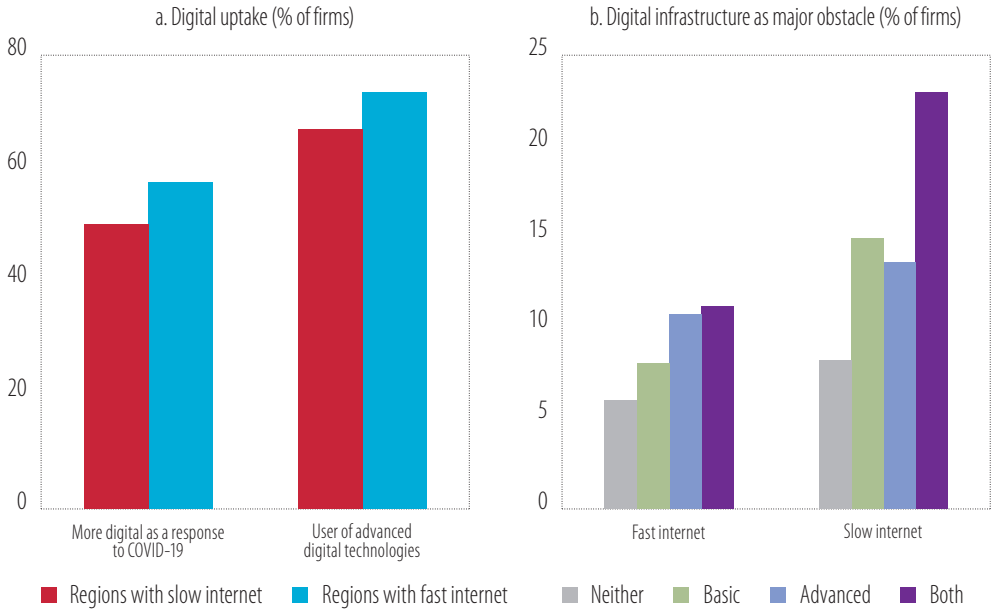
Source: *EIB staff calculations based on Ookla.*
Note: *The figure shows data from the first quarter of 2019 to the first quarter of 2022. Each point represents a NUTS 2 region in the European Union. The left panel shows the increase in internet speed (the inverse of average latency) in relative terms, while the right panel shows the increase in the latency measure in absolute terms. See note to Figure 12 for the definition of internet speed in a region.*

Regions with faster internet speeds tend to have a higher share of digital firms. Regions with fast internet (where internet speed is above median internet speed across NUTS regions) have a higher share of companies that use advanced digital technologies and a higher share of firms that invested in becoming more digital as a response to COVID-19 (Figure 14a). Digitally advanced firms that operate in regions with slow internet also cite the lack of adequate digital infrastructure as an investment barrier (Figure 14b).

The returns from digitalisation are greater for firms located in regions with better infrastructure and faster internet speeds. Better digital infrastructure has provided additional productivity gains for firms that invested in becoming more digital as a response to COVID-19. In regression analysis, the effect can be seen as the positive interaction between investment in digitalisation and fast internet (Table 1).[4] At the same time, while firms that use advanced digital technologies tend to be more productive, firms that already use advanced digital technologies in regions with fast internet see no benefit. In the regression, the interaction term is close to zero. This highlights how critical digital infrastructure was in supporting firms' rapid digital transformation during the pandemic. More generally, it also illustrates how complementary public and private digital investments can improve firm performance and economic resilience.

4 Table 1 reports estimates from ordinary least square regressions (OLS), but the results are similar when using Huber robust regressions.

Figure 14
Digital adoption and regional internet speed



Source: *EIB staff calculations based on EIBIS 2022 and Ookla 2021.*
Note: *See note to Figure 12 for the definition of internet speed in a region. See note to Figure 2 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)? Thinking about your investment activities, to what extent is access to digital infrastructure a major obstacle?*

Source: *EIB staff calculations based on EIBIS 2022 and Ookla 2021.*
Note: *See note to Figure 12 for the definition of internet speed in a region. See Figure 9 for the definition of digital profiles.*
Question: *Thinking about your investment activities in the last financial year, to what extent is access to digital infrastructure an obstacle? Is it a major obstacle, a minor obstacle or not an obstacle at all?*

Table 1
Digital adoption, digital infrastructure and firm productivity

Dependent variable	Total factor productivity	Labour productivity	Total factor productivity	Labour productivity
More digital during COVID-19	0.073***	0.095***		
	(0.019)	(0.024)		
Advanced digital technologies			0.106***	0.133***
			(0.019)	(0.024)
Regions with fast internet	0.071***	-0.034	0.106***	-0.022
	(0.020)	(0.023)	(0.022)	(0.028)
More digital x fast internet	**0.086*** **	**0.086** **		
	(0.028)	**(0.035)**		
Advanced digital technologies x fast internet			0.000	0.030
			(0.028)	(0.035)
Sample size	9 678	11 300	9 672	11 298
R-squared	0.370	0.259	0.369	0.259

Source: *EIB staff calculations based on EIBIS 2022 and Ookla 2021.*
Note: *Firms in the EU27. Total factor productivity and labour productivity are expressed in natural logarithms. The ordinary least squares (OLS) regressions control for firm size, firm age, country and sector (three groups of EU countries and four macroeconomic sectors). Region with slow internet: NUTS 2 region with average latency higher than the median latency across all regions (based on Ookla data). See note to Figure 12 for the definition of internet speed in a region. Bootstrap standard errors with 500 replications are in parentheses for total factor productivity, and robust standard errors are in parentheses for labour productivity. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

Investment in digital infrastructure by European municipalities

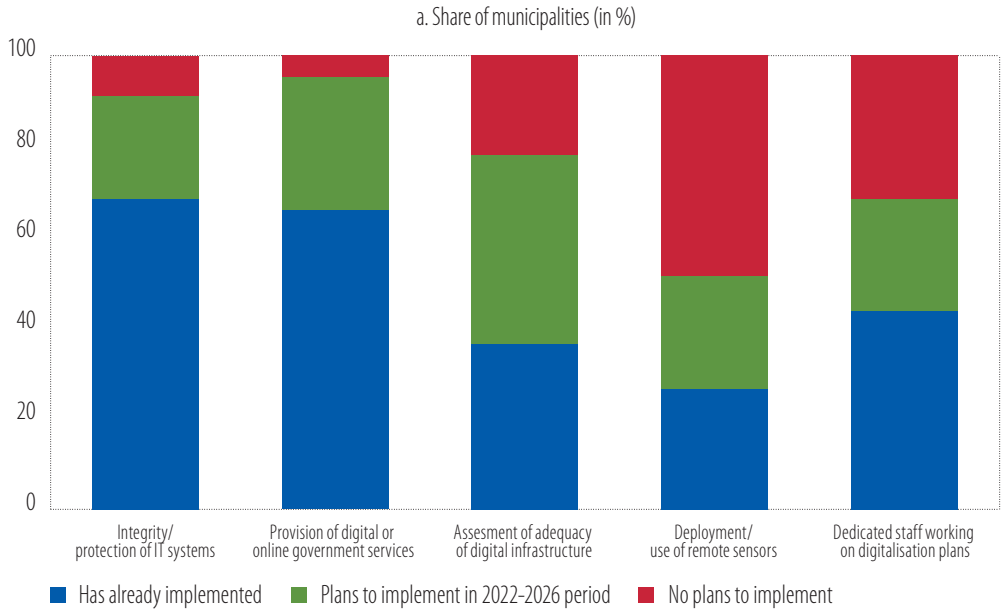
The coronavirus pandemic forced municipalities to find new ways of working. The EIB Municipality Survey 2022 asked municipalities in the European Union about the development and deployment of different digital capabilities. These include (i) ensuring the integrity and protection of IT systems (cyber security), (ii) providing digital or online government services, (iii) systematically assessing the adequacy of digital infrastructure, (iv) deploying and using remote sensors (such as real-time traffic or weather monitoring) and (v) employing staff to work exclusively on digitalisation plans.

Most municipalities in the European Union have already implemented measures to support the integrity and protection of IT systems. Most municipalities also provide digital or online government services (Figure 15a). However, deploying remote sensors and employing staff to work exclusively on digitalisation plans appear to be less of a priority in the short to medium-term (2022 to 2026).

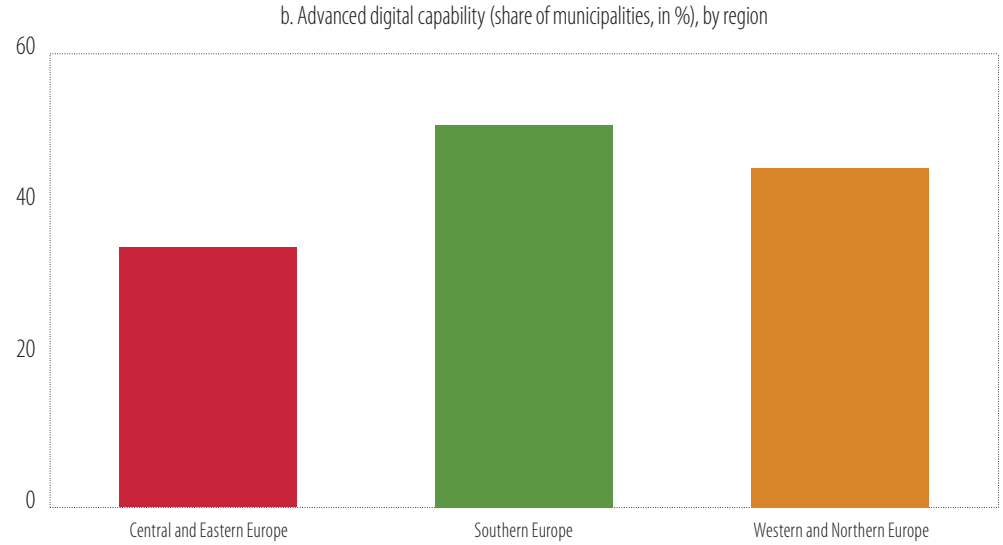
Municipalities in Central and Eastern Europe tend to be less digitally advanced. The municipality survey response can be used to create an indicator of digital capability, acting as a proxy for the degree to which municipalities are addressing the challenges of digitalisation. Municipalities are considered to have advanced digital capability and sophistication if they have implemented at least three of the five digital capabilities in Figure 15a. About one-third of municipalities in Central and Eastern Europe tend to be digitally advanced, compared with one-half of municipalities in Southern Europe and 45% of municipalities in Northern and Western Europe.

Municipalities with greater digital capabilities and sophistication are less likely to report a lack of investment in digital infrastructure. This relationship is particularly strong in Southern Europe, where digitally advanced municipalities are more likely to judge their investment in digital infrastructure to have been broadly adequate over the last three years (from 2019 to 2021) than digital laggard municipalities (Figure 16). Investment in digital infrastructure appears to be closely linked to the digitalisation of key digital public services, such as the integrity and protection of IT systems (including cyber security) and the provision of digital or online government services.

Figure 15
Municipal administrative digital capability and sophistication



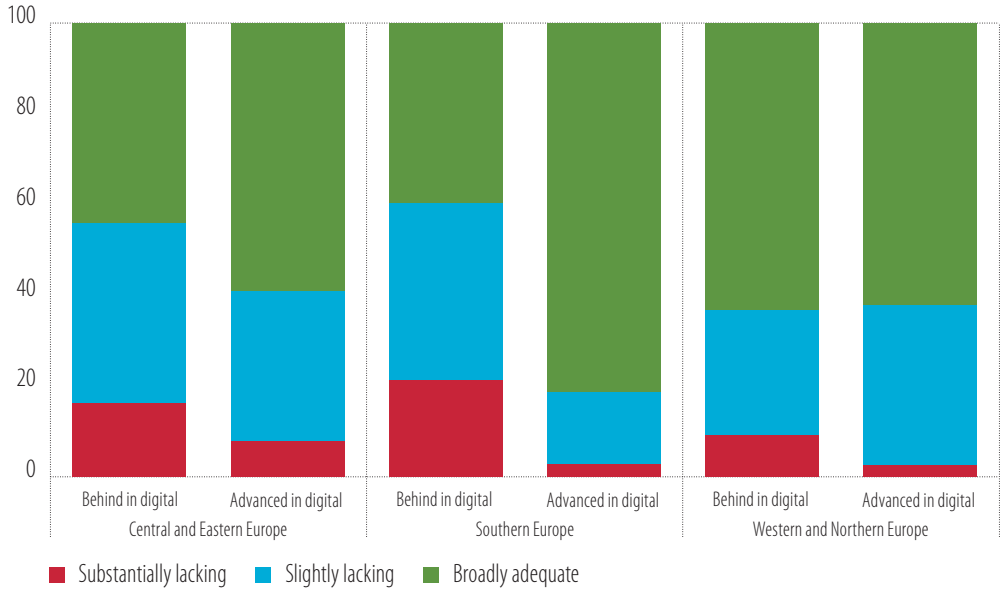
Source: *EIB Municipality Survey 2022.*
Question: *Thinking about digital technologies: For each of the following please tell me whether your municipality has already implemented, has plans to implement in the 2022-2026 period or has no plans to implement in the 2022-2026 period?*



Source: *EIB Municipality Survey 2022.*
Note: *A municipality is considered advanced in digital capability if it has implemented at least three of the five digital capabilities in Figure 15a.*

Figure 16

Assessment of digital infrastructure quality (share of municipalities, in %)**, by digital capability**

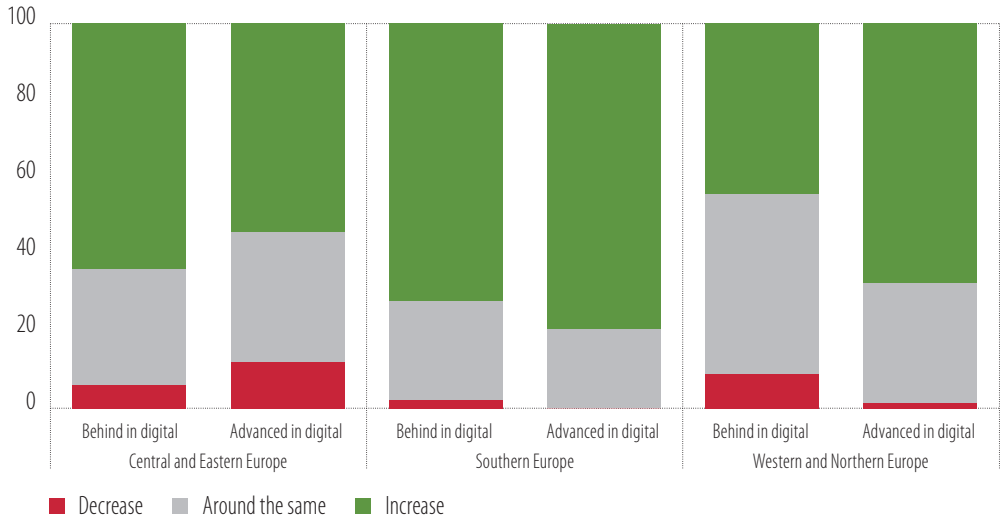


Source: *EIB Municipality Survey 2022.*
Note: *See note to Figure 15b for the definition of municipalities advanced in digital capability.*
Question: *In the last three years, that is to say between 2019 and 2021, would you say that within your municipality the level of investment in digital infrastructure projects was broadly adequate, slightly lacking or substantially lacking?*

Municipalities with better digital capabilities and sophistication are also more likely to state that they are planning to increase investment in digital infrastructure. A large share of municipalities in Western and Northern Europe that are lagging on digitalisation said they do not plan to increase investment in infrastructure from 2022 to 2026 (Figure 17), potentially exacerbating the infrastructure gap with more digitally advanced municipalities. Policy support will be key to reducing regional disparities in digital infrastructure.

Figure 17

Outlook of digital infrastructure spending (share of municipalities, in %), **by digital capability**

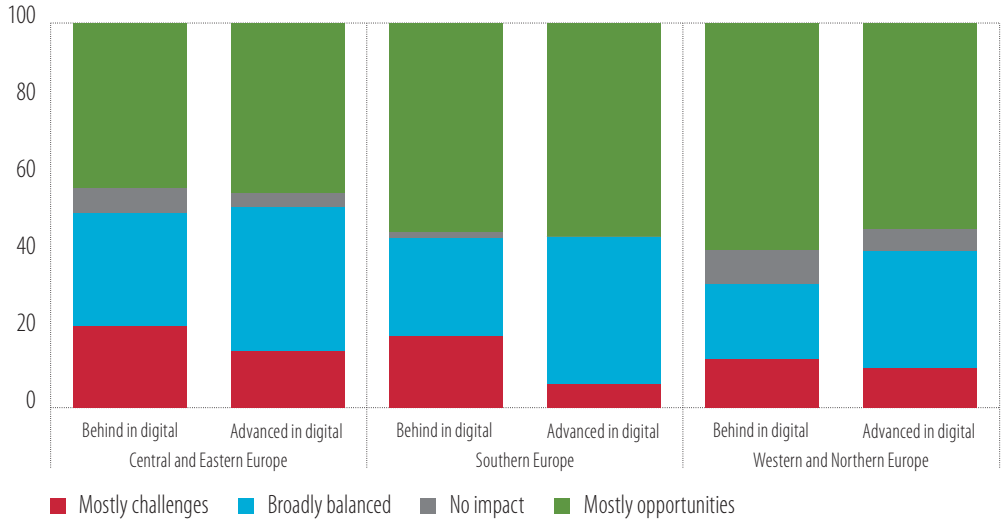


Source: *EIB Municipality Survey 2022.*
Note: *See note to Figure 15b for the definition of municipalities advanced in digital capability.*
Question: *For digital infrastructure, if you compare the average annual infrastructure investment you are planning for the 2022-2026 period vs. the average annual infrastructure investment recorded in 2019-2021, does your municipality expect to increase, decrease or have around the same level of spending on infrastructure investment?*

Municipalities with lower digital capabilities and sophistication tend to be less optimistic about the digital transition. In contrast, digitally advanced municipalities see more digitalisation-related opportunities than challenges (Figure 18). Overall, the evidence hints at a growing digital divide between municipalities.

Figure 18

Opportunities and challenges stemming from digitalisation (share of municipalities, in %), **by digital capability**

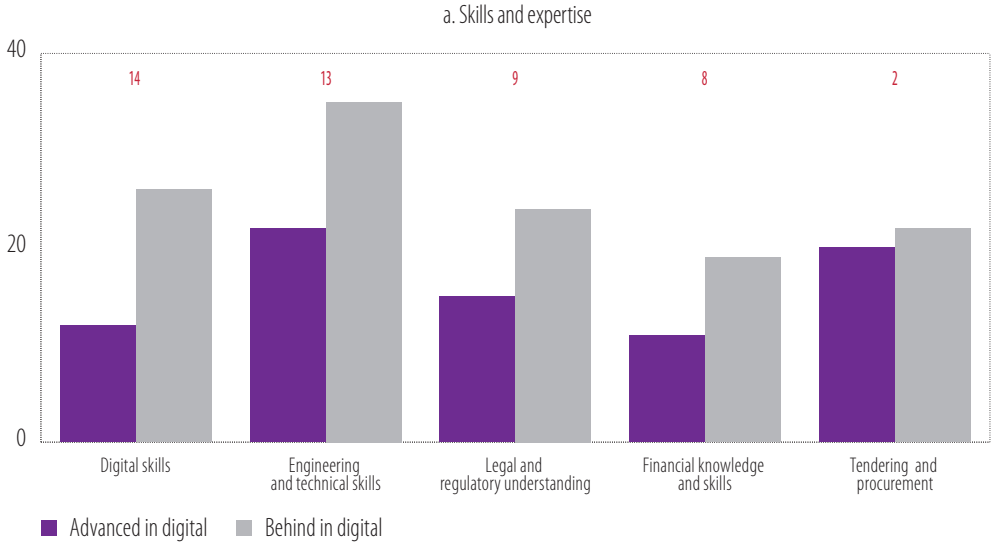


Source: *EIB Municipality Survey 2022.*
Note: *See note to Figure 15b for the definition of municipalities advanced in digital capability.*
Question: *Thinking about digitalisation, do you expect this global trend to present opportunities or challenges to your municipality?*

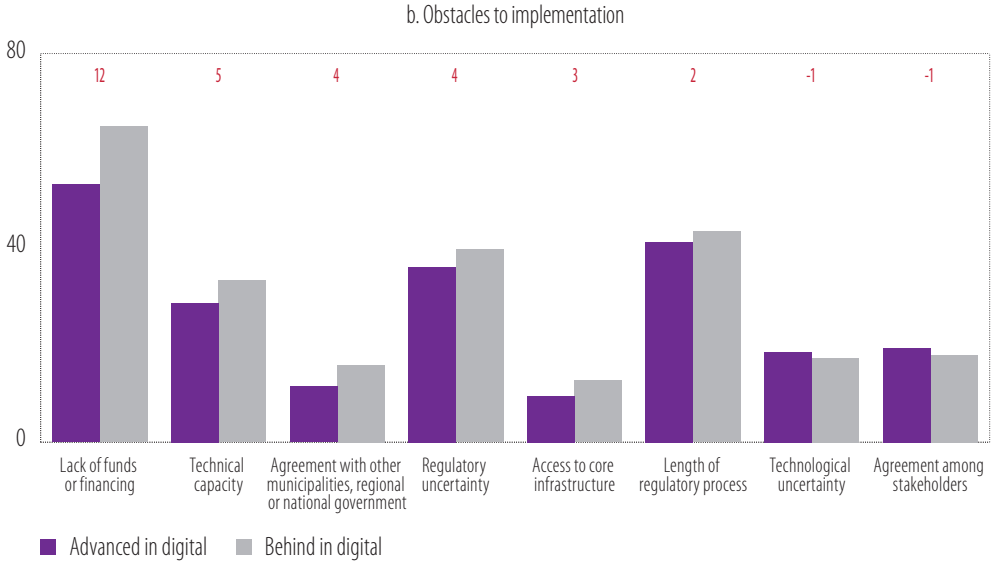
Access to digital and a lack of technical skills are major obstacles to EU municipalities' digital transformation. These obstacles are more prevalent among municipalities that are lagging digitally (Figure 19a). Other obstacles confronting laggard municipalities are a limited availability of funding and a lack of technical capability (Figure 19b). Improving digital capabilities and sophistication is not only about financing digital infrastructure but also about the skills that are required and regulatory uncertainty.

Figure 19

Major barriers to digitalisation (share of municipalities, in %)**, by digital capability**



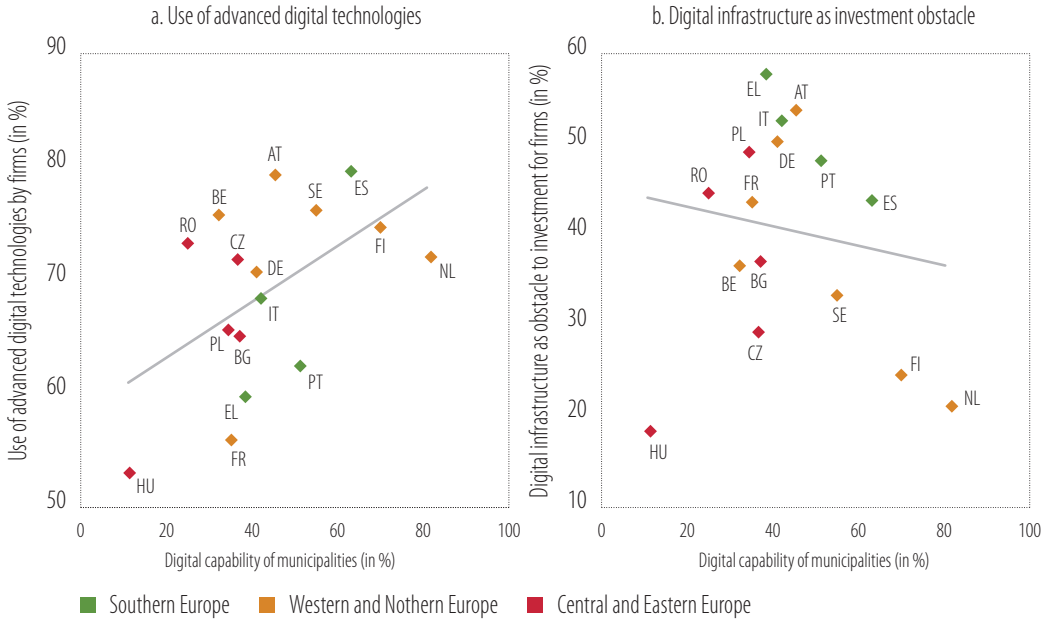
Source: *EIB Municipality Survey 2022.*
Note: *See note to Figure 15b for the definition of municipalities advanced in digital capability. The numbers over the bars indicate the percentage point difference in firms behind and advanced in digital technologies.*
Question: *For each of the following areas, to what extent is access to experts a major problem to the delivery of your municipality's investment programme?*



Source: *EIB Municipality Survey 2022.*
Note: *See note to Figure 15b for the definition of municipalities advanced in digital capability. The numbers over the bars indicate the percentage point difference in firms behind vs. advanced in digital technologies.*
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?*

The digital capabilities of municipalities are positively correlated with firm uptake of digital technologies. Firms have higher rates of digital adoption in countries where a high share of municipalities are digitally sophisticated (Figure 20a). In addition, there is a slight negative correlation between municipal adoption of digital technologies, and the share of firms reporting the lack of digital infrastructure as an investment obstacle (Figure 20b).

Figure 20
Digital activities of firms and digital capability of municipalities



Source: *EIB Municipality Survey 2022 and EIBIS 2022.*
Note: *See note to Figure 15b for the definition of municipalities' digital capability and Figure 2 for the definition of firms' use of advanced digital technologies. Only municipalities with at least 30 observations are considered.*

Source: *EIB Municipality Survey 2022 and EIBIS 2022.*
Note: *See note to Figure 15b for the definition of municipalities' digital capability.*
Question: *Thinking about your investment activities, to what extent is access to digital infrastructure an obstacle? Only municipalities with at least 30 observations are considered.*

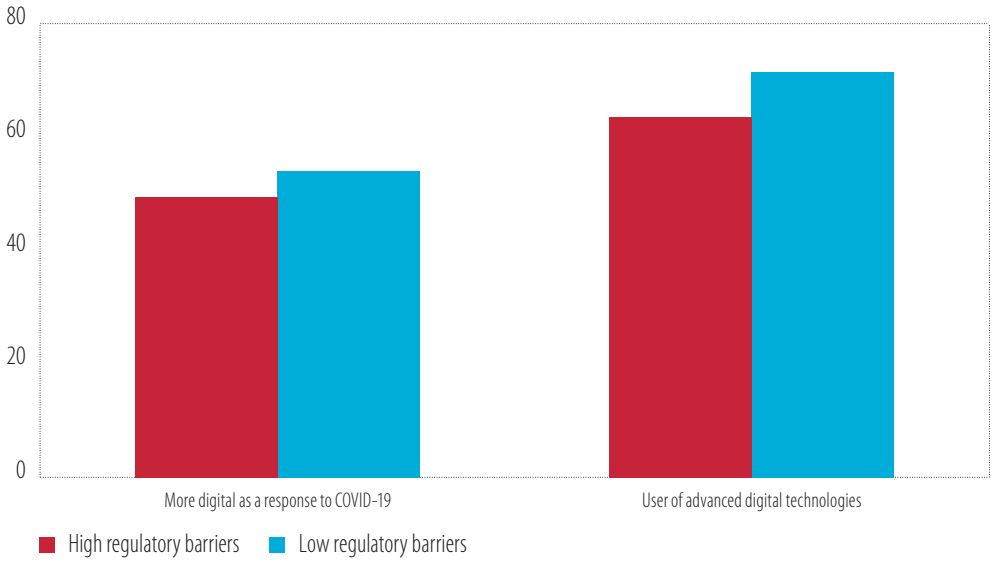
Digital security concerns are a major barrier to the adoption of digital technologies. More digital operations, teleworking and virtual client interaction increase risks and the vulnerability of digital systems. Digital security threats have increased markedly since the coronavirus pandemic. To address the issue, digital security must move up from a mere technical issue to the top tier of business decision-making. This involves raising awareness and empowering all stakeholders to understand and manage digital security risks, and to continuously assess those risks.

Product market regulation and market power

Regulation has a direct impact on competition and innovation. Policymakers are increasingly turning their attention to the effect competition regulation has on innovation and digital adoption. Several studies highlight the positive impact a regulatory environment that encourages competition has on innovation (Akcigit, Ates and Impullitti, 2018; Perla, Tonetti and Waugh, 2021). However, while competition may push firms to innovate more, it may also dissuade them from innovating because of decreasing innovation returns (Aghion et al., 2005; Griffith and van Reenen, 2021). In addition, trade regulation influences import competition and innovation, but the effects differ from country to country and from firm to firm (Shu and Steinwender, 2019). Policymakers are therefore presented with a trade-off between rewarding inventors with monopoly power and fostering competition to push technology forward.

Lower regulatory barriers for firms entering a market and increased competition tend to enhance digitalisation. Firms operating in an environment with lower regulatory barriers (using the OECD Product Market Regulation indicators at the country level as a proxy) tend to invest more in digitalisation (Figure 21). Firms using advanced digital technologies are also more prevalent in regions with low regulatory barriers. National regulatory frameworks can play an important role in the ability of firms to react to crises.

Figure 21
Digital adoption and regulatory environment (% of firms)



Source: *EIB staff calculations based on EIBIS 2022 and OECD Product Market Regulation indicators 2018.*
Note: *The data for the product market regulation indicators are at the country level and are not available for some countries.*
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 2 for the definition of the adoption of advanced digital technologies.*

Digitalisation is at the heart of policy discussions on rising market concentration and competition policies. Digital technologies often come with scale and synergies, giving an advantage to large firms. The high mark-ups and profits enjoyed by these firms often foster market concentration (Haskel and Westlake, 2017). These factors help create a few superstar firms that dominate a very large share of their market (Philippon, 2019; Autor et al., 2020). In the past two decades, the productivity gap between firms on the global cutting edge and laggards has risen (Andrews, Criscuolo and Gal, 2016). Cutting-edge firms are typically larger, are more innovative and have higher rates of digital technology adoption. Market concentration and mark-ups tend be more pronounced in sectors in which digital technologies, especially digital services, are developed or widely adopted (Calligaris, Criscuolo and Marcolin, 2018; Diez, Leigh and Tambunlertchai, 2018). The rapid increase in the adoption of digital technologies and the acceleration during the pandemic have added new layers to the debate on the polarisation created by technology and winner-takes-all dynamics in which a few firms dominate a market (Rückert et al., 2021).

Firms operating in more concentrated markets tend to be more digital. Competition (or the lack thereof) can be measured by the share of overall sales occupied by the top five or ten firms in a country and industry.[5] The estimates in Table 2 show that firms operating in markets in which the top five (or top ten) firms play a more dominant role are more likely to fall into the "both" category — firms that invested in becoming more digital as a response to COVID-19 and use advanced digital technologies. In other words, market concentration is strongly associated with digital adoption.

5 Using Orbis data, Bajgar et al. (2019) measure market concentration using the top four, top eight and top 20 firms in an industry.

Table 2

Market concentration and digital adoption

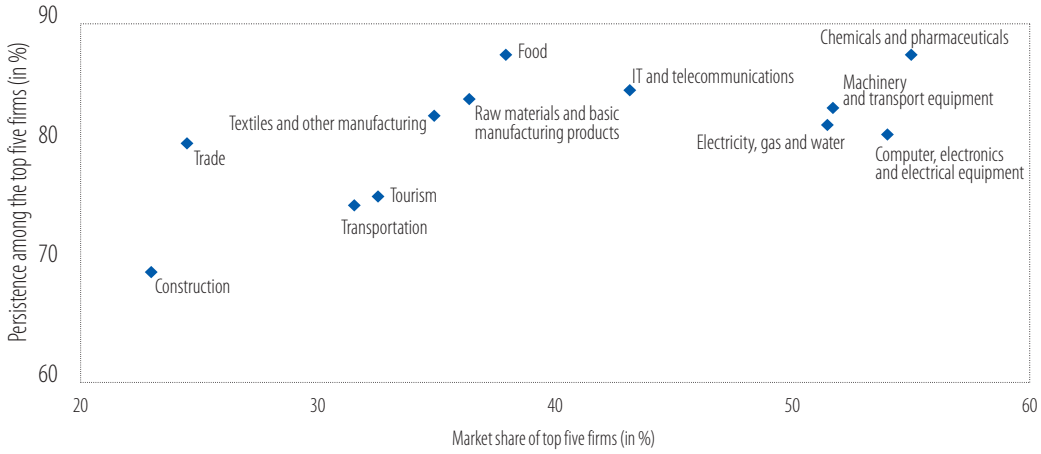
Dependent variable: "Both": more digital during COVID-19 and user of advanced digital technologies		
Market share of top five firms	0.0454**	
	-0.0205	
Market share of top ten firms		0.0504**
		-0.0208
Sample size	11 566	11 566
R-squared	0.115	0.115

Source: *Authors' calculations based on EIBIS 2022 and Orbis.*
Note: *All regressions control for firm size, age, country and sector (27 EU countries and 12 sectors). Robust standard errors are in parentheses. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

In more concentrated markets, firms are more likely to remain among the top market leaders. Sectors where the top five (or top ten) firms play a dominant role in terms of market share tend to see a lower turnover of these firms (Figure 22). This winner-takes-all market dynamic is particularly strong in the chemicals and pharmaceuticals sector and utilities (electricity, gas and water companies), but also in the digital sectors, such as computer and electronics, machinery and transport equipment, and IT and telecommunications. These sectors experience stronger digital adoption (Figure 8).

Figure 22

Market concentration and persistence of firms remaining in the top five, by sector



Source: *EIB staff calculations based on Orbis.*
Note: *Persistence refers to the annual probability of remaining among the top five firms for market share.*

Policymakers should focus on the conditions and incentives needed to help smaller firms transform digitally. The results linking the importance of market concentration to digital adoption do not indicate the direction of causality. However, the positive correlation between market concentration and digital adoption is in line with previous studies (for example, Acemoglu et al., 2022). The research also argues that the high costs of adopting advanced digital technologies can be a major issue for small firms, creating advantages for large firms in the adoption and use of these technologies. This dynamic, in turn, further drives rising market concentration. The findings suggest that policymakers should focus on the conditions and incentives needed for the digital transformation of smaller businesses. These companies might otherwise fall victim to bigger firms with excessive market power, and their disappearance might be associated with lower market contestability and openness to innovation. Such issues are particularly relevant for Europe's strategic autonomy in certain industries, keeping in mind that it needs to increase the resources available for research, innovation and critical technologies.

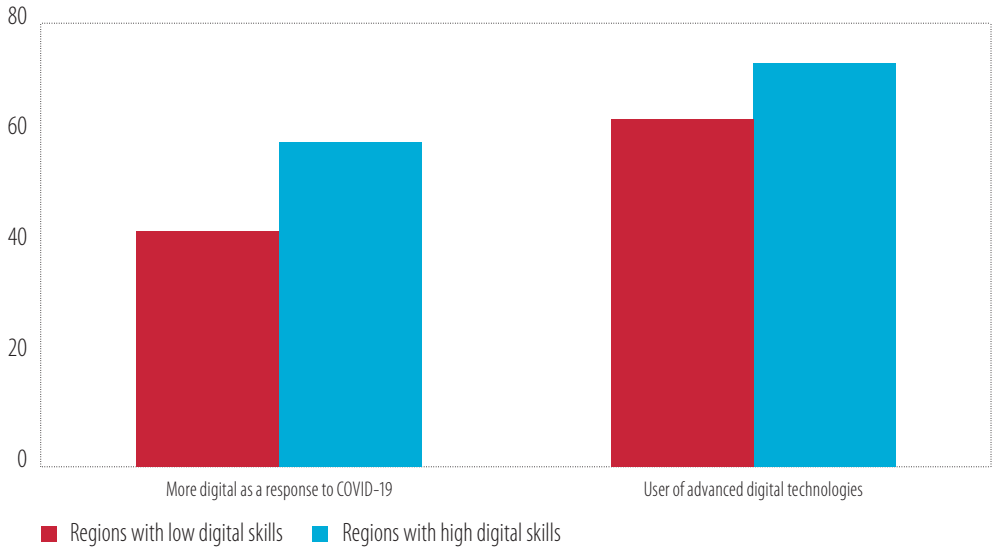
Internal factors enabling digitalisation: Skills, management decisions and the diffusion of digital innovation

This section focuses on internal factors and management decisions that help firms take advantage of the upside of digitalisation. These factors include investment in employee training to improve digital skills, modern management practices and trade with firms in innovative sectors, which enhances the diffusion of cutting-edge digital technologies.

Digital skills and worker exposure to digitalisation

The availability of workers with digital skills supports the digital transformation. Firms operating in regions where the population has above-average digital skills tend to have implemented advanced digital technologies more often (Figure 23). They are also more likely to have invested in becoming more digital as a response to COVID-19. This may be the result of firms' tendency to hire skilled labour already available on the market rather than bearing the costs of in-house training (Brunello et al., 2023). 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).

Figure 23
Digital adoption and digital skills (% of firms)



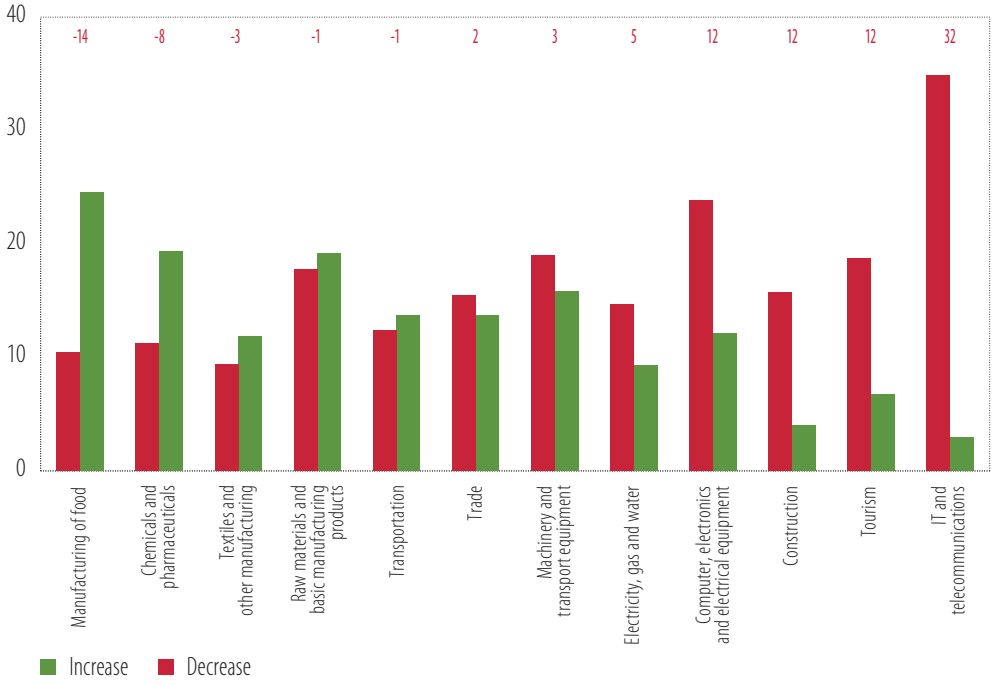
Source: *EIB staff calculations based on EIBIS 2022, Regional Innovation Scoreboard (RIS), 2021 and European Innovation Scoreboard (EIS), 2021.*
Note: *The level of digital skills in each NUTS region is based on the indicator "individuals who have above basic overall digital skills" in the Regional Innovation Scoreboard (RIS) and European Innovation Scoreboard (EIS). Regional data for digital skills from the RIS are available at the NUTS level 2 for most countries and at the NUTS level 1 for Austria, Belgium, Germany, Greece, Spain, Finland, France and Portugal. Data for Cyprus, Estonia, Malta, Lithuania and Luxembourg are only available at the country level and from the EIS.*
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 2 for the definition of the adoption of advanced digital technologies.*

The adoption of advanced digital technologies may facilitate the automation of tasks previously performed by employees. Advanced robots can be used in manufacturing to automate tasks such as welding and assembly. Artificial intelligence can also be used to create algorithms capable of achieving

human-level proficiency at predictive tasks, such as driving autonomous vehicles. At the same time, firms using these technologies introduce new processes and create new tasks for workers (Goergieff and Hyee, 2021). Affected workers will need to learn new skills or improve their existing skills to adapt to the reorganisation of tasks and the emergence of new tasks following the introduction of advanced digital technologies, and to navigate transitions to new jobs (Brunello et al., 2023).

Workers' exposure to automation differs from sector to sector. To understand the importance of automation, the EIBIS asks firms using advanced digital technologies how they expect digital technologies to affect employment. Workers in the food manufacturing and chemicals and pharmaceuticals sectors are most exposed to automation (Figure 24). On balance, firms in these sectors expect a stronger decrease in employment than in the construction and tourism sectors. Employees in the IT and telecommunications sector appear the least affected, with 35% of firms reporting an expected increase in employment, compared with only 3% that expect a decrease.

Figure 24
Worker exposure to automation (% of firms)**, by sector**



Source: *EIBIS 2022.*
Note: *Weighted for employment. The numbers over the bars indicate the net balance (the share of firms that expect an increase in the number of employees minus the share of firms that expect a decrease) in percentage points.*
Question: *Over the next three years, what impact do you expect your business' use of this technology to have on the number of people your company employs? Increase employees, decrease employees, no change?*

Management decisions and investment in employee training play a crucial role in whether firms see advantages from adopting technologies. Well managed firms may be better able to identify their digital needs and to allocate digital resources more efficiently. Firms with advanced managerial practices are not only more likely to implement advanced digital technologies, but they also tend to have higher productivity (see Box B). Providing employees with training to improve their digital skills also influences whether firms benefit fully from advanced digital technologies (see Box C). This suggests that firms' digitalisation strategies should also look at the need for transforming managerial practices and skills.

Box B

Digital adoption, labour share and labour productivity

Following Acemoglu et al. (2022), this analysis uses firm-level data on digital adoption, the labour share of revenue (wage bill divided by revenue), the average wage per employee (wage bill per employee) and labour productivity (revenue per employee).[6] The estimates in Table B.1 show that the higher labour productivity of digital adopters is driven by the lower share of revenues taken by labour and by higher wages. Advanced digital technologies enable firms to produce in a more capital-intensive way by relying more on specialised equipment and software and less on labour. Furthermore, these technologies may reduce the employment of less-skilled workers and increase the hiring of skilled workers, and this focus on skilled workers can also increase labour productivity.

Table B.1

Labour productivity, labour share, average wage per employee and adoption of digital technologies

Dependent variable: Advanced digital technologies		
Labour productivity	0.165*** (0.012)	
Labour share		-0.319*** (0.052)
Average wage		0.192*** (0.016)
Use of KPIs	0.698*** (0.022)	0.693*** (0.023)
Sample size	46 796	44 100

Source: *EIB staff calculations based on EIBIS 2019-2022.*

Note: *Labour productivity, labour and average wage per employee are in natural logarithms. All regressions control for firm size, age, year, country and sector (27 EU countries and 12 sectors). Logit regressions were used. Use of key performance indicators (KPIs): The firm uses a formal strategic business monitoring system that compares the firm's current performance against a series of strategic indicators. Robust standard errors are in parentheses. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

Although the correlations in Table B.1 do not provide guidance on the direction of causality, digital adopters paying higher wages is in line with the theory that higher wages generate incentives for automation. Likewise, users of advanced technologies having lower labour shares and higher labour productivity is consistent with the evidence that these technologies can lead to automation. Across all technologies, larger firms tend to be more digital (see Figure 4). Looking at individual technologies, firms that use advanced robotics, the internet of things and big data analytics tend to pay higher wages and have lower labour shares (Table B.2). Furthermore, firms with advanced managerial practices are not only more likely to implement advanced digital technologies, but they also tend to have higher productivity.

Labour productivity is associated with the use of advanced digital technologies. Advanced robotics, big data, the internet of things, drones, online platforms and augmented reality are positively associated with labour productivity, whereas 3-D printing is negatively associated (Table B.3). In addition, labour productivity increases with firm size and age.

6 Labour productivity can also be defined as the average wage per employee divided by the labour share of revenue.

Table B.2

Labour share, average wage per employee and adoption of advanced digital technologies

Dependent variable	Internet of things	Artificial intelligence	3-D printing	Advanced robotics	Online platforms	Augmented reality
Labour share	-0.195***	-0.378***	0.205**	-0.368***	-0.177**	-0.176
	(0.055)	(0.087)	(0.094)	(0.123)	(0.074)	(0.153)
Average wage	0.097***	0.264***	-0.026	0.146***	0.203***	0.210***
	(0.016)	(0.028)	(0.029)	(0.034)	(0.023)	(0.045)
Use of KPIs	0.554***	0.866***	0.506***	0.508***	0.692***	0.784***
	(0.024)	(0.036)	(0.041)	(0.044)	(0.033)	(0.060)
Sample size	43 282	34 162	32 625	13 201	20 971	20 172

Source: *EIB staff calculations based on EIBIS 2019-2022.*
Note: *Labour share and average wage per employee are in natural logarithms. All regressions control for firm size, age, year, country and sector (27 EU countries and 12 sectors). Logit regressions are used. Use of key performance indicators (KPIs): The firm uses a formal strategic business monitoring system that compares the firm's current performance against a series of strategic indicators. Robust standard errors are in parentheses. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

Table B.3

Adoption of advanced digital technologies and labour productivity

Dependent variable: Labour productivity					
Sector	All sectors	Manufacturing	Construction	Services	Infrastructure
Advanced digital technologies	0.150***				
	(0.010)				
3-D printing		-0.096***	-0.076**		-0.086**
		(0.020)	(0.037)		(0.043)
Advanced robotics		0.080***			
		(0.017)			
Internet of things		0.032*	0.000	0.065***	0.068***
		(0.017)	(0.023)	(0.023)	(0.022)
Big data and artificial intelligence		0.134***		0.101***	0.177***
		(0.022)		(0.031)	(0.028)
Drones			0.295***		
			(0.026)		
Augmented reality			0.139***	-0.046	
			(0.037)	(0.039)	
Online platforms				0.106***	0.117***
				(0.022)	(0.022)
Sample size	44 983	13 194	9 373	10 891	10 085

Source: *EIB staff calculations based on EIBIS 2019-2022.*
Note: *All regressions control for firm size, age, year, country and sector (27 EU countries and 12 sectors). OLS regressions. Standard errors are in parentheses. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

Box C

Smart technologies, workforce training and investment strategy: Evidence from European firms[7]

EU countries have implemented various policies fostering the adoption of smart or digital technologies in recent years. However, official statistics and the relevant literature have struggled to gauge the causal impact of technology adoption on productivity, labelling it the productivity paradox. While it is becoming clearer that the adoption of smart technologies by firms should be accompanied by a parallel investment in workforce retraining to take full advantage of technology's potential, not enough evidence exists on this complementarity yet. Whether firms are currently on track to strike the right balance between machine input and human labour is therefore a salient policy question.

Novel ways of measuring smart technology adoption using EIBIS data and distinguishing between technology types shed light on this phenomenon. These methods analyse adoption patterns and performance when technology adoption comes with large-scale investment in workforce training. The analysis shows that productivity improves when firms adopt technologies and invest heavily in training. Conversely, firms that only partially adopt smart technologies and do not invest in workforce retraining do not seem to realise increases in productivity.

Smart technologies and adoption patterns

The economic literature considers different technologies and mainly identifies firms as technological adopters by counting the number of smart technologies adopted (McElheran et al., 2021). This analysis, however, created adoption indicators based on the type of technology used. The indicators make it possible to distinguish between big data[8] and hardware[9] technologies, considering the firm's sector of activity.

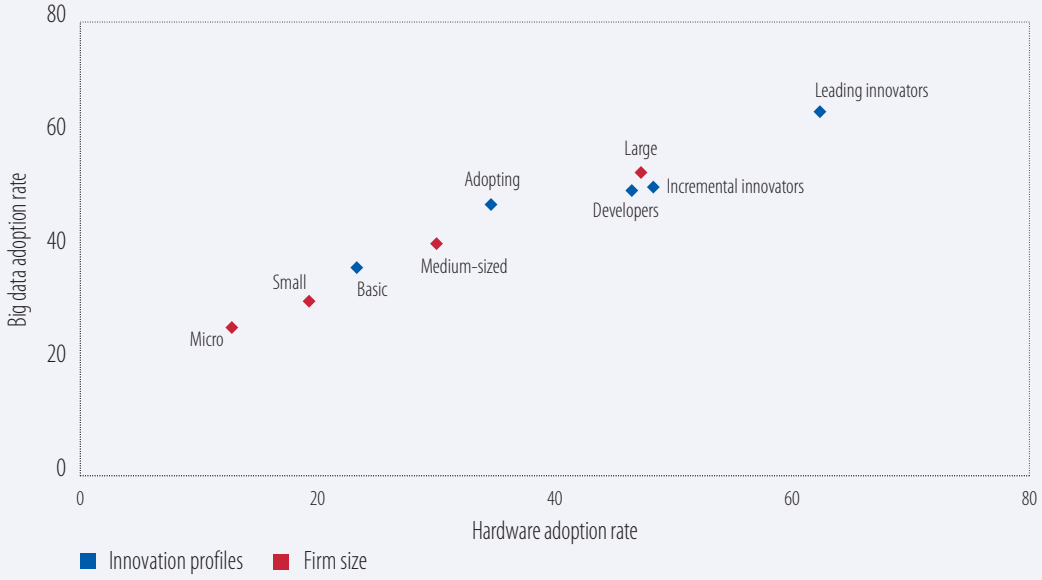
Figure C.1 reports adoption rates for the two types of technologies according to two different firm-level characteristics: firm size and innovation profiles, as defined by Veugelers et al. (2019). Overall, there is a strong positive correlation between hardware and big data technology adoption rates, suggesting that the two investments complement one another. When it comes to firm size, larger companies are more likely to adopt both types of technology. When considering firm-level innovation profiles, adoption rates are higher for more innovative firms, with leading innovators recording the highest shares.

7 This box was prepared by Giacomo Casali and Andrea Coali (Bocconi University).

8 The big data indicator considers the adoption of big data analytics and/or the internet of things. A firm is labelled as an adopter if it uses at least one of the two technologies. For firms in construction, which are only questioned about their use of the internet of things (but not big data analytics), a firm is labelled as an adopter if it uses the internet of things.

9 The hardware indicator depends on the firm sector. For firms in manufacturing, it is whether the firm has either 3-D printing capabilities and/or advanced robotics; in construction, whether it has drones and/or 3-D printing capabilities; and in infrastructure, whether it has 3-D printing capabilities. For firms in the service sector, this indicator is not used.

Figure C.1
Big data and hardware adoption rates (% of firms)



Source: *Authors' calculations based on EIBIS 2019-2021.*
Note: *Statistics for hardware and software technologies have been weighted by value added on the EU sample of firms.*

Smart adoption and training

To better explore the relationship between technology adoption, investment in workforce training and firm productivity, a workforce training index was created based on information about investment in employee training. A firm is deemed to have high investment in training if its per-employee investment levels are in the upper quartile of the distribution. Productivity is estimated using either a firm-specific Cobb-Douglas production function, where output is estimated using value added (revenues minus material costs), or by using labour productivity. The production function is estimated using the Wooldridge (2009) approach, while labour productivity divides value added by the number of employees. The analysis uses EIBIS data from 2019 to 2021.

Table C.1 considers both the direct relationship between technology adoption (hardware or big data) and investment in training, and the interaction between the two variables. There is a positive relationship between productivity outcomes and big data or technology adoption. Similarly, high investment in human capital (training) is associated with higher productivity. On the other hand, and quite counterintuitively, the coefficient on the interaction term shows there is no productivity premium for firms with both high investment levels and technology adoption when looking at hardware technologies. The literature highlights that these two aspects complement each other strongly. However, given the relatively recent introduction of such technologies, this analysis does not find a complementary relationship because training activities are not yet designed to take full advantage of the digital capabilities of the firm more broadly. Skilled labour can be directly hired when new technologies are implemented, but the positive productivity gained from combining digital investments with training may not yet have been fully realised (Brunello et al., 2023).

Table C.2 further explores these patterns, considering firms that have adopted big data and hardware technologies vs. those that have adopted only one technology. A triple interaction between the big data indicator, the hardware indicator and the training indicator is also considered. The results show a positive productivity premium when firms combine the technologies with high levels of human capital investment. Larger productivity gains from the adoption of smart technologies may only be seen in the few firms that invest heavily in smart technologies and workforce upskilling.

Table C.1

Digital technologies and productivity

Dependent variable: Total factor productivity				
Big data	0.058***	0.057***		
	(0.011)	(0.012)		
Training	0.207***	0.206***	0.183***	0.207***
	(0.016)	(0.020)	(0.017)	(0.019)
Big data X High training		0.002		
		(0.023)		
Hardware			0.089***	0.112***
			(0.014)	(0.016)
Hardware X High training				-0.082**
				(0.024)
Sample size	27 466	27 466	20 838	20 838
R-squared	0.509	0.509	0.554	0.554
Dependent variable: Labour productivity				
Big data	0.061***	0.061***		
	(0.011)	(0.012)		
Training	0.232***	0.232***	0.207***	0.225***
	(0.016)	(0.021)	(0.017)	(0.019)
Big data X High training		0		
		(0.022)		
Hardware			0.090***	0.108***
			(0.015)	(0.016)
Hardware X High training				-0.064*
				(0.025)
Sample size	28 428	28 428	21 534	21 534
R-squared	0.425	0.425	0.463	0.464

Source: *Authors' calculations based on EIBIS 2019-2021.*

Note: *Pooled-OLS regression, including controls for wave, sector and country, firm age and firm size (log of number of employees) and total investments per employee in intangibles. Standard errors clustered by country and sector are in parentheses. Includes the EU sample only. Statistical significance: *** p-value<0.001 ** p-value<0.01 *p-value<0.05, ^p-value<0.1.*

Overall, these results show that there is still a long way to go for European firms to take full advantage of the opportunities and benefits of smart technologies, with only a handful of firms currently achieving this. Policy interventions could target not only the adoption of smart technologies, but also the promotion of the accompanying training needed to unlock their full potential. Incentive schemes could be designed to increase firms' investment in workforce upskilling when they also

invest in technological upscaling. This could be especially important when dealing with hardware technologies in sectors where these are often seen as substitutes for human labour, with the aim of fully applying the synergies between human and machine contributions.

Table C.2

Digital technologies and firm productivity — three-way interaction

	Total factor productivity	Labour productivity
Big data (one tech)	0.026 -0.023	0.045^ -0.023
Big data (two tech)	0.073** -0.024	0.085*** -0.024
Hardware	0.121*** -0.02	0.131*** -0.019
High training investment	0.189*** -0.023	0.210*** -0.022
Big data (one tech) X Hardware X High training	-0.005 -0.06	0.01 -0.057
Big data (two tech) X Hardware X High training	0.123* -0.063	0.121* -0.06
Sample size R-squared	20 640 0.556	21 329 0.466

Source: *Authors' calculations based on EIBIS 2019-2021.*

Note: *Pooled-OLS regression, including controls for wave, sector and country, firm age and firm size (log of number of employees) and total investments per employee in intangible assets. Standard errors clustered by country and sector are in parentheses. Includes the EU sample only. Statistical significance: *** p-value<0.001 ** p-value<0.01 *p-value<0.05, ^p-value<0.1.*

Innovative environments and the diffusion of digital innovation

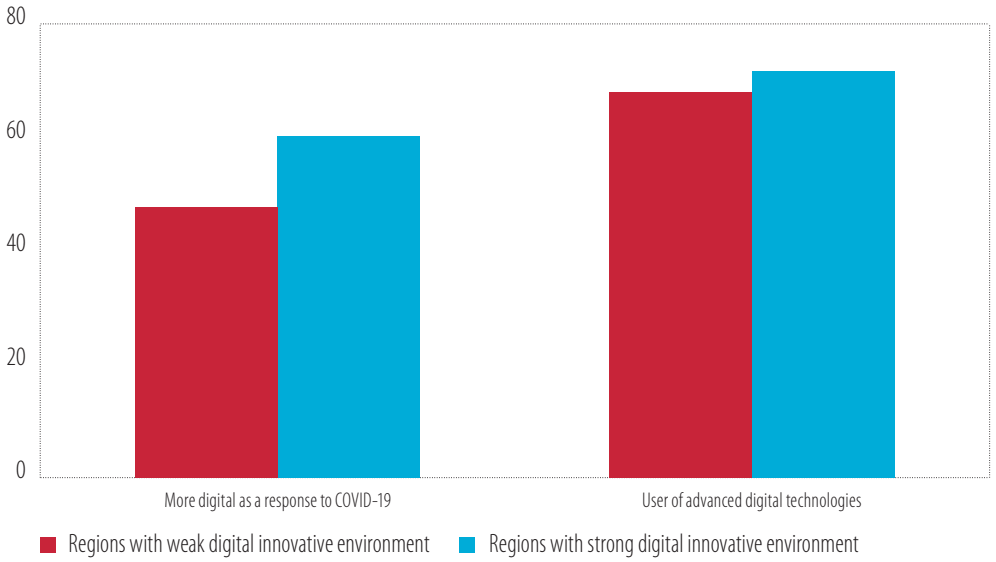
Operating in a more innovative environment helps firms to digitalise. Firms operating in highly digitally innovative environments were more likely to invest in digitalisation as a response to COVID-19 (Figure 25). This is in line with the evidence reported in the previous section, showing that digital responsiveness depends on multiple factors. At the same time, highly digitally innovative regions and weaker regions show no significant difference in the use of advanced technologies. This suggests that, while the innovative environment may have played a role in fostering transformative capabilities during the pandemic, the adoption of advanced digital technologies does not necessarily depend on geography, and other factors are at play.

EU firms operating in industries that are digitally innovative tend to adopt more digital technologies (Figure 26). The number of digital patents produced by an industrial sector and the digital patent intensity (the number of digital patents divided by all patents held in that sector) are strongly associated with digital adoption, even after controlling for firm characteristics such as firm size, age, country, sector and year (Table 3). In other words, firms operating in sectors where digital innovation is particularly active are more likely to use digital technologies.[10]

10 In this section, digital innovation in a sector is based on patenting activities in digital technologies by the top 2 000 global R&D investors. The digital innovators can be located outside the European Union, for example in the United States, China, Japan or South Korea. Digital adoption is based on EIBIS, see Figure 2.

Figure 25

Digital adoption and innovative environments (% of firms)



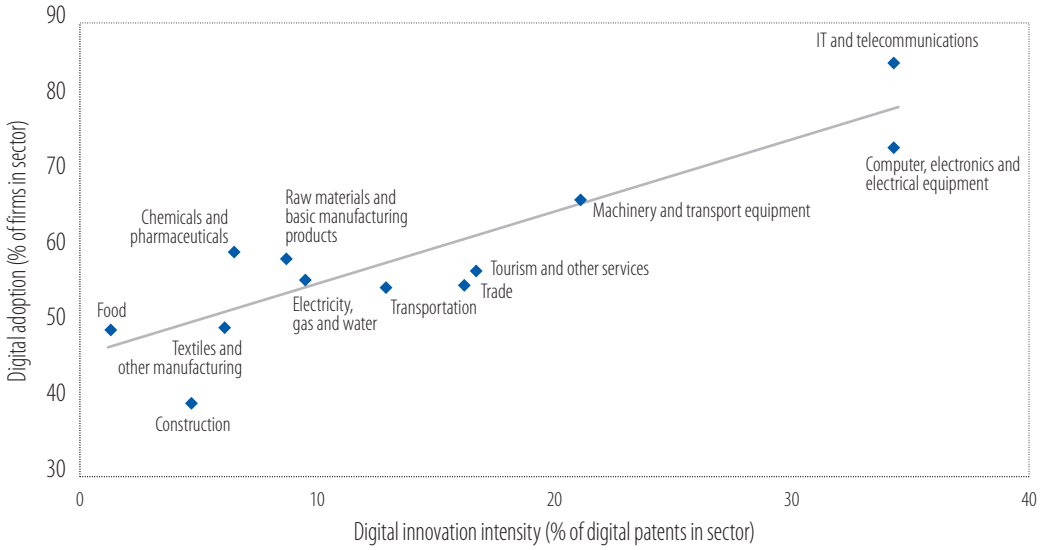
Source: *EIB staff calculations based on EIBIS 2022 and PATSTAT (PCT) data prepared in collaboration with the Centre for Research and Development Monitoring (ECOOM).*

Note: *The digital innovative environment in a region is considered strong if the digital patent intensity (the share of digital patents out of all patents held in the region) is above the 75th percentile of the distribution of digital patent intensity across NUTS 2 regions.*

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 2 for the definition of the adoption of advanced digital technologies.*

Figure 26

Adoption of advanced digital technologies and digital innovation intensity, by sector



Source: *EIB staff calculations based on EIBIS 2019-2021 for digital adoption and the JRC-OECD COR&DIP database v.3 for digital innovation.*

Note: *Digital innovation is measured by the share of digital patents of a sector (the number of digital patents divided by all patents held in that sector).*

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.*

Table 3
Digital innovation intensity and digital adoption

Dependent variable: Advanced digital technologies		
Digital patents (share)	0.343***	
	(0.030)	
Digital patents (sum)		0.013***
		(0.001)
Sample size	36 312	36 312
R-squared	0.118	0.119

Source: *EIB staff calculations based on EIBIS 2019-2021 for digital adoption and the JRC-OECD COR&DIP database v.3 for digital innovation.*
Note: *All regressions control for firm size, age, year, country and sector (27 EU countries and 12 sectors). OLS regressions. Digital innovation is measured with the share of digital patents of a sector (the number of digital patents divided by all patents held in that sector) or the number of digital patents held by firms operating in a sector. Robust standard errors are in parentheses. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

However, the diffusion of digital innovation is also likely to be driven by the sectors with which firms trade. The analysis below uses input-output tables to look at the data from a more macroeconomic standpoint. These tables depict industrial relationships within an economy, showing how output from one industrial sector may become an input to another.[11] The tables illustrate how interdependent the sectors are, in the purchasing of outputs and supplying of inputs. Firms can also act as purchasers and suppliers within the same sector.

Digital innovation in upstream and downstream sectors (suppliers and clients of firms) drives digital adoption. Figure 27 shows that digital innovation in upstream and downstream sectors is strongly associated with digital adoption. The first bar illustrates the role of sectors outside the firm's industry, while the second bar shows the role of the firm's sector as a source of inputs (for upstream sectors) or as a provider of intermediate inputs (for downstream sectors).

The adoption of digital technologies is also strongly associated with firm performance. Companies have started to take advantage the positive effects of digitalisation. Businesses that adopt digital technologies tend to be more productive, grow faster (for employment), and are more likely to invest in employee training and to use strategic monitoring systems (with key performance indicators) (Table 4). These results are in line with previous evidence on the positive relationship between digital adoption and firm performance (European Investment Bank, 2022).

Table 4
Digital adoption and firm performance

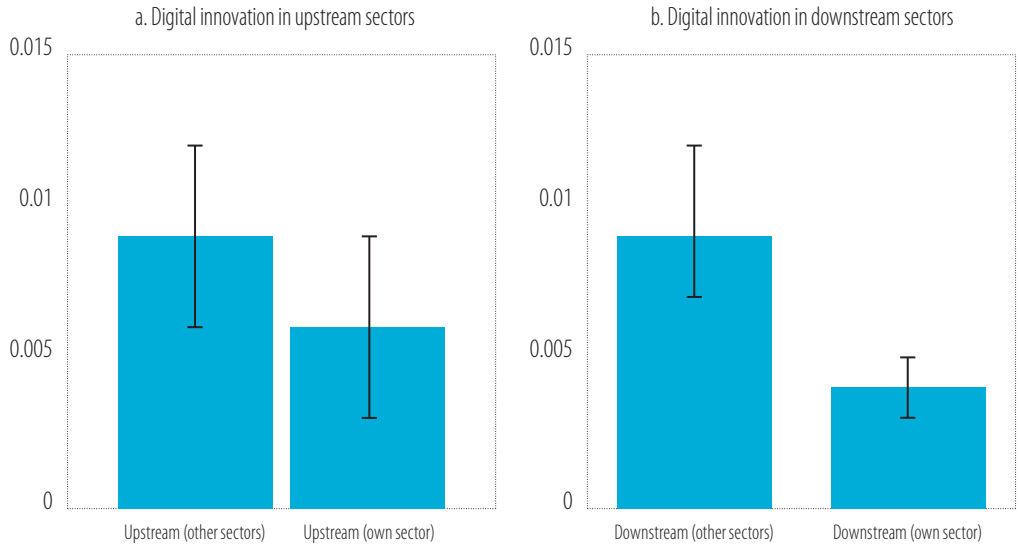
Dependent variable:	Labour productivity	Positive employment growth	Training	Management
Advanced digital technologies	0.158***	0.046***	0.113***	0.150***
	(0.012)	(0.005)	(0.005)	(0.005)
Sample size	38 589	38 147	35 358	38 896
R-squared	0.274	0.096	0.126	0.198

Source: *EIBIS 2019-2021.*
Note: *Labour productivity is expressed in natural logarithm. Positive employment growth, investment in employee training and the use of advanced management practice (formal strategic business monitoring system with key performance indicators) are binary variables. All regressions control for firm size, age, year, country and sector (27 EU countries and 12 sectors). OLS regressions. Robust standard errors are in parentheses. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

11 The input-output framework centres on tables tracking supply and use, which shows how domestic production and imports of goods and services in an economy are used by industries for intermediate consumption and final use.

Figure 27

Firms' digital adoption as a response to digital innovation (regression estimates)



Source: *EIB staff calculations based on EIBIS 2019-2021 for digital adoption, JRC-OECD COR&DIP database v.3 for digital innovation, and Eurostat input-output tables (updated in March 2022) for upstream and downstream sectors.*

Note *Digital innovation is measured with the share of digital patents of a sector (the number of digital patents divided by all patents held in that sector) held by firms in upstream and downstream sectors. The lines represent the coefficients from OLS regressions with 95% confidence interval. All regressions control for firm size, age, year, country and sector (27 EU countries and 12 sectors).*

Digital adoption has a causal effect on firm performance. To identify the causal relationship between the adoption of digital technologies and firm performance, digital innovation is used as an instrumental variable for digital adoption in a first stage regression. The estimates reported in Table 5 have the same implications, in terms of the sign, as those in Table 4, but the magnitude of the causal estimates reported in Table 5 is significantly higher. This underscores the positive benefits of firms adopting digital technologies if they trade with upstream sectors that are more active in digital innovation. These findings have implications for trade regulations and policy aiming to further strengthen and defend the European Union's ability to innovate and to develop and use strategic technologies.

Table 5

Digital adoption and firm performance, instrumental variable regressions

Dependent variable:	Labour productivity	Positive employment growth	Training	Management
Advanced digital technologies	0.793	0.352***	0.630***	0.463***
	(0.923)	(0.136)	(0.230)	(0.110)
Sample size	37 646	37 162	34 453	37 888
First stage F-test statistic	9.49	9.90	9.39	9.37

Source: *EIB staff calculations based on EIBIS 2019-2021 for digital adoption, JRC-OECD COR&DIP database v.3 for digital innovation, and Eurostat input-output tables (updated in March 2022) for upstream and downstream sectors.*

Note: *Labour productivity is expressed in natural logarithm. Positive employment growth, investment in employee training and the use of advanced management practice (formal strategic business monitoring system with key performance indicators) are binary variables. All regressions control for firm size, age, year, country and sector (27 EU countries and 12 sectors). Instrumental variable two-stage least squared regressions. Digital innovation in upstream sectors is used as the instrumental variable for digital adoption. Digital innovation in the first stage regression is measured with the share of digital patents (the number of digital patents divided by all patents of a sector) held by firms in upstream sectors. Standard errors are clustered by sector in parentheses. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

How digitalisation drives firms' resilience to trade disruptions and climate change

Digitalisation can be a driver of firm resilience and is critical to adapting quickly to changing environments. This section highlights the importance of digitalisation in managing trade disruptions and the economic transformation required by climate change.

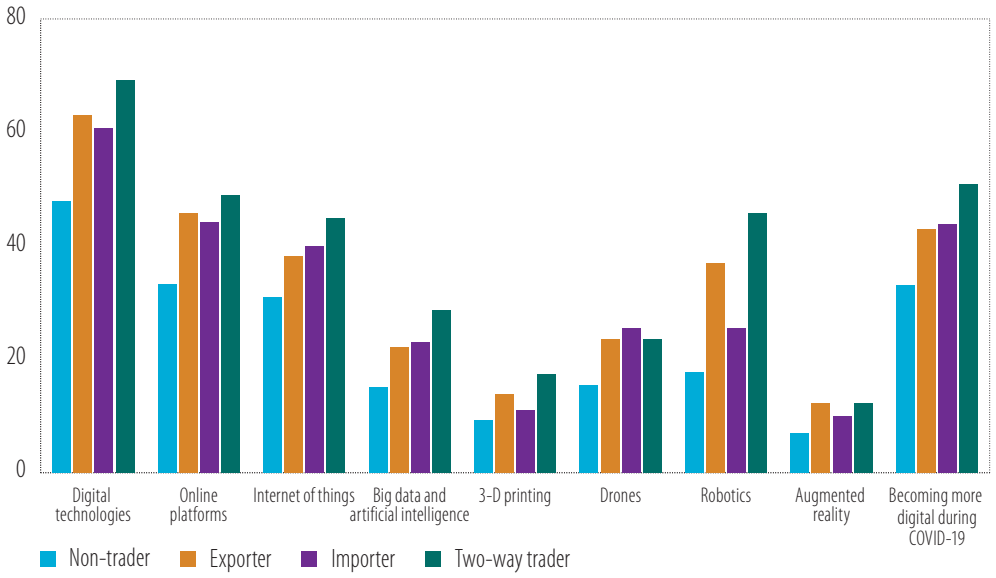
International trade, digitalisation and firms' ability to react to shocks

The rise of internet and digital technologies have improved trade-related information flows and reduced communication costs. They have made it easier for firms to find foreign buyers and integrate foreign customers and suppliers into their production processes, enhancing participation in global value chains and reaping the benefits of economies of scale (Abel-Koch, 2013; World Trade Organization (WTO), 2019). Trade in digital services from the European Union has also been growing rapidly over the past decade.

Firms that engage in international trade are more likely to use advanced digital technologies or build their business around such technologies. Exporters and importers are more than 10 percentage points more likely to adopt advanced digital technologies than non-trading firms (Figure 28). The difference for firms that export and import (two-way traders) is even higher — more than 20 percentage points. This is in line with evidence showing that exporters and importers are more likely to invest in the development of new products and modern technologies to maintain their market share (Melitz and Redding, 2021).

Firms that traded internally were more likely to respond to the COVID-19 crisis by increasing their digitalisation efforts. One-third of non-trading firms invested in increasing digitalisation during the pandemic, compared with 40% of exporters and importers and more than half of two-way traders.

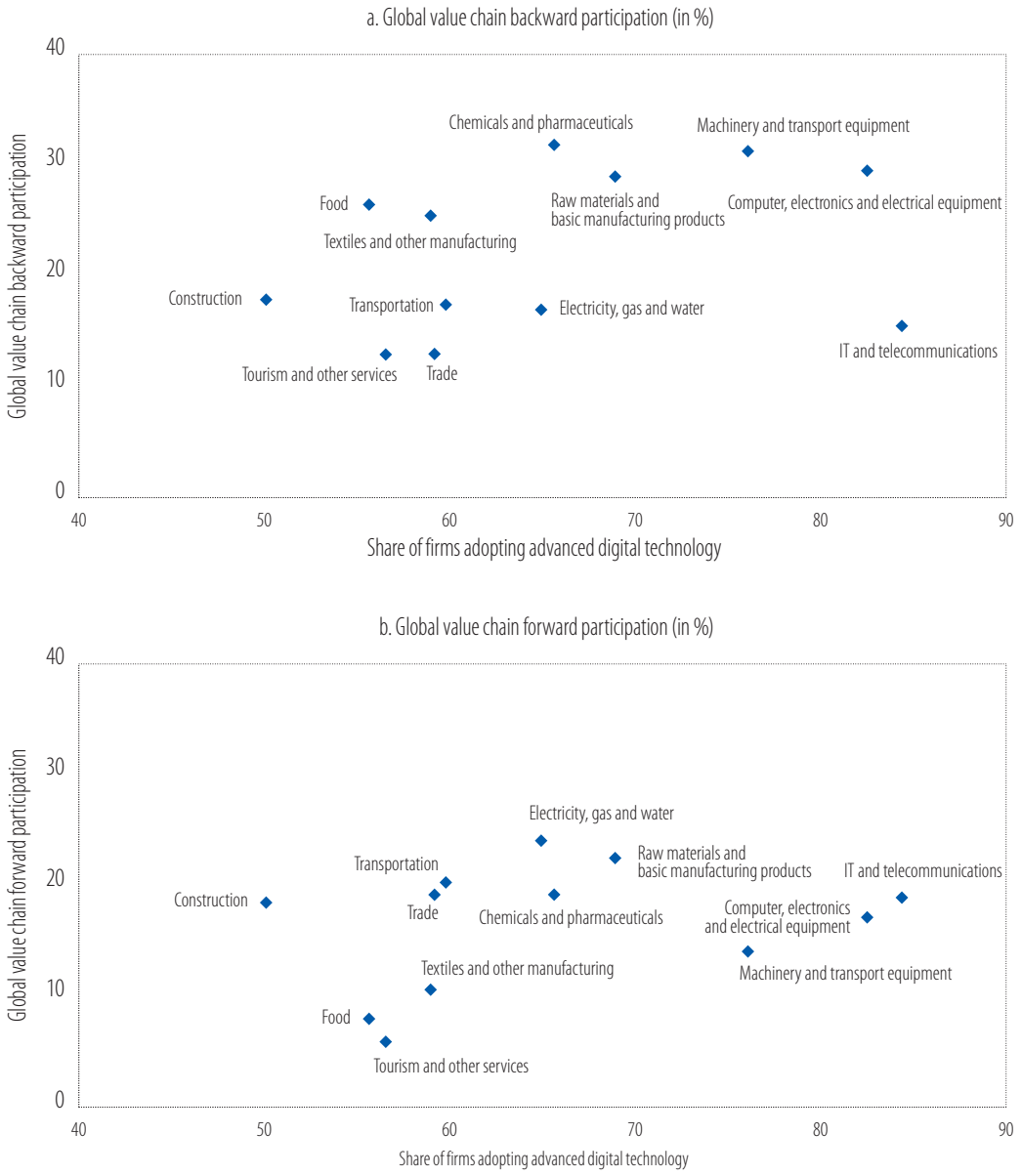
Figure 28
Probability of digitalisation (in %)**, by trade profile**



Source: *EIBIS 2022.*
Note: *The bars represent the probability of digitalisation by trade profiles, estimated from logistic regressions. The regressions control for country and sector (27 EU countries and the United States, and 12 sectors).*
Question: *In 2021, did your company export or import goods and/or services? To what extent, if at all, are each of the following digital technologies used within your business? Please, say if you do not use the technology within your business? And as a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital?*

Firms in sectors with more globally integrated value chains tend to be more digital. The most digitalised manufacturing sectors — such as machinery and transport equipment and electronics (Figure 8) — are more likely to rely on inputs produced abroad (backward participation) than less digitalised sectors (Figure 29). In addition, these sectors are more likely to provide inputs to companies in other countries (forward participation).

Figure 29
Digitalisation and global value chain participation



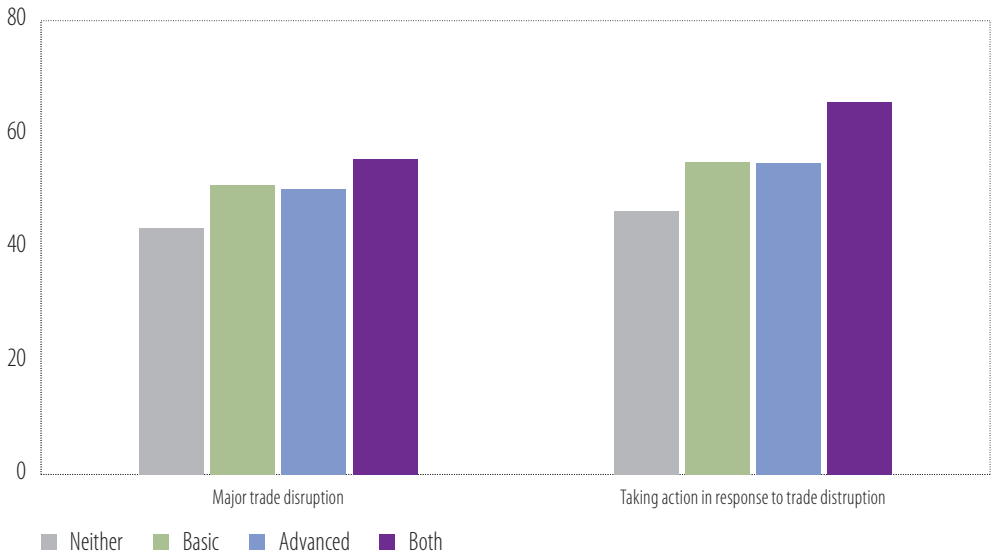
Source: *EIB staff calculations based on EIBIS 2022 and OECD TIVA database 2021 edition.*
Note: *The top panel shows the average backward participation, while the bottom panel shows the average forward participation of a sector against the average share of digitalised companies in the same sector. The backward participation expresses the degree to which a sector's exports relied on imported value added. The forward participation means the degree to which the export value of a sector is used in other countries' production. See note to Figure 2 for the definition of the adoption of advanced digital technologies.*

Digital firms are more likely to have reported major trade disruptions since the start of the pandemic. This is not surprising, as firms engaged in international trade are more likely to be affected by disruptions to global value chains, logistics, access to materials or new trade regulations. However, this finding holds even when considering firms' trade engagements. About two in five firms that did not adopt digital technologies or invest in digitalisation (the "neither" category) as a response to the pandemic report experiencing major disruptions in trade, compared with 56% of the companies that can be classified as "both" (the most advanced digital firms that invested to become even more digital during the pandemic) (Figure 30).

Digital firms are more likely to act to mitigate the adverse effects of trade disruptions. The chart on the right-hand side of Figure 30 reveals two patterns related to firms' response to trade disruptions. On the one hand, firms that use advanced digital technologies are more likely to take action to mitigate adverse effects by either diversifying their trade partners or by looking for domestic suppliers and buyers. On the other hand, regardless of whether they are already digital, firms that have responded to the pandemic by investing in digitalisation are more likely to respond to trade shocks. These findings suggest that digitalisation increases the economy's resilience and ability to adapt to large, unexpected economic shocks.

Figure 30

Probability of trade disruption and taking action in response (in %)**, by digital profile**



Source: *EIBIS 2022.*

Note: *See Figure 9 for the definition of the digital profiles. The bars represent the probability of a trade disruption (left) and the probability of taking action in response to a trade disruption (right), estimated from logistic regressions. The regressions control for country and sector (27 EU countries and the United States, and 12 sectors). The regressions in the left panel also control for trade status, and the regressions in the right panel for trade status and major disruption reported.*

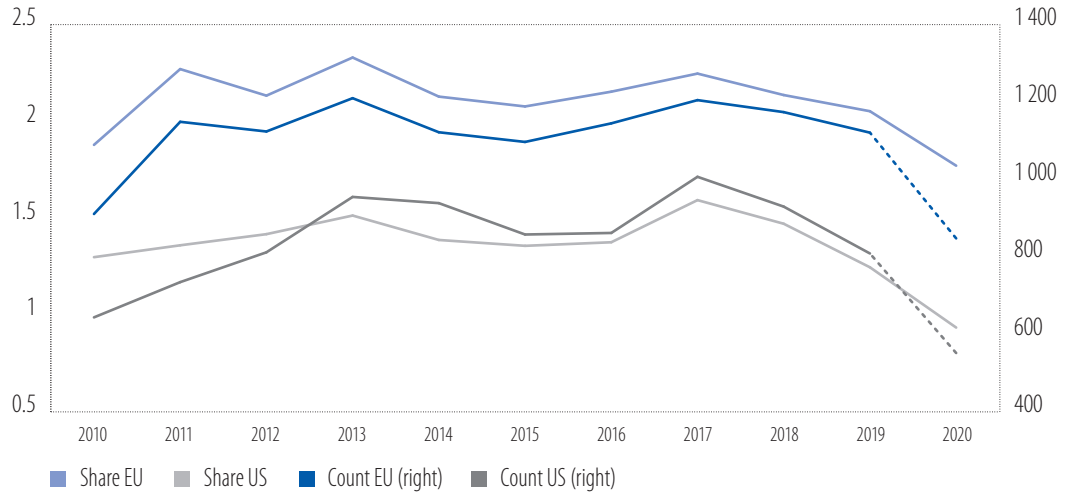
Question: *In 2021, did your company export or import goods and/or services? To what extent, if at all, are each of the following digital technologies used within your business? Please, say if you do not use the technology within your business? And as a response to the COVID-19 pandemic, have you taken any actions or made investments to become more digital? Since 2021, did any of the following present an obstacle to your business's activities? Is your company taking any actions to mitigate the impact of these disruption?*

Digitalisation and investments in green innovation and climate change

The European Union is a global leader in the development of new technologies that combine digital and green innovations. While Europe lags behind the United States for digital innovation and patenting (see Chapter 2), it is strong in the development of new green technologies. A substantial share of EU patenting activities is concentrated in climate change technology, and it leads on green innovation that incorporates digital technologies (Figure 31).

Figure 31

Green and digital patents in 2010-2020 (left axis: patent share in %; right axis: patent count), **by region**



Source: *EIB staff calculations based on Patstat (PCT) data prepared in collaboration with ECOOM.*
Note: *The light lines show the share of digital and green patents in the total portfolio of patents (left axis); the dark lines show the count of digital and green patents (right axis).*

The development of new green and digital technologies is stagnating, however, and policymakers should take notice. If emerging digital technologies are properly employed, they could play a key role in tackling environmental challenges. Examples of such technologies include smart urban mobility, precision agriculture, sustainable supply chains, environmental monitoring and disaster prediction. In addition, digital technologies can be instrumental in monitoring climate change and facilitating the much-needed shift to a circular economy. Data analytics enables companies to better manage resources by matching supply and demand for underused assets and products. Cloud computing, in combination with mobile and social media, can take products or even entire industries fully online. 3-D printing also creates opportunities for manufacturing biodegradable inputs that can be used in production (Lacy and Rutqvist, 2015; Intergovernmental Panel on Climate Change (IPCC), 2022).

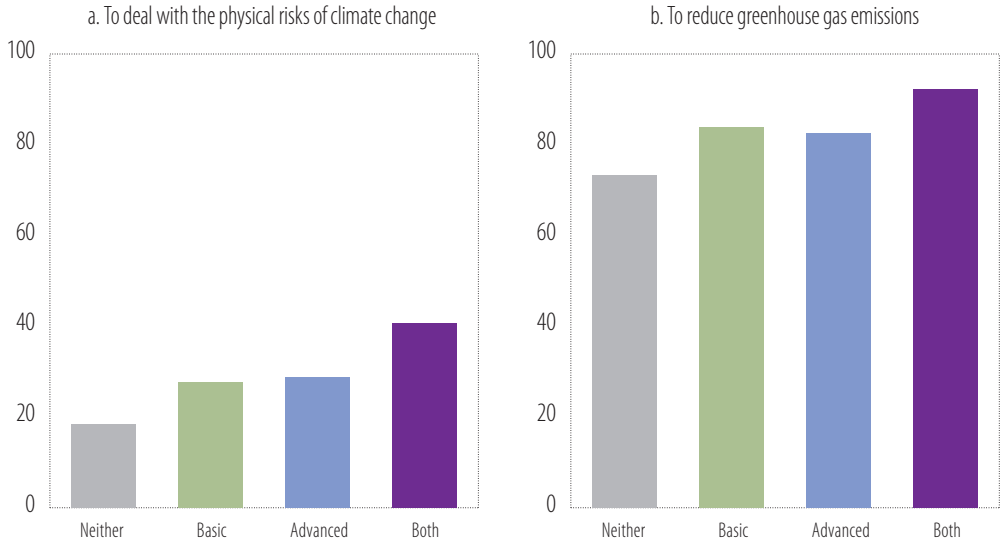
Digital technologies are key enablers of the green transition and can help meet the goals of the European Green Deal. If it is to maintain its long-term competitiveness, the European Union must play a role in combining digital technologies with innovations to address the climate change challenges. Digital technologies are also important to innovations in transport, one of the biggest emitters of greenhouse gas (European Investment Bank, 2022). Europe will need to invest heavily in digital innovation to live up to its green ambitions, especially given the United States' strong head start.

Digitally advanced firms have invested more in building resilience to the physical risks of climate change. 42% of EU firms that fall into the "both" category have invested in adaptation strategies (strategies that involve changing procedures and/or operations to increase the resilience of the organisation), compared with only 20% of firms in the "neither" category (Figure 32a). The association of the companies' digital profiles with investments intended to avoid or reduce exposure to climate risks is more pronounced in the European Union than in the United States.

Digitally advanced firms invest more in measures to reduce greenhouse gas emissions (Figure 32b). 71% of companies in the "both" category have invested in waste minimisation and recycling, compared with 48% of firms in the "neither" category. The gap between digital profiles is most pronounced in energy efficiency investments, where 69% of firms in the "both" category invested, compared with 38% in the "neither" group, as well as for less polluting technologies, where the gap is 28 percentage points.

Figure 32

Climate investment (% of firms investing in at least one measure), **by digital profile**

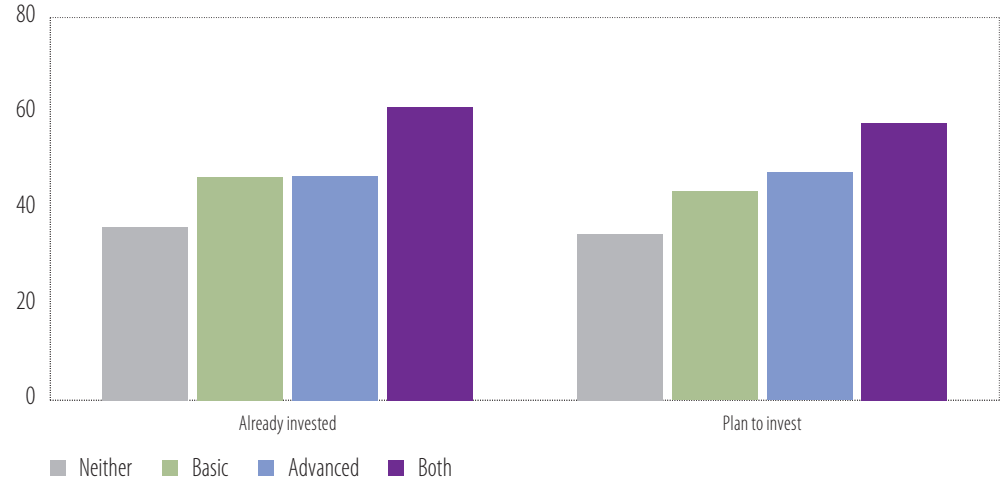


Source: *EIBIS 2022.*
Note: *See Figure 9 for the definition of digital profiles.*
Question: *Has your company developed or invested in any of the following measures to build resilience to the physical risks to your company caused by climate change? Is your company investing or implementing any of the following to reduce greenhouse gas emissions? Less polluting technologies, energy efficiency, renewable energy, waste minimisation, recycling, sustainable transport options.*

More digitally advanced firms tend to invest more frequently in tackling climate change. These firms are more likely to report that they have invested or have plans to invest more in climate adaptation in the next three years than their less digitally advanced counterparts (Figure 33).

Figure 33

Investments to tackle climate change (% of firms), **by digital profile**



Source: *EIBIS 2022.*
Note: *See Figure 9 for the definition of the digital profiles.*
Question: *Which of the following applies to your company regarding investments to tackle the impacts of weather events and to help reduce carbon emissions? Company has already invested, company invested this year, company intends to invest over the next three years.*

Conclusion and policy recommendations

Digitalisation drives firms' resilience to economic disruption and climate change, and it has helped European businesses adjust at a time of repeated shocks. Digital companies displayed more resilience to the economic and trade disruptions unleashed by the COVID-19 crisis and the war in Ukraine, suggesting that the crisis forced them to find more efficient ways of working. Digital firms generally perform better overall than non-digital firms, tending to be more innovative and productive. They are also more likely to engage in international trade and invest in addressing the physical and transition risks of climate change. Digital technologies will be key to meeting the ambitious goals of the European Green Deal.

Successfully managing the digital transition and taking advantage of its long-term benefits goes beyond technology. The digital transformation is a societal change. Striking the right technological balance is a complex process for the European Union. It is caught between global players that are defining the cutting edge of digital innovation, national preferences and societal and regulatory patterns that set boundaries on the use of digital technologies. To make the most of the digital transformation, the European Union will need to position itself well in the global environment, creating better internal conditions for innovation in technologies that are crucial to European interests and taking full advantage of the benefits of digitalisation, while staying within the boundaries of the European economic model.

Policymakers need to pay equal attention to measures aimed at facilitating the use of digital technologies and to those addressing potential problems, such as the automation of tasks. While potential productivity gains from digital technologies are large and the risk of not keeping up with digital developments high, digitalisation does present potential problems for industries and societies. New technologies tend to reinforce the need for skilled labour and can replace low-skilled workers who perform routine tasks. European policymakers need to foster innovation while also reinforcing a system of lifelong learning for employees. Policy measures also need to address the lack of digital skills in small businesses. More than ever, accomplishing those diverse aims will require finding synergies between private and public investment.

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Chapter 6

Green transition and the energy crisis

Europe is experiencing an unprecedented energy crisis that threatens to derail the post-pandemic economic recovery and undermine political and social support for the green transition. Fuelled by Russia's invasion of Ukraine, energy prices — especially for natural gas — soared to record highs in mid-2022, draining households of their income and altering the competitiveness of European firms. To shield individuals and businesses, national governments have provided temporary measures like direct transfers to consumers to cover high energy bills, as well as other incentives to save energy and switch to cleaner sources. In parallel, the European Union has agreed on several measures and proposed a "toolbox for action and support" to strengthen the internal energy market and ensure that national measures are in line with the Fit for 55 package, a set of proposals to revive and update EU legislation on reducing emissions at least 55% by 2030, compared to 1990 levels. While energy prices have stabilised and lowered as they converged among EU countries, uncertainty remains as prices continue to be volatile and sensitive to potential future supply shortfalls.

The energy price shock has been felt throughout Europe, but the impact varies among EU members, reflecting the fragmentation of the European energy market. Factors like national fuel mixes, competition, import diversification, network costs and energy policies (such as taxation or energy subsidies prompted by the crisis) explain the uneven economic hardship experienced in different countries and consumer groups. Energy-intensive industries suffered the most. Likewise, countries in Central and Eastern Europe appear to be more at risk because of their direct and indirect exposure to Russia. However, most countries (especially in the Baltics and Western and Northern Europe) moved swiftly to reduce their reliance on Russian fossil fuels by diversifying gas supplies and saving energy.

Rising energy costs are pushing firms to pursue climate action, but growing uncertainty holds them back. The EIB Investment Survey (EIBIS) for 2022 shows that the rise in the share of firms engaging in climate action accelerated in 2021, a post-pandemic rebound which is expected to continue, based on the share of firms with plans to invest in the future. In parallel, almost 90% of firms have implemented at least one measure to reduce their carbon footprint, with waste management and energy efficiency being the most popular choices. By contrast, only one-third of firms have developed or invested in one or more measures for building resilience to physical risks. Nevertheless, the current economic environment is marked by considerable risks, including decelerating demand and tighter financing conditions that may well constrain firms' investments.

The current energy crisis calls for enhanced coordination and coherent governance of European energy markets to ensure proper internal functioning and affordable energy for all. Bolstering investment by companies will require a combination of policies to reduce uncertainty, which is currently on the rise. Here, it could prove beneficial to de-risk instruments, which would protect investors from the cost of uncertainty. In parallel, short-term policy interventions to manage the energy crisis should be carefully examined so that they do not disincentivise investment in the green transformation. Complementary public and private investment opportunities could also play a role. Despite the many efforts — common regulations and practical initiatives — and ample political will, the energy crisis has once again shown how much remains to be done before national energy markets are integrated. Preparing Europe to better respond to the current climate crisis and any future crises will require structural reforms, support for green finance, innovation and new infrastructure developments — to enhance the security of energy supply, maintain corporate competitiveness and achieve climate goals.

Introduction

The war in Ukraine has provoked a structural overhaul of the EU energy market that has ramifications for the entire economy. The energy crisis poses an immediate challenge, with policymakers facing a key question of how to diversify away from Russian energy dependency while ensuring sufficient supply of affordable energy to the continent.

But as it unfolds, the energy crisis is also unveiling structural weaknesses and inefficiencies in the EU energy market, beyond the dependency on Russia. The energy shock is, in fact, a formidable opportunity to design a more integrated, efficient, resilient market structure for the future — one that fully exploits the advantages of European integration. The current turmoil underscores the need to reduce the overall EU dependence on fossil fuels and boost investments in clean energy technologies, with far-reaching benefits for sustainability, affordability and security of supply.

Against this backdrop, this chapter explores the compound effects of energy supply shocks by laying out key macro-level shifts and their impact. The first and second sections give an overview of the energy crisis in Europe, including recent patterns in energy price movements and aspects of the security of supply in the short and longer term. The third section covers firm-level responses, based on EIBIS results. Focus is placed on the key factors that influence firms' climate change strategy, their awareness of climate risks, sustainable choices, financial levers and the communication of firms' strategies. The final section discusses the financial sector's support for climate strategies.

Rising energy costs threaten Europe's competitiveness

Energy is a key input for economic growth, which means that any price shock would bring significant economic challenges. This part of the chapter discusses current energy price developments and how price turbulence flows from energy producers to consumers. Findings show that high energy prices weighed on the welfare of people and on the competitiveness of industries in Europe more than in other areas of the world. Although this shock is common to European countries and end users, some groups appear to be more vulnerable than others, indicating that European energy markets are fragmented.

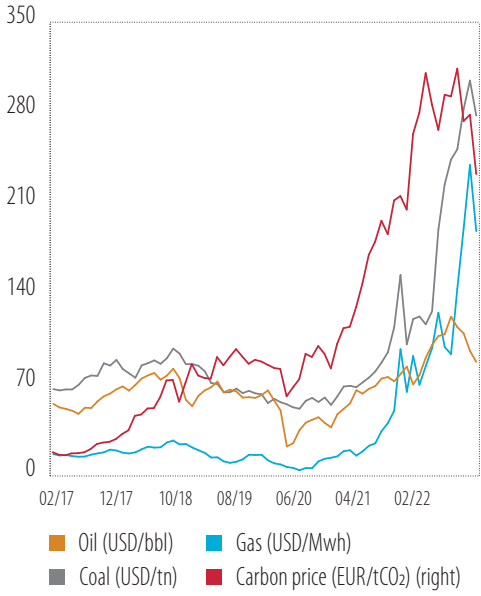
Energy prices reach record highs, displaying great volatility

Energy prices were volatile and reached unprecedented highs in mid-2022, and they are showing no sign of returning to pre-pandemic levels just yet. The world faced the lowest fuel prices in decades in 2020, the result of low global demand because of the COVID-19 crisis. Starting in 2021, by contrast, energy prices rose to extraordinarily high levels, pushed by the strong global economic recovery (among the fastest post-recession growth surges in the last 80 years), a long cold winter in Northern Europe, weaker-than-expected supply growth and mounting supply concerns resulting from the war in Ukraine (Figure 1).

Geopolitical tensions and fear of being cut off from the Russian gas supply increased prices and volatility on European energy markets. Uncertainty is being exacerbated by the temporary supply bottlenecks, diversification efforts and demand swings generated by the rush to accumulate energy reserves. When war broke out in Ukraine, energy spot prices rose steeply, followed by major swings that reflected fears of a disruption to Russian imports. Major events that affected energy prices included Russia's move to decrease or terminate gas shipments to several European countries in the early summer of 2022, the coordinated push to fill gas storage facilities, and news of the physical disruption of pipelines. On the opposite side, September 2022 saw prices converge to lower levels amid announcements that storage facilities had been filled successfully and energy sources were being diversified. Energy efficiency measures and policy intervention also helped to contain prices. A mild winter has allowed for relatively low energy prices at the beginning of 2023, but uncertainty will continue to unsettle European energy

markets. Those markets will remain sensitive to short-term news about the war, increasing global demand (largely from China), extreme weather conditions, infrastructure bottlenecks or concerns about refilling gas storage facilities for the next European winter.

Figure 1
Evolution of oil, gas, coal (left axis) **and carbon prices** (right axis)



Source: *Bloomberg.*

Figure 2
Capacity utilisation factor of EU coal and gas-fired power plants (in %), **2015-2022**

Source: *European Network of Transmission System Operators for Electricity (ENTSO-E), International Energy Agency (IEA), EIB staff estimates.*
Note: *Estimations for 2022 are based on data from the first half of the year. Capacity utilisation factor refers to the ratio of a solar plant's actual output over the year (kWh) compared to the maximum possible output from it for a year (kWh) under ideal conditions.*

Natural gas prices have risen the most among energy commodities, as the role of liquified natural gas increased in the energy supply vs. pipeline gas; coal is also back on the scene. In mid-2022 the Dutch Title Transfer Facility (TTF) gas futures contract[1] soared to a record high, increasing tenfold compared to 2020 and surging well above EUR 200 per megawatt hour. Similarly, international coal prices rose to around five times their levels a year earlier. Diversification resulted in supplies shifting away from Russia, a reduction in pipeline gas and an increase in liquified natural gas (LNG). The steep increases in natural gas prices have also prompted some substitution away from natural gas to coal to generate electricity in the very short term in the United States, Europe and Asia. While use of coal-fired power plants in Europe had fallen since 2018 (Figure 2), the trend reversed in 2021.[2]

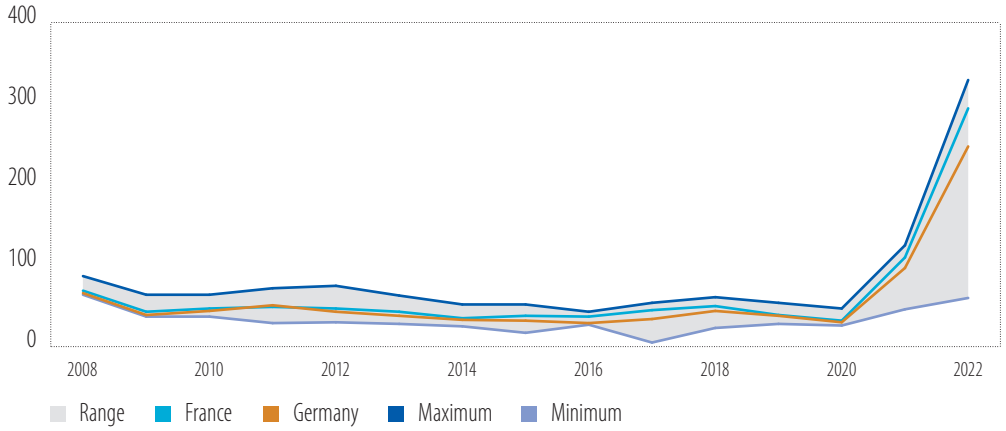
1 The Dutch TTF is a virtual trading point for natural gas in the Netherlands. It combines pipeline and liquified natural gas, and has traditionally been considered as a benchmark for the EU gas energy market. However, transport bottlenecks have raised concerns about the market's ability to represent actual conditions. The European Commission has proposed developing a new alternative liquified natural gas price benchmark, based on the effective price of physical transactions.

2 Coal has benefited from the unexpected changes in the prices of different energy sources and the fear of supply restrictions and possible energy embargos. The increased usage of coal-fired power plants, however, is at odds with the European Union's climate objects and plans to gradually phase out coal. Germany is considering putting retired coal-fired plants back online. Slovenia and the Czech Republic have declared their intention to end coal use by 2033. According to pledges by other EU countries, coal will only be used in Poland and the Western Balkans.

The increased use of coal is driving up carbon prices in Europe and carbon emissions from electricity generation globally. EU carbon prices have been steadily increasing, to hit around EUR 80 per tonne of carbon as coal grew in the energy mix (Figure 1). Carbon prices have risen steadily since 2017, with the pandemic providing a brief respite. In parallel, crude oil prices have also been supported by higher natural gas prices and remain above USD 80 per barrel.

Higher gas and coal prices combined with rising European carbon prices have resulted in higher rates for wholesale electricity, reflecting the merit order principle[3], with significant differences among EU countries. The highest prices were expected in markets dependent on gas for a large share of their electricity generation (Figure 3). In contrast, markets with large shares of hydropower, including the Nordic countries, managed to control price increases and recorded the lowest prices in Europe. Electricity prices in all wholesale electricity markets have generally increased since the start of the war in Ukraine. At the end of 2022, they stood more than four times above their pre-pandemic levels, with massive variation between countries. This increase contrasts with the more contained changes recorded over the last 15 years.

Figure 3
Wholesale electricity prices (EUR/MWh) **across European countries**



Source: Bloomberg, ENTSO-E.

Existing pricing models, in which the overall price of electricity is set by the most expensive source, enabled some electricity generators to record windfall profits. Prices in most European wholesale electricity markets are set by natural gas plants. As their prices reached record levels, consumers ended up paying far more for their electricity than the (average) cost of electricity production. Electricity generators with a mix of renewables, nuclear and lignite plants in their portfolio appear to have benefited the most, as they were paid windfall revenues well above their levelised cost of electricity[4] production. Similar benefits were also seen by fossil fuel companies that operate in wholesale and retail markets, whose profits swelled from the higher spot prices for energy that resulted from concerns about the Ukraine war.

The energy shock has also prompted countries to nationalise utility companies. Volatile prices caused problems for several utilities that were hedging their exposure, and eventually led to liquidity shortfalls. Those shortfalls prompted margin calls on certain hedges, putting the financial health of the utility companies in jeopardy. As a result, utility companies have been nationalised in countries including Austria, Finland, Denmark, Germany and France.

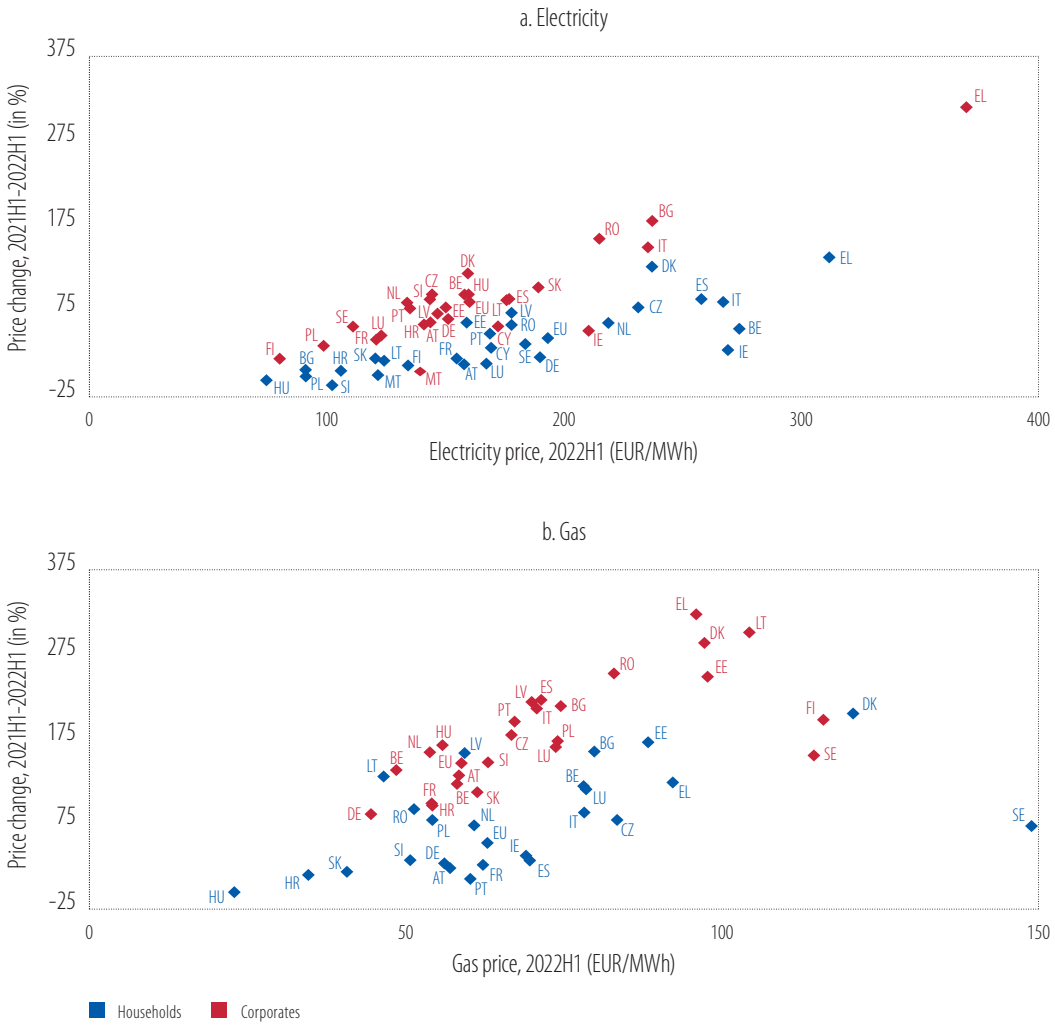
3 The merit order principle refers to the mechanism by which the market price is set. In the energy-only market, the merit order effect describes the sequence in which power plants contribute power to the market, with the cheapest offer made by the power plants with the smallest operating costs setting the starting point (renewables and nuclear, for example) and the most expensive offer usually made by natural gas power plants.

4 The levelised cost of electricity is a measure of the average net present cost of electricity generation for a power plant over its lifetime.

Surging energy prices erode Europe's competitiveness and broaden price gaps

In line with global energy prices, electricity and gas prices for European consumers have risen considerably, but asymmetrically among countries and end users. Despite differences, a consistent rise in electricity and gas prices was recorded in almost all EU members in the first half of 2022, for households and firms alike (Figure 4). For the electricity and gas markets, consumers in the EU countries with the highest prices are paying three times as much as those in countries with the lowest prices. Household retail gas prices, prices are almost six times higher. This gap has widened over time, especially in the case of household gas prices. Price differences between countries persist due to differences in the fuel mix, competition, import diversification, network costs and national policies (like taxation). Despite many efforts — common regulations and practical initiatives — and ample political will, the energy crisis has shown (once again) how much remains to be done to integrate national energy markets.

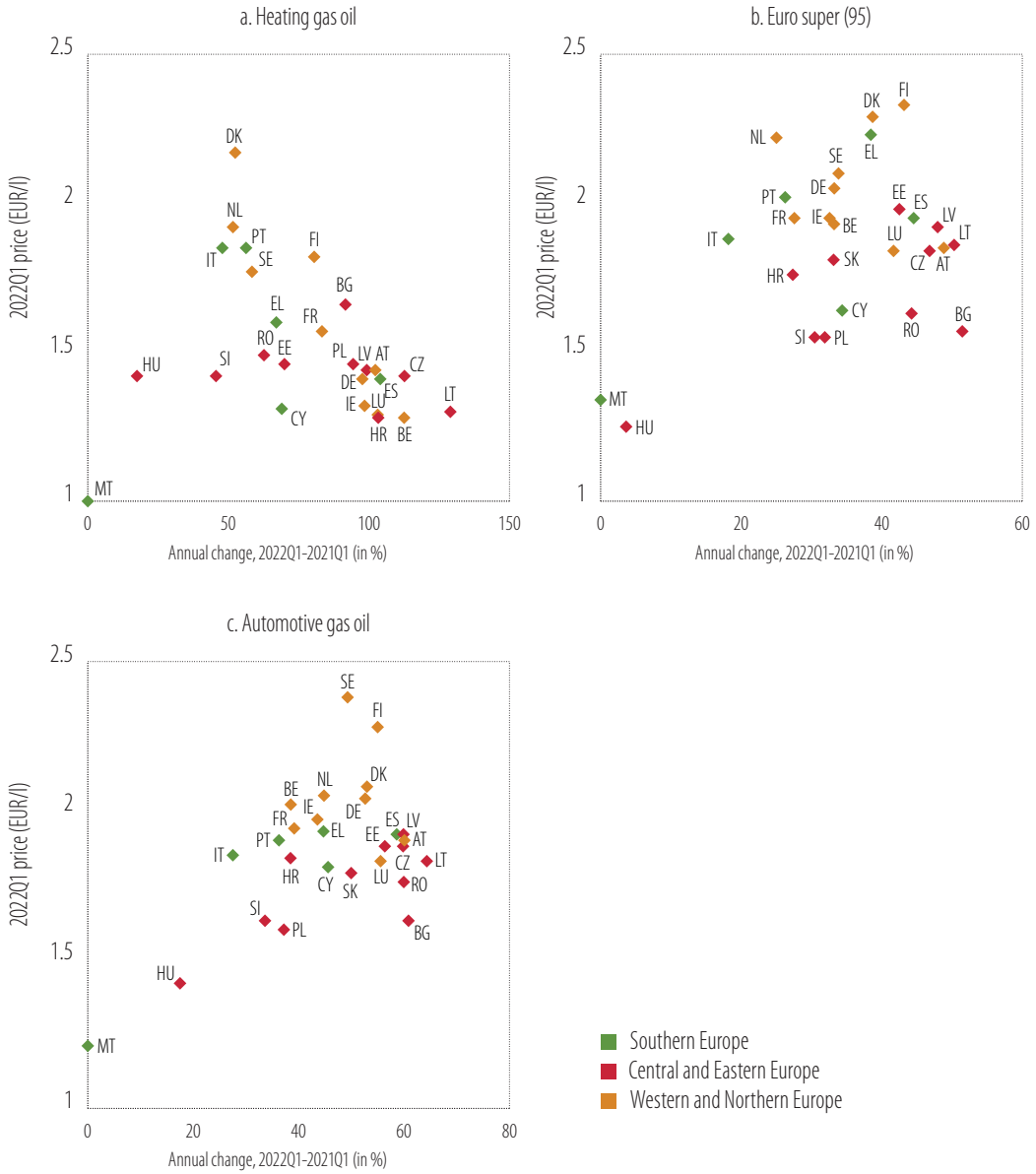
Figure 4
Electricity and gas price developments in EU members



Source: *Eurostat, European Commission Directorate-General for Energy.*
Note: *Changes in electricity and gas prices for households (consumption bands: DC and D2) and firms (consumption bands: IC and I3) in first half 2022 compared with the same half of previous year.*

In all European countries, industrial consumers appear the most affected by price increases. Gas prices for EU industrial users increased 147%, compared with 53% for households, in the first half of 2022, vs. the same period a year earlier (Figure 4). The same was true for electricity prices (+86% for industry vs. +44% for households). Industrial gas prices increased most, compared to household gas prices, in Spain, Greece and Portugal, while industrial electricity prices increased most, compared to household electricity prices, in Greece and Bulgaria.

Figure 5
Oil price developments in EU members

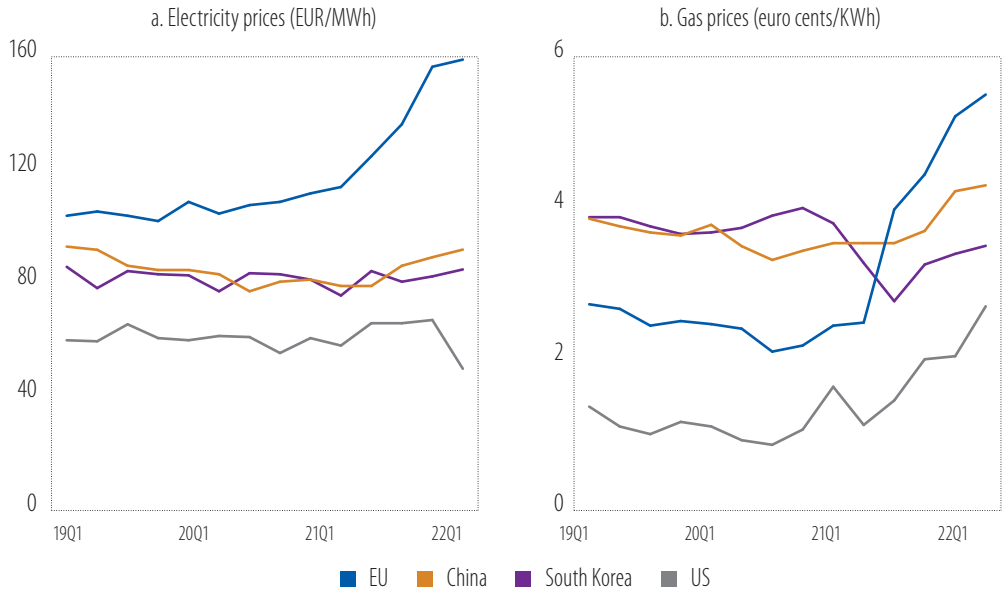


Source: *European Commission Directorate-General for Energy.*

Prices for oil products, like heating oil, in EU members followed the evolution of crude oil prices, but absolute levels differ considerably. The large differences in oil product prices are mainly driven by excise duties and value-added taxes, which vary by product and country, reflecting energy policy preferences (Figure 5). These extra costs affected the prices of oil products among countries, which rose

by more than 50%, and in some cases doubled (notably for heating gasoil). The prices of oil products in Western and Northern Europe are among the highest, while fluctuations in prices appear more pronounced in Central and Eastern Europe.

Figure 6
EU retail electricity and gas prices of industry vs. major trading partners



Source: *Eurostat, IEA, CEIC, European Commission's Directorate-General for Energy computations.*
Note: *Eurostat (EU average, for industrial consumption band I4) and CEIC. EU prices are without value-added and other recoverable taxes.*

High energy prices are harming Europe's competitiveness, especially for energy-intensive industries. In the electricity and the gas markets, industrial retail prices in Europe were higher than for international competitors (Figure 6). This gap in costs remained constant until the second quarter of 2021 and widened exponentially following the increased global demand for gas, various supply constraints and especially the war in Ukraine. While industrial electricity prices were always higher in Europe than for its international peers, those for gas peaked at the end of the COVID-19 crisis and the beginning of the war in Ukraine. Industrial electricity prices increased by 40% in the second quarter of 2022 compared to the same quarter of the previous year, while in China they rose by only 12% and in the United States they declined by 8%. Similarly, gas industrial prices in Europe were 23% higher than in China and 53% higher than in the United States.

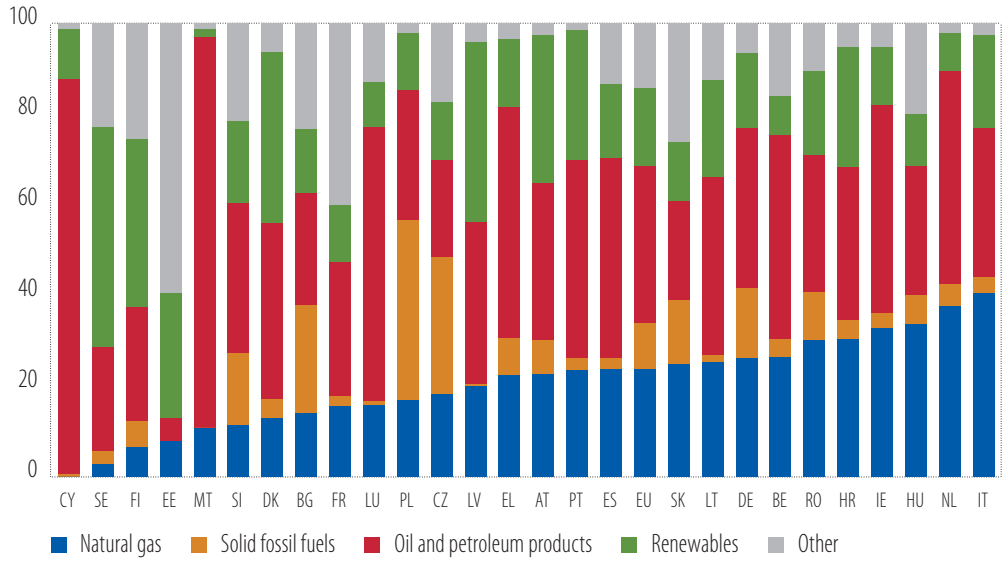
Security of supply tops the EU policy agenda

The unfolding energy crisis has pushed security of supply to the top of the energy policy agenda, requiring a revision of the policy framework and energy market design. This part of the chapter presents key features of the energy infrastructure in Europe and in EU countries to identify vulnerability to supply disruptions. It also discusses the progress made after the adoption at the EU level of coordinated measures to tackle the current energy crisis. Findings show that Europe has moved swiftly to reduce its reliance on Russian fossil fuels, notably by diversifying gas supplies and filling up gas storage facilities. Nevertheless, challenges persist across European countries, which have different starting points, resources and capacities for tackling potential supply disruptions.

EU members are addressing energy security from vastly different starting points

Because fuel mixes and dependence on Russian energy vary considerably between EU members, the same energy shock has different implications for European economies. Fuel mixes result from resource availability, geographic position, economic structure and national energy policy. For example, the share of solid fuels (hard coal, lignite and coal products) was highest in Poland (40%) and the Czech Republic (30%), while Estonia has a unique mix with peat and peat products accounting for 52% (Figure 7). The share of petroleum products stood out in Cyprus (87%) and Malta (86%), as well as in Luxembourg (60%).[5] Natural gas accounted for more than 30% in the Netherlands, Hungary, Ireland, Croatia and Romania. France had the highest nuclear share (41%), followed by Sweden (25%), Slovakia (25%), Bulgaria (24%) and Slovenia (23%). Generally, countries that were less dependent on fossil fuels had a mix of nuclear and/or renewables, including Sweden, France and Denmark.

Figure 7
Energy mix (in %) **in Europe, 2020**

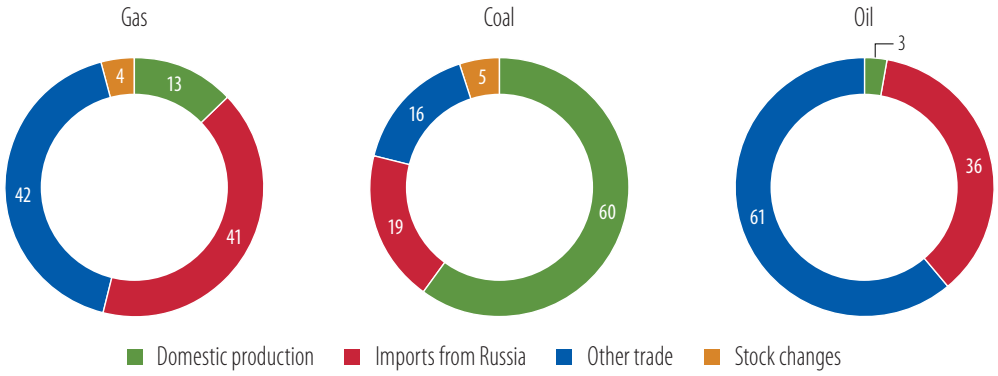


Source: *Eurostat.*
Note: *Other includes nuclear, non-renewable waste, electricity and heat. The graph shows for each EU country the energy mix by source.*

Overall, Europe imports around 60% of its energy needs. With a small and declining production of fossil and solid fuels, Europe is heavily reliant on imports to satisfy its domestic energy needs, which amplifies the implications of energy supply disruptions (Figure 8). From 2010 to 2020, domestic oil production declined by 35%, while gas production fell 63% and coal production declined 43%. Although the domestic production of renewable energy rose by 39%, and energy efficiency increased significantly in the same period, it was insufficient to compensate for the decline in production of EU coal, lignite and gas. The European Union remained dependent on imports for gas (83% of consumption), oil (97%) and hard coal (70%).

5 Cyprus and Malta are small islands with limited alternatives, while Luxembourg figures are affected by fuel shopping by consumers from neighbouring countries (due to lower fuel prices).

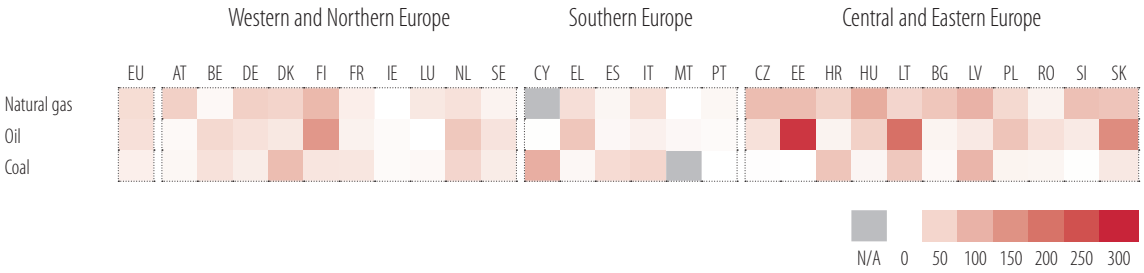
Figure 8
EU production trade and imports in gas, coal and oil (in %)**, in 2020**



Source: *Eurostat.*

Russia has been the main exporter of oil, gas and coal to Europe for many decades. Russia's aggression against Ukraine puts the bloc's energy security at risk. Before the war began, Europe's energy imports from Russia equalled just under 1% of the EU gross domestic product on average. In the gas sector, Russia provided around 45% of total EU gas imports in 2021, with an average of around 40% in recent years. The other main gas suppliers to the European Union were Norway (23%), Algeria (12%), the United States (6%) and Qatar (5%). Russia was also the largest supplier of crude oil imports (27%), followed by Norway (8%), Kazakhstan (8%) and the United States (8%). Coal imports have declined in recent years, but Russia remains the leading supplier here as well (46%), followed by the United States (15%) and Australia (13%).

Figure 9
Russian imports of gas, oil or coal as a share of gross available energy (in %)**, in 2020**



Source: *Eurostat estimates.*
Note: *Above 100% indicates that the country imports more than it needs for domestic consumption and exports different energy products (for example, oil in Estonia, Lithuania, Slovakia and Finland).*

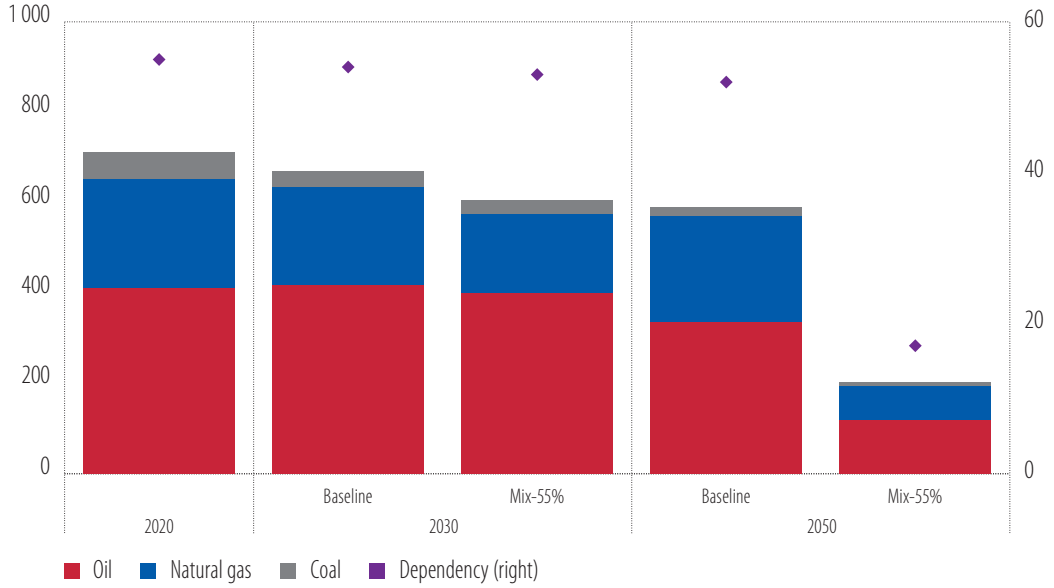
EU members' dependence on Russian energy exports varied greatly. Most countries in Central and Eastern Europe, including Bulgaria, Latvia and Slovakia, depended on a single Russian supplier (and often a single supply route) for 80% to 100% of their oil consumption (Figure 9). This was also the case for gas imports. Other countries relied on a more diverse range of suppliers, in which Russian imports nevertheless dominated. Some EU countries (Ireland, Spain, Cyprus, Malta and Portugal, for instance), did not import any fossil fuels from Russia.

Energy imports are expected to remain significant contributors to final energy demand (albeit to a lesser extent than they are today), justifying concerns about energy security in the event of geopolitical tensions. In the latest available simulations published by various institutions (Figure 10), coal imports trickle off by 2030, driven by more stringent climate policies, while oil accounts for 30% of final energy demand and gas 17%. Assuming a 55% net reduction of greenhouse gas emissions by 2030, simulations show that the volume of fossil fuel imports will fall by 27% over the same period, coal

declines by 71-77%, natural gas shrinks 13-19% and oil 23-25% (depending on the model). However, energy dependency (imports over gross domestic consumption) will remain high (around 55%) until 2030, shrinking dramatically only thereafter. By 2050 imports of coal, natural gas and oil will be reduced by at least 70% compared to 2020.

Figure 10

European energy imports (left axis, Mtoe) **and energy dependency** (right axis, in %) **in 2020, 2030 and 2050**



Source: *European Commission.*
Note: *Dependency is the ratio between total net imports and gross available energy (gross inland consumption and maritime bunkers). MIX-55% achieves the 55% reduction in greenhouse gas emissions, by expanding carbon pricing and moderately increasing policy ambitions, but to a lesser extent than if regulations were changed. The baseline assumes that the 2030 targets for emission reduction, renewable energy and energy efficiency are achieved.*

Box A

Sensitivity of the European economy to energy sectors

The energy shock is likely to propagate differently across sectors and countries, depending on the relevance of each energy sector to economic activity. An analysis based on input-output tables is presented below to better understand the role of different energy sectors in European economies. This analysis assesses the degree of interconnectedness across economic sectors and the relevant linkages (the relative importance of the energy sector for other industries in Europe).

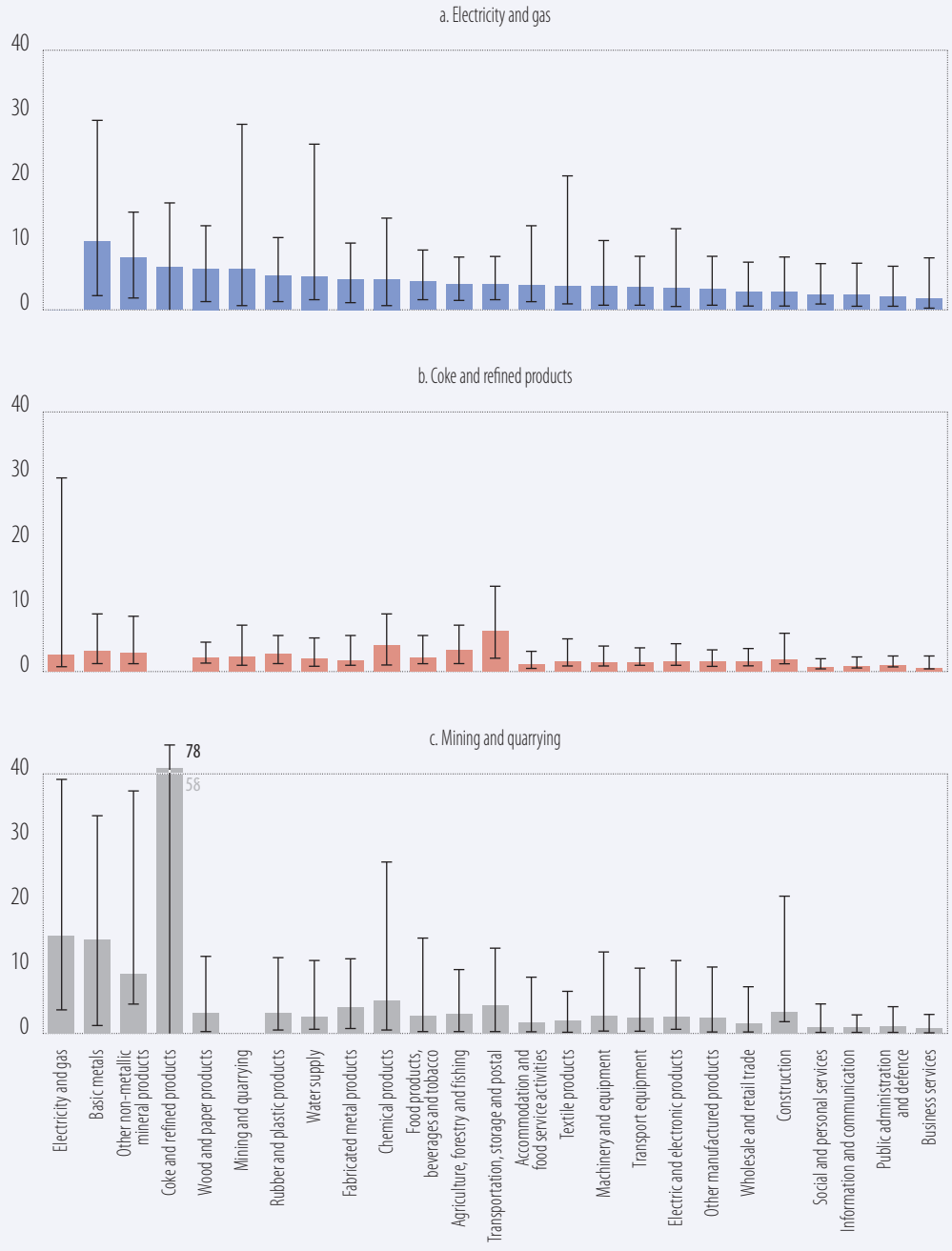
Linkages are multipliers that are estimated within an input-output framework to show a sector's relationship as a supplier (intermediate products) vs. as a customer (inputs) with respect to other producers in the market. When compared against all other sectors, a single sector's importance in the whole economy can be determined based on its input and output with the other sectors. It can also be determined how connected the sector is to downstream or upstream suppliers. These linkages can be defined as first-round (direct only) and/or second-round (direct or indirect) economy-wide effects induced by the sector's final demand or supply.

The input-output tables compiled by the Organisation for Co-operation and Development (OECD, 2021) show that among the energy sectors, electricity and gas are particularly relevant for energy-intensive industries and countries. The mining and quarrying sector is an important supplier for the

oil sector, which in turn largely feeds the electricity generation of non-interconnected islands (such as Cyprus) and the transportation sector. By contrast, most sectors — including basic metals, water supply, mining and quarrying and the manufacturing industries in general — tend to rely more heavily on energy and electricity for production (Figure A.1). Among EU members, the electricity and gas sectors' input is less pronounced in the Nordic countries, including Sweden, Denmark and Finland.

Figure A.1

Direct and indirect inputs for the production of various energy sectors (in %)



Source: *Estimation based on OECD (2021) input-output tables (see Kalantzis and Musto, 2022).*
Note: *The total impact (Leontief coefficients) are derived from input-output tables. The error bar represents the range of the impact across European countries.*

After the linkages of all economic sectors are normalised using the above classification, the sectors with the strongest economic impact can be identified. The linkages are normalised by the average of all domestic sectors, to capture the overall economic implications. Specifically, when normalised by the average forward and backward linkages in each economy, a value greater than one for both types of linkages indicates a "key" sector for the economy overall (Table A.1). A shock to such a sector will generally cause larger-than-average disruptions to several industries, based on its connection with the rest of the economy. If only the normalised backward value is greater than one, then the sector depends on other sectors' supplies, whereas if only the normalised forward value is greater than one, then the sector depends on other sectors' demand for its output.

Table A.1

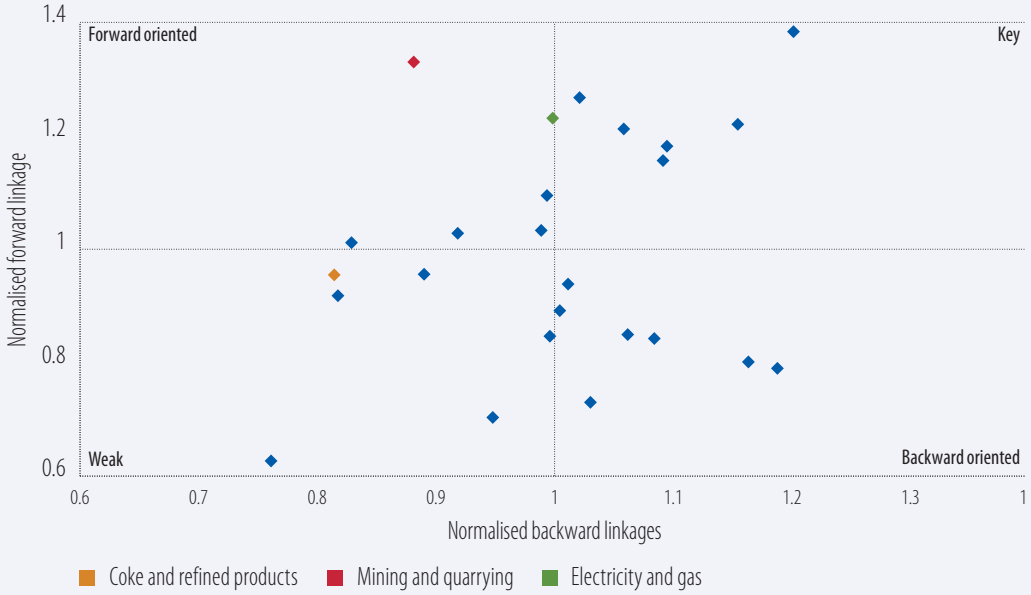
Classification of sectors according to network linkages

		Forward linkage	
		Low (<1)	High (>1)
Backward linkage	Low (<1)	Weak	Forward oriented
	High (>1)	Backward oriented	Key

Source: Miller and Blair (2009).

Figure A.2

Normalised linkages of selected European sectors



Source: Estimation based on OECD (2021) input-output tables (see Kalantzis and Musto, 2022).
Note: The blue diamonds represent other sectors (including basic metals, chemicals etc.), as specified in Figure A.1.

Looking at energy sectors alone, electricity and gas generally appear to be interconnected upstream and downstream (meaning that electricity and gas markets are important suppliers and customers of other sectors) with normalised forward and backward linkages well above one (Figure A.2). This implies that changes in these sectors' demand and supply could heavily influence the broader European economy. Coal is placed in the lower-left quadrant, with normalised forward linkages above one and backward linkages below one. Coal, therefore, could be viewed as a major supplier of the European economy, and as highly dependent on intersectoral demand. By contrast, oil has normalised linkages below one, and thus appears to be generally independent of energy sectors upstream and downstream. This implies that changes in oil have less of an impact on the rest of

the European economy. Finally, the key sector quadrant in Figure A.2 shows that sectors outside of energy could have major implications for the European economy. These effects are estimated at a European level, and they may change across EU members whose economies are structured differently.

Coordinated measures to break the European Union's dependence on Russian energy

Since the crisis erupted, European policymakers have been working on a plan to thwart the impact of a cut in supplies of Russian gas and oil. On 18 May 2022, the European Commission presented REPowerEU, a plan to rapidly reduce reliance on Russian fossil fuels and speed up the green transition. The aim is twofold: first, to end Europe's reliance on Russian fossil fuel imports by 2027, with an interim target of replacing two-thirds of Russian gas consumed by the end of 2022; second, to ensure a secure energy supply and access to affordable energy, and to promote long-term sustainability goals by slowly ending the long-standing relationship with Russia.

This package was complemented by several other regulations to enhance the security of energy supplies and to address the negative consequence of the crisis on European economies. For example, a new regulation (2022/1032) on gas storage was imposed before the winter of 2022, accompanied by a voluntary commitment (2022/1369) from all EU members to reduce their gas consumption by at least 15% in the same period. At the same time, a political agreement (2022/1854) was reached to tackle high energy prices by capping the windfall profits of specific electricity generators and fossil fuel companies and by using these funds to counter the negative implications of the recent revision of greenhouse gas reduction targets.

Box B

Beating the energy crisis — an overview of the REPowerEU package

The REPowerEU package includes several short- and long-term objectives and measures, structured across three main pillars. The first is to reduce demand for fossil fuels. The second is to diversify energy supply routes and reinforce of existing infrastructure. The third is fostering a faster transition to renewable energy, including hydrogen. The range of measures seeks to change behaviours across energy markets (Table B.1). For example, individuals are expected to do their part by consuming less energy. EU members are expected to adopt more climate-friendly policies and enhance coordination with one another, and the European Union is expected to adopt more ambitious climate targets and strengthen its negotiating power and collaboration with non-EU countries.

In the short-to medium run, reorienting natural gas imports is more challenging than reorienting oil and coal imports. This is due to different needs in supply infrastructure, transportation and storage. While part of the long-term solution lies in promoting renewable energy sources and energy efficiency savings (Figure B.1), the European Union will still need large volumes of natural gas imports in the short and medium term. It is therefore important to diversify gas supplies in the short run, for example by encouraging imports from non-Russian suppliers and by increasing the use of liquified natural gas.

According to the European Commission's analysis, REPowerEU will require additional investment of EUR 300 billion by 2030, compared to the approximately EUR 100 billion the European Union currently spends on Russian energy imports each year. This investment is on top of an additional estimated EUR 390 billion per year needed to deliver the European Green Deal, including meeting Fit for 55 objectives. More than two-thirds of the money should be invested by 2027, and the bulk will go to projects that accelerate the transition to renewable energy and energy savings. Only a small percentage will be allocated to fossil fuel infrastructure (Figure B.2). These investments are expected to be financed by a mix of national and EU funding sources, including private funding. For this purpose, the Recovery and Resilience Facility, which supports Europe's pandemic recovery, will provide EUR 225 billion in loans, with the remainder covered by grants.

Table B.1

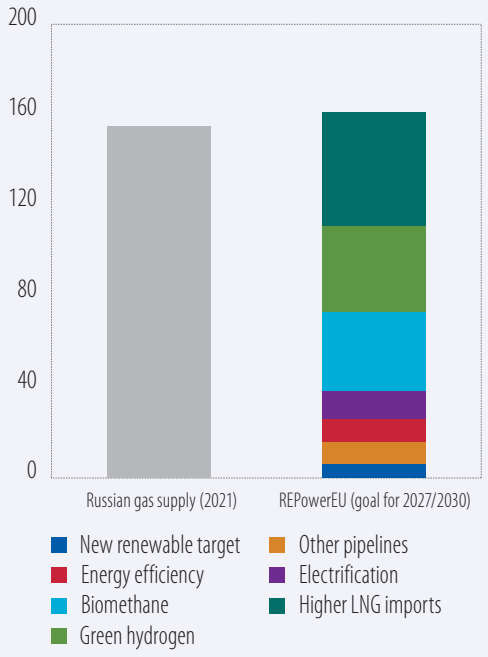
Mapping the level of intervention based on the REPowerEU package

Individuals	Member States	EU wide	Third partners
Eco-design and energy labelling information	Guidance on national energy and climate plans, power purchase agreements, state aid, and the prioritisation of non-protected customers	Energy efficiency directive target for 2030 increased to 13% from 9%	EU external energy engagement strategy
European Solar Rooftops Initiative	EU recommendation on permitting corresponding high-level summits and country-specific recommendations	Renewable energy directive target for 2030 increased to 45% from 40%	EU energy platform for pooled purchase of gas, liquid natural gas and hydrogen
EU Save Energy communication	Designation of "go-to" areas for renewable energy infrastructure development	Solar strategy targeting 320 GW of solar photovoltaic energy by 2025 and 600 GW by 2030	Emergency synchronisation of third countries to the EU electricity grid
	Guidance on application of recovery and resilience plans	Complete the legislation for the production of hydrogen from renewable sources	Global European Hydrogen Facility
	Update of emergency and risk preparedness plans	Progress report on hydrogen uptake	Engagement on critical raw materials with third countries
		35 billion m^3 of biomethane production by 2028	
		EU Solar Photovoltaic Industry Alliance	
		A coordinated EU plan for the curtailment of industry	

Source: Conti and Kneebone (2022).

Figure B.1

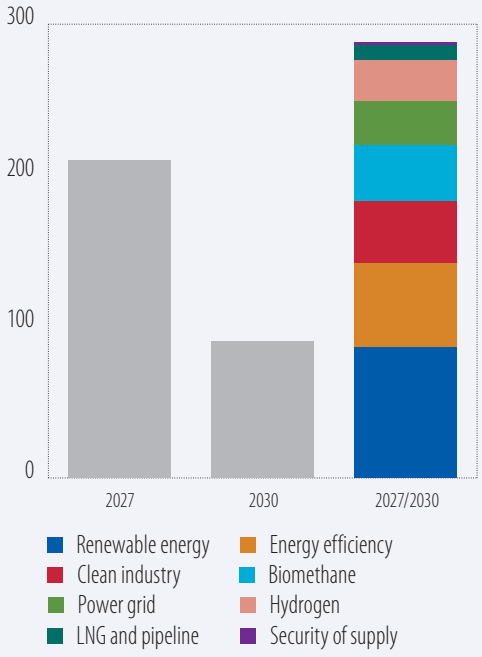
EU plans to substitute Russian gas
(billion m^3/year)



Source: EIB staff estimates based on REPowerEU.

Figure B.2

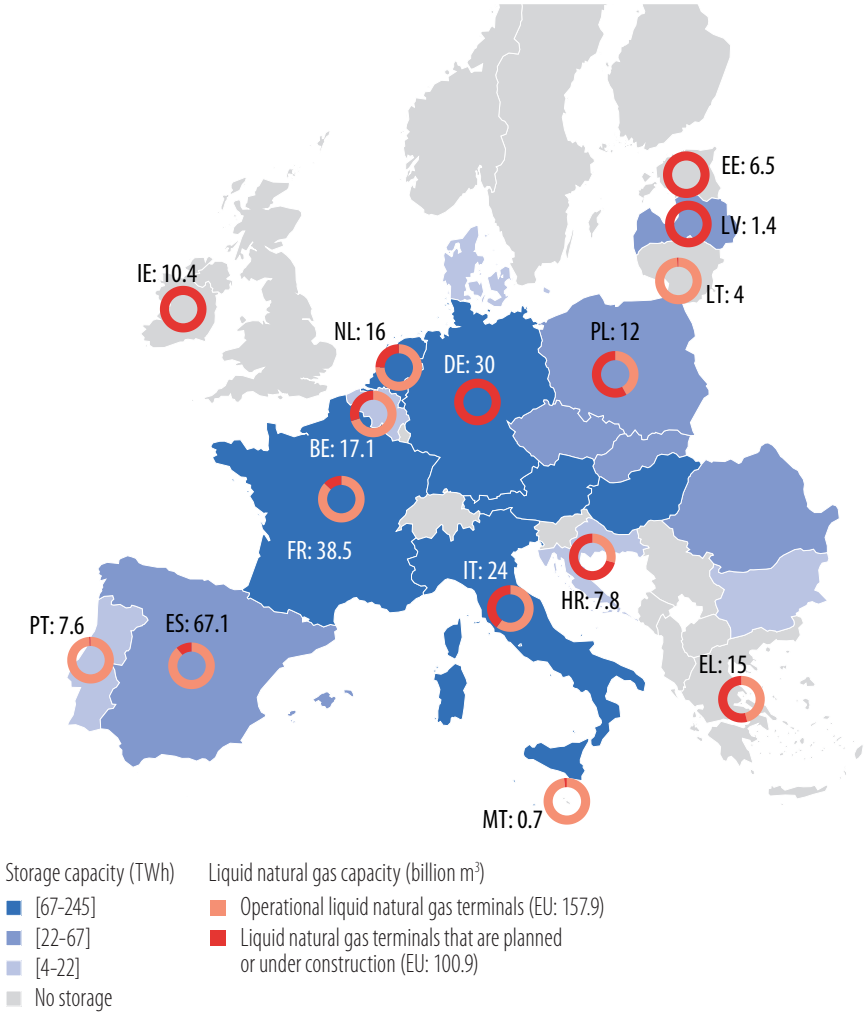
Investment needs of REPowerEU
(EUR billion)



Source: EIB staff estimates based on REPowerEU.

Ramping up the capacity of liquified natural gas terminals is central to Europe's energy response. The main advantage of liquified natural gas over pipeline gas is that it can be easily imported from a wide range of countries, and so enhances the security of supply. The main disadvantage of liquified natural gas is that supplies are often more costly, and also raise some environmental concerns because of the emissions from transportation and regasification, or the process of converting liquified natural gas to pipeline gas. In addition, specific infrastructure must be built so that the gas can be received and regasified before entering the pipeline network.

Figure 11
Storage (TWh) **and LNG capacity** (billion m^3) **in the European Union**



Source: *Bruegel, ENTSO-G.*

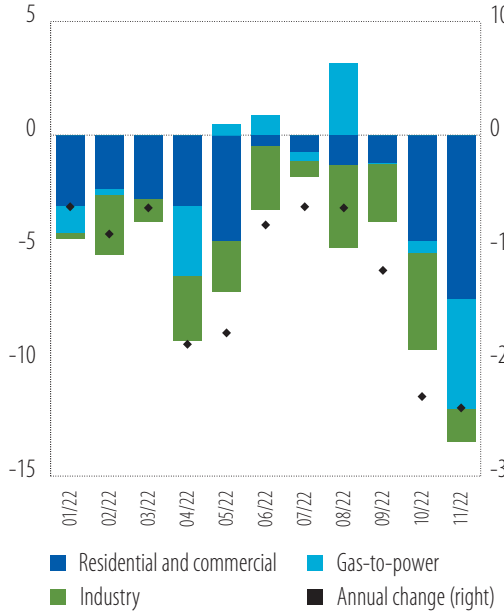
Liquified natural gas capacity is unevenly distributed across the European Union and pipeline connections are weak, while coordination between EU countries remains challenging for security reasons. The European Union has a total annual capacity to receive and regasify 158 billion m^3 of liquified natural gas per year, with more than 100 billion m^3 of new projects either planned or under construction (Figure 11). Some EU members, even large ones such as Germany, are currently building infrastructure to import liquified natural gas. Around 37% (60 billion m^3) of the European Union's total capacity is located in Spain, which has limited pipeline connections to France and the rest of Europe. Other major liquified natural gas importers within the European Union are France (33 billion m^3), Italy (15 billion m^3), the Netherlands (12 billion m^3) and Belgium (11 billion m^3). Liquified natural gas capacity is lower in Eastern

and Southeastern Europe, the areas most dependent on Russian gas. To counter the energy shock and ensure access for all countries, a process for rapid investment in infrastructure connections has been developed so that no country will be isolated in the event a shortfall in Russian supply.

However, these steps alone will not be enough to replace deliveries from Russia in the short run. That is why the European Union is also attempting to ensure that all underground gas storage facilities are filled to at least 80% by November 2022 (and 90% in the following years). So far, the data shows that Europe is on track[6], but challenges remain. Total EU gas storage capacity is around 114 billion m^3 (Figure 11), much lower than overall annual gas imports from Russia, which are 155 billion m^3. Even worse, like liquified natural gas transport capacity, storage capacity is not evenly distributed across the European Union. Five countries account for almost three-quarters of the total (Germany, Italy, France, the Netherlands and Austria), while around one-third of smaller EU countries have no storage capacity of their own (although some have arrangements to access gas stored in neighbouring countries).

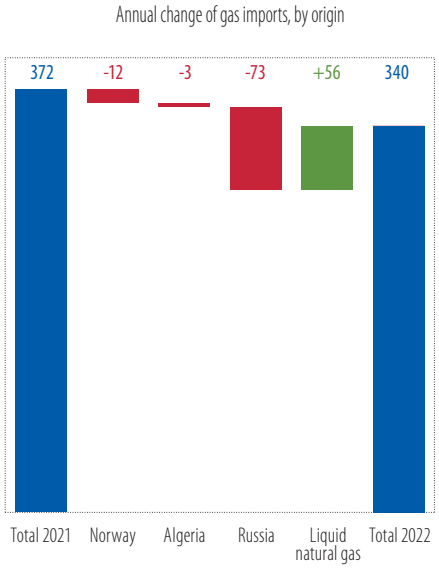
The good news is that energy savings — the quickest and the cheapest way to tackle the current energy crisis, according to Europe's plan — are taking centre stage. According to the most recent data (Figure 12), Europe's natural gas demand declined by almost 25% in November 2022, a new record. Most of these savings come from the power sector and households, and to a lesser extent from industry. Among EU members, the savings achieved in the Nordic countries and the Baltics stand out.

Figure 12
Gas demand reductions, 2021-2022
(left: billion m^3; right: in %)



Source: *IEA.*

Figure 13
Change in European and UK gas imports, 2021-2022
(million m^3)



Source: *Bruegel.*

6 The plan also suggests measures to address energy pricing (taxes on windfall profits, price regulation and state aid) and gas storage (storage obligations, coordinated gas refilling and investigations into operators' behaviour).

Another positive development is that, after years of Russian dominance of fossil fuel imports to Europe, new energy trade partners are now emerging. As Russian imports shrank throughout 2022 (Figure 13), EU countries signed bilateral deals with new trading partners, including the United States, Algeria, Egypt and Azerbaijan. Joint purchase agreements were forged in the autumn of 2022 to better coordinate the crisis response at the EU level, allocate available resources more efficiently to EU members and preserve the integrity of the single market.

The corporate sector faces twin climate and energy challenges

The turmoil in the energy markets underscores the need for further investment in clean energy technologies, with far-reaching benefits for sustainability, security of supply and affordability. This section investigates how firms are responding to the twin climate and energy challenges based on EIBIS results. Findings show that firms are engaging in climate action to maintain competitiveness amid high energy prices, but that growing uncertainty remains a fundamental challenge to investment. Firms' characteristics and degree of climate awareness play a key role in their willingness to invest in adaptation and mitigation measures.

Corporate investment in climate is set to grow despite persistent challenges

Energy market disruptions, combined with soaring prices in the wake of the war in Ukraine and following the pandemic, are challenging European businesses. Russia's invasion of Ukraine and the consequent reduction in energy supplies to Europe are influencing the European Union's transition to a net-zero carbon economy by 2050. Plans to reduce reliance on fossil fuels could speed up the climate transition. However, climate goals could be undermined by the temporary switch many EU countries have chosen to make to carbon-emitting fuels, such as coal, in reaction to immediate energy security issues and soaring energy prices.

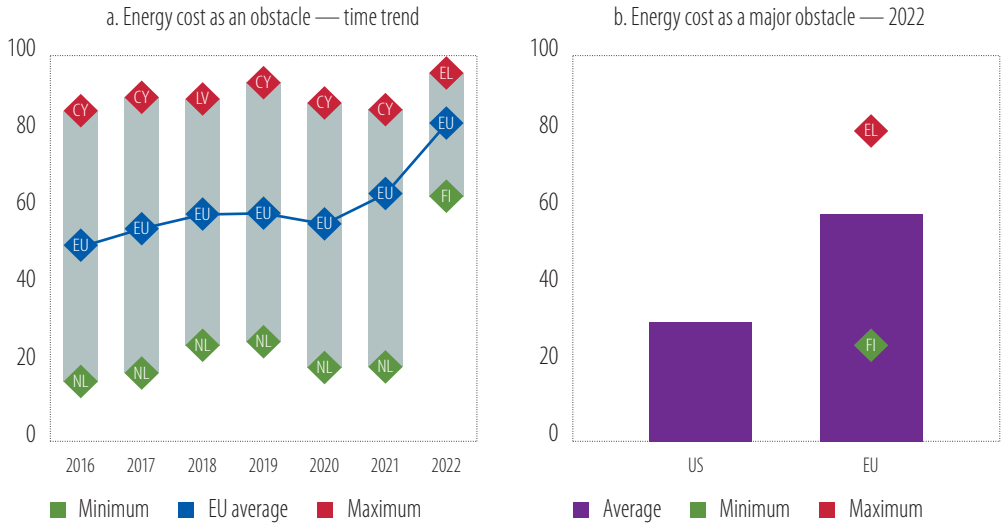
Amid growing uncertainty, the share of firms that see rising energy costs as a constraint to their investment skyrocketed in 2022. According to EIBIS data, the perception that energy costs were stymying investment has increased over the years, and especially after 2020 (Figure 14). In 2022, 58% of European firms said energy costs were a major impediment to investment — almost 20 percentage points above US firms, implying that the energy crisis is playing out differently across the Atlantic. The growing concerns appear across European countries, with the upper end of the spectrum almost always marked by Cyprus and the lower by the Netherlands. The range of responses across Europe shrank considerably in 2022, indicating the ubiquitous nature of the energy shock.

Higher energy costs influence firms' decision to invest — and their investment focus. On the one hand, high energy prices result in higher production costs, reducing output and spurring downsizing, which negatively affects investment decisions. On the other hand, higher energy prices can also push firms to modernise their operations, using capital to replace old equipment and renovate buildings. This modernisation effect has an ambiguous impact on overall investment, as spending on energy-efficient technologies crowds out investments not related to energy.

EIBIS 2022 shows that the share of firms engaging in climate action rebounded after stalling in the previous year. Some 51% of firms have already invested in climate action, of which 8% invested for the first time in 2022. A similar share (51%) is also planning to invest in the future. This figure has risen constantly since 2020 (41%), implying that green investments are becoming essential to competitiveness (Figure 15). Nevertheless, the European Union-wide figures mask great heterogeneity across countries, which appeared to widen in 2022, especially for those firms that have invested in climate action.

Figure 14

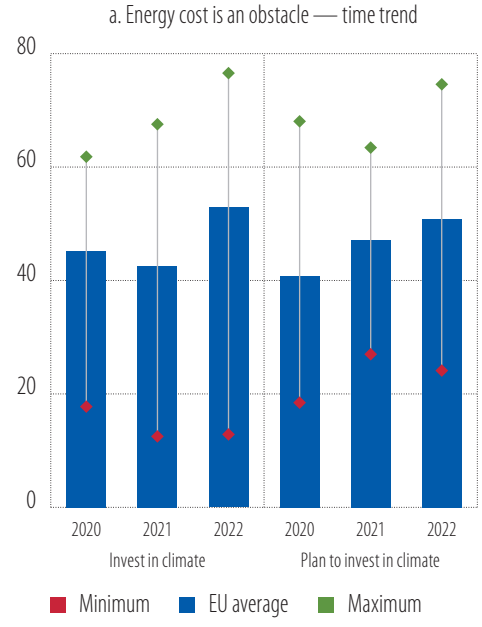
Share of firms (in %) **considering energy cost to be an obstacle to investment**



Source: *EIBIS 2016-2022.*
Note: *The chart on the left represents the share of firms saying that energy cost is a major and minor obstacle, whereas the chart on the right represents firms saying energy cost is a major obstacle.*
Question: *Thinking about your investment activities, to what extent is energy cost a major, minor or not an obstacle?*

Figure 15

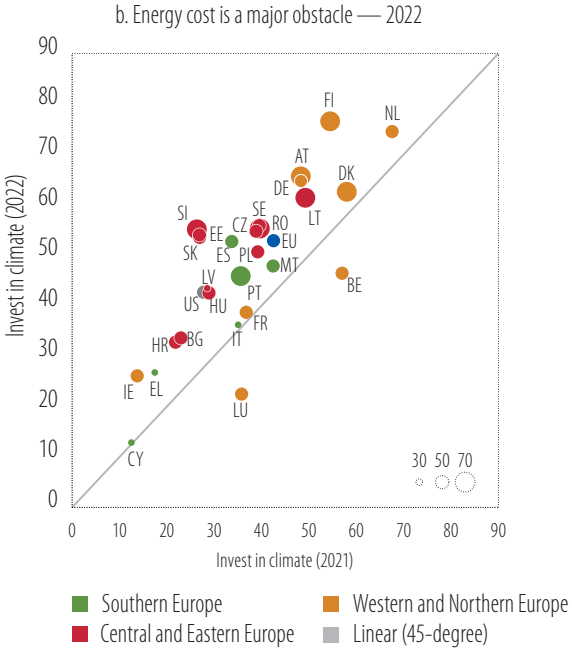
Share of firms (in %) **investing in climate or planning to invest**



Source: *EIBIS 2020-2022.*
Note: *The graph represents the EU average and the maximum and minimum across EU countries.*
Question: *Thinking about investments to tackle the impacts of weather events and to deal with the process of reduction in carbon emissions, which of the following applies?*

Figure 16

Comparison of firms (in %) **that have invested in 2022 vs. 2021, with those that plan to invest in 2022** (bubble size)

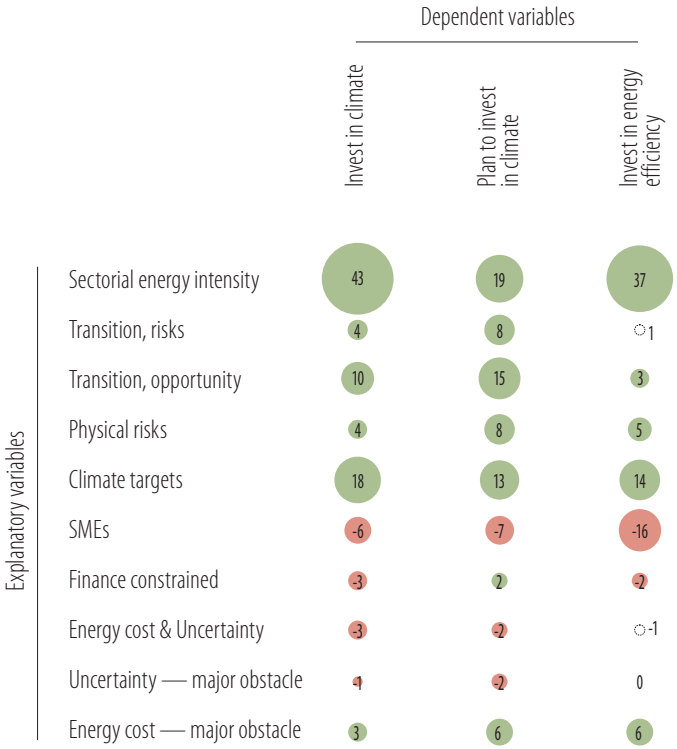


Source: *Bruegel.*
Note: *The bubble sizes represent the percent of firms planning to invest.*

Firms in Western and Northern Europe are at the forefront, while those in some Central European countries are catching up. Climate investment in these two regions is gaining momentum, with a high share of firms planning to continue investing (Figure 16). By contrast, firms in certain countries (including Cyprus, Greece, Ireland and Luxembourg) constantly lag behind, and also show little interest in investing in climate in the next three years.

As the energy crisis unfolds, it raises questions about climate investment's resilience to the shock. Interesting evidence emerges from an analysis of firms' investments in energy efficiency and their ability to cope with climate change. The empirical analysis (Figure 17) shows that energy cost concerns positively influence investment decisions on climate action. However, the data show that increasing uncertainty might outweigh or cancel out the incentive to engage in climate action (including energy efficiency). How these two investment obstacles — uncertainty and high prices — interact is relevant in the current context. To some extent, uncertainty prevails over energy cost concerns, leading to reduced investment. The effect of credit constraints, which are increasing because of the crisis, is also relevant. The analysis shows that firms affected by credit constraints are less likely to engage in climate action. On a more structural level, the analysis finds that small and mid-sized enterprises (SMEs) are less likely to invest in energy efficiency and climate action. Climate change awareness is also important, with firms more likely to invest if they have climate targets, have been affected by extreme weather or perceive that the transition to a low-carbon future will impact their businesses.

Figure 17
Likelihood of adopting greener profiles (in percentage points)



Source: *EIB staff estimates.*
Note: *The graph presents the estimated average marginal effect of several factors, based on logistic regression with robust standard errors. The dependent variables are in columns and the explanatory variables are in rows. All dependent variables are binary, based on firms' answers to the related questions. Regression controls include the fixed effects for countries and sectors. Sectorial energy intensity represents estimates of the total importance of energy sectors in 13 selected sectors based on the OECD input-output country tables. Other explanatory variables represent whether the firm has invested in climate, plans to do so in the next three years, invests in energy efficiency, views energy cost and uncertainty about the future to be major investment impediments, sets climate targets, is finance constrained views the climate transition as a risk or opportunity, was affected by physical risks, and is an SME or large firm. The colours green and red represent positive and negative coefficients that are statistically significant, at least at 10%. No colour indicates that the coefficient is not statistically significant at least at 10%.*

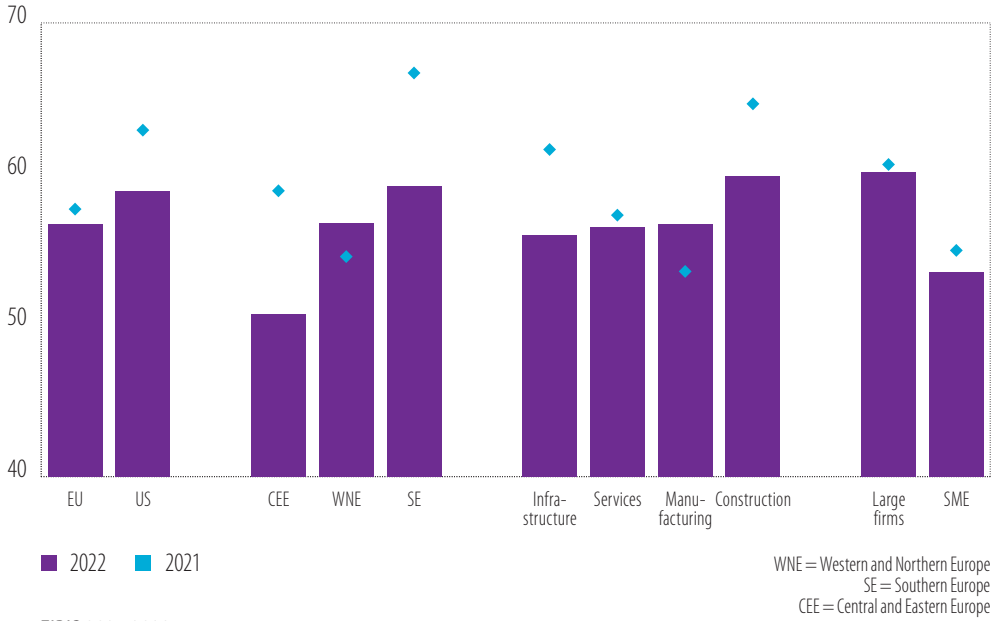
The energy crisis is creating promising investment opportunities

The ongoing energy crisis presents an opportunity for the private sector to accelerate its green plans and position itself at the forefront of the fight against climate change. Firms have a crucial role to play in tackling the climate emergency and in addressing the associated climate change risks. For some, extreme weather events and changes in weather patterns have already proved detrimental. In parallel, the impact of immediate decarbonisation measures (transition risks) is now spreading widely to all industries, not just carbon-intensive ones. While in the past many companies overlooked the array of pressing climate risks they faced, they are realising that understanding these risks is the only way to protect their business, and they are identifying ways to compete in a carbon-neutral economy.

Climate change risks are no longer a distant reality

In 2022, extreme weather events across the globe led to loss of life and large-scale economic damage. Heatwaves, forest fires and a persistent drought in several European regions in the summer of 2022 had dire consequences for a number of industries, from agriculture to transportation. The scientific community warns that climate change will increase the frequency of these kinds of events. European companies must act swiftly if they are to meet the challenge.

Figure 18
Share of firms (in %) **affected by physical climate risks**

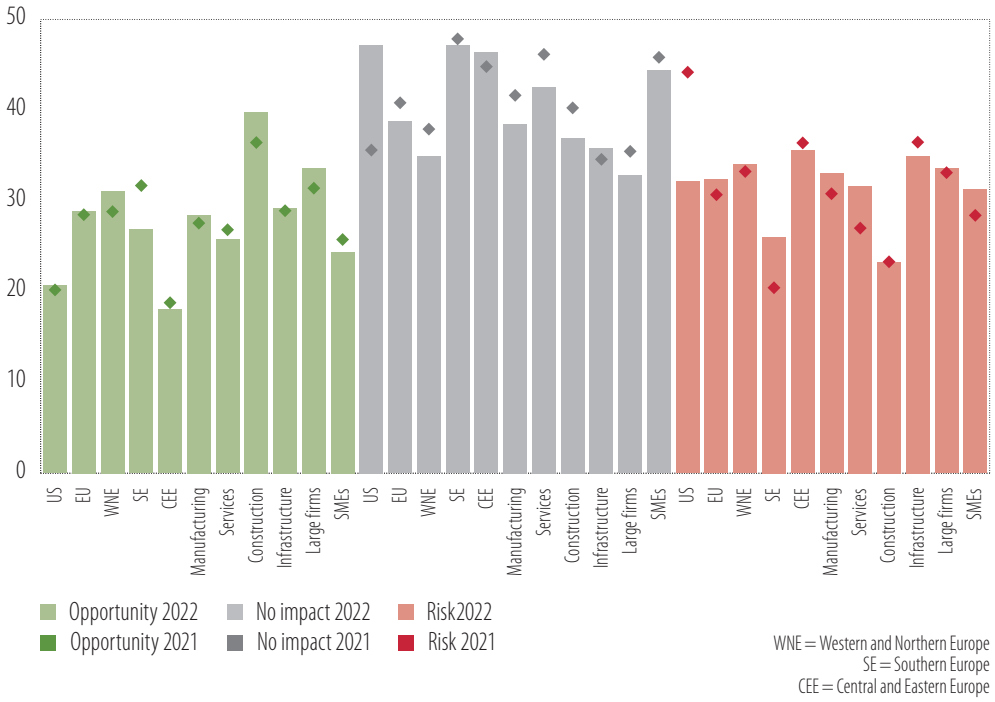


Source: *EIBIS 2021-2022.*
Question: *Thinking about climate change and the related changes in weather patterns, would you say these weather events currently have an impact on your business?*

A large swathe of European firms is aware of the risks climate change poses. The share of companies that perceive themselves as at risk is broadly similar in the European Union, 57%, and the United States, 59% (Figure 18). However, more companies in Europe (17%) report being extremely affected by climate change than in the United States (13%). In Southern Europe, indicators for vulnerability to global warming — as measured by location, exposure to extreme weather events and inability to cope with their consequences — are higher than on the rest of the continent. This is reflected in businesses' high awareness of the issue — 64% of firms in Portugal, for example. This awareness is understandable given

the persistent wildfires Portugal endured during the hot and dry summer of 2022. At the same time, Central and Eastern European countries also appear to feel more vulnerable, although the perception of climate change risks in this region is lower (apart from Romania).

Figure 19
Impact of the energy transition on firms (in %)



Source: *EIBIS 2021-2022.*
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?*

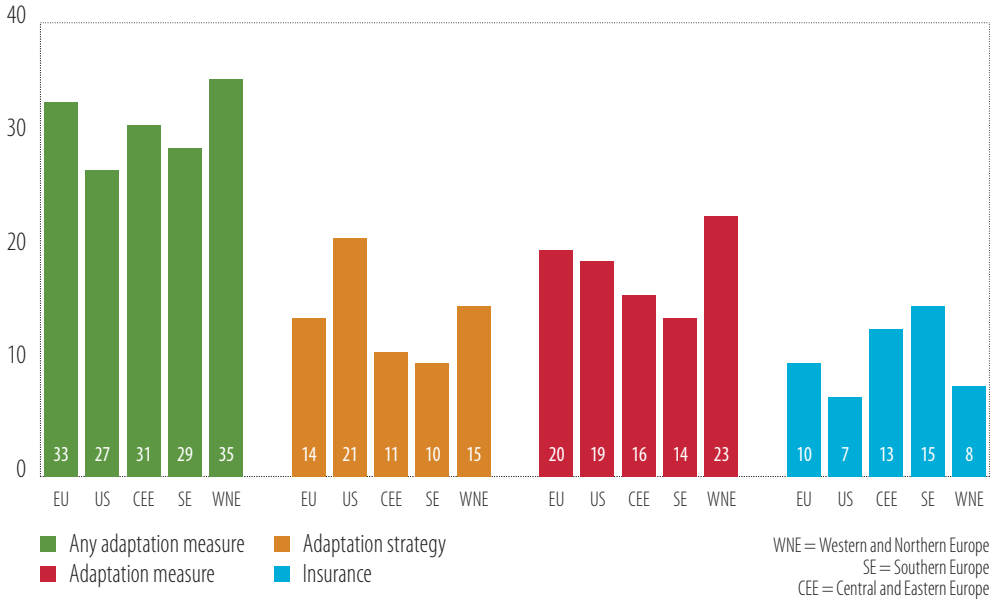
European firms' perceptions of transition risks remained broadly stable from last year, whereas firms in the United States have become less concerned about the transition's negative impact. Firms in Central and Eastern Europe continued to feel that the transition to a low-carbon future poses risks, while those in Western and Northern Europe see opportunity (Figure 19). Among European sectors, firms in construction have positive views overall, as they did last year, while a higher share of firms in the remaining sectors see the transition as a risk rather than an opportunity to be seized.

Wide variation in responses to the climate emergency across Europe

Attitudes towards adaptation measures differ between EU members, with countries in Western and Northern Europe pursuing more active strategies. EIBIS 2022 data reveal that, at the European level, 33% of firms have taken at least one action towards adaptation (Figure 20). However, this is much lower than the share of firms reporting that their business had been affected by physical risks. Despite worrying about the physical risks of climate change, firms may feel that the problem needs to be dealt with more broadly by government and not simply by their individual actions.

One-fifth of firms in the United States claimed to have an adaptation strategy, compared to 14% in the European Union (Figure 20). However, European firms invested more in reducing their exposure and offsetting climate-related losses through insurance products. Firms' adoption of active measures seems to go hand-in-hand with the existence of an adaptation strategy.

Figure 20
Firm (in %) **investing in specific adaptation measures**



Source: *EIBIS 2022.*
Question: *Has your company developed or invested in any of the following measures to build resilience to the physical risks to your company caused by climate change?*

Firms in most Western and Norther European countries were clearly oriented towards more active strategies. Some 23% of companies took steps to reduce their exposure to climate change risks, whereas 15% claimed to have an adaptation strategy. A larger share of companies in Southern Europe (15%) had bought insurance, following a passive adaptation strategy, instead of investing in measures to reduce their exposure to direct physical risks. Central and Eastern Europe followed a similar pattern, although more companies in that region acted to reduce exposure than to insure against climate risks (16% vs. 13%).

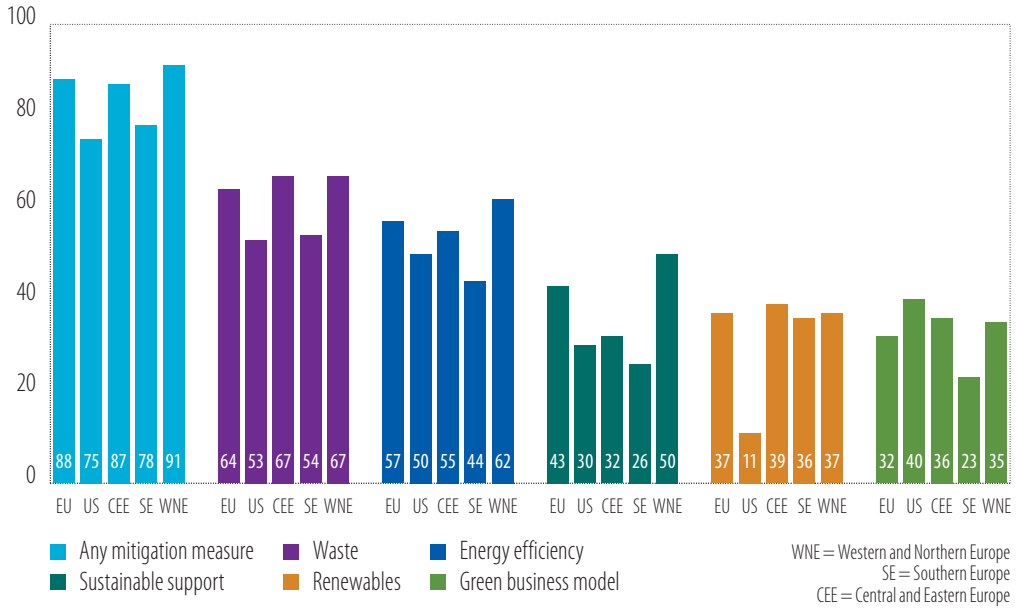
Turning to investment in climate change mitigation in Europe, 88% of firms have taken at least one action to reduce their carbon footprint. The majority of firms are taking action to invest in waste minimisation or energy efficiency (Figure 21). Interestingly, 32% of firms are considering changing their production and business models to shift the business towards less polluting activities — a sign of radical transformation of firms' behaviour. This strategy is more likely to be pursued in Central and Eastern Europe and in Western and Northern Europe, and less likely in Southern Europe.

Engagement in climate change mitigation also appears to follow a regional divide. Western and Northern European countries lead the way, with only 9% of all companies saying they are not pursuing any of the five mitigation measures proposed in the EIBIS. Investment in sustainable transport is one of the top mitigation measures chosen, with about half of all companies pursuing it (more than in other regions). Central and Eastern Europe follow suit, with only 13% of companies not investing in at least one of the five measures (a result largely driven by Romania, where the share reaches 23%). Finally, Southern Europe lags behind, with the highest share of companies deciding not to invest in mitigation (22%) or investing in only one measure (28%).

Through investment in climate change adaptation and mitigation, the corporate sector can and must play a key role in the climate transition. Businesses are an important economic engine. They bring growth, drive innovation in technologies and influence consumption choices. Their actions to address climate change will benefit society at large. Their level of activity, however, depends partly on their size. A greater share of larger firms, 18%, had adopted an adaptation strategy in 2022, compared with just 10% of small and medium firms. Small businesses also have the largest share, 18%, that did not implement any

mitigation measures at all in 2022. That figure drops to 5% for other firms. Public policies to encourage climate change adaptation and mitigation need to include small and medium firms, which account for more than half of the EU economy.

Figure 21
Firms (in %) **investing in specific mitigation measures**



Source: *EIBIS 2022.*
Question: *Is your company investing or implementing any of the following to reduce greenhouse gas (GHG) emissions?*

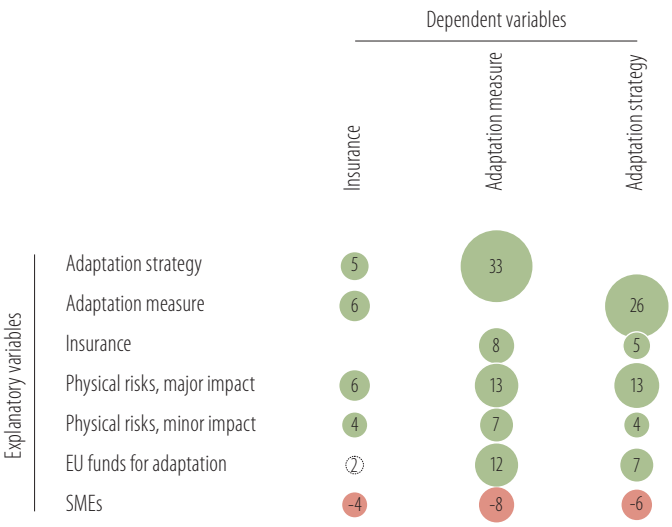
Firm characteristics and their climate awareness influence investment

Adaptation choices depend on firm characteristics and their awareness of climate change risks. The EIBIS 2022 shows that firms with an adaptation strategy are more likely to implement specific measures to address climate change (Figure 22). The likelihood that these firms will buy insurance (a more passive approach to adaptation) is less closely tied to having an adaptation strategy, but still positively correlated. Firms' awareness of physical risks posed by climate change also determines the kinds of adaptation measures they choose to implement. Firms that say physical risk is a major concern, rather than a minor one, are twice as likely to take action. Firms that are experiencing major climate change effects tend to employ active strategies rather than passive ones. The availability of EU funds also plays a role. Firms are more likely to adopt active strategies (have a strategy in place or implement adaptation measures) when these funds are available. On a more structural level, small businesses are far less likely than other firms to implement measures to protect themselves against the physical risks of climate change.

The specific mitigation measures a firm pursues reflect its climate objectives and level of ambition. The scope of a firm's transition to a low-carbon economy determines just how much adjustment is required (Kalantzis et al., 2022) or the extent to which it will reduce its environmental impact (Figure 23). A firm may choose to implement multiple strategic measures at the same time, perhaps to different degrees. Therefore, a firm's mitigation strategy can be understood as the combination of mitigation measures it takes, possibly marked by distinct strategic preferences.[7]

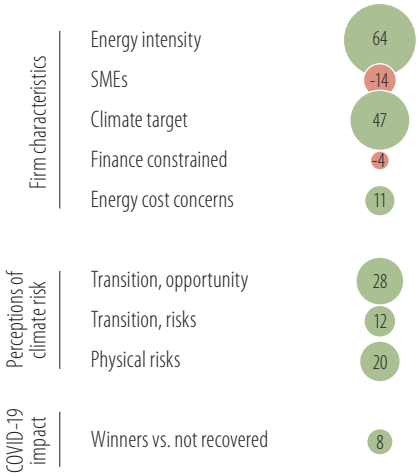
7 A first fundamental distinction between the mitigation measures sought by firms to reduce energy cost vs. to reduce carbon footprint was made by Thollander et al. (2007), and more recently by Kalantzis et al. (2022).

Figure 22
Likelihood of implementing specific adaptation measures (in percentage points)



Source: *EIB staff estimates.*
Note: *The graph presents the estimated average marginal effect of several factors, based on logistic regression with robust standard errors. The dependent variable is a binary variable indicating whether or not a firm has adopted the specific adaptation option — for example, having an adaptation strategy, implementing adaptation measures or buying insurance. Regression controls include the fixed effects for countries and sectors. EU funds for adaptation represents the allocation of EU funds to countries for adaptation purposes. For definitions of the remaining variables, please see the notes of Figure 17. The colours green and red represent positive and negative coefficients that are statistically significant, at least at 10%. No colour indicates that the coefficient is not statistically significant at least at 10%.*

Figure 23
Likelihood of implementing more mitigation measures (in percentage points)



Source: *EIB staff estimates.*
Note: *The graph presents estimated average marginal effect of several factors, based on count outcome (poisson) regression with robust standard errors. The dependent variable represents how many mitigation measures a firm has adopted. Regression controls include the fixed effects for countries and sectors. Peer effects have been calculated based on the leave-one-out formula. The rest of the variables have been defined in Figure 17 and 22. The colours green and red represent positive and negative coefficients that are statistically significant, at least at 10%. No colour indicates that the coefficient is not statistically significant at least at 10%.*

A firm's decision to take action on climate change can be influenced by its history and culture, core competencies and the competitive environment, along with prevailing market and economic conditions. The EIBIS 2022 shows that, all other things being equal, each additional unit (percentage point) in the energy intensity of the sector in which a firm operates (Figure 23) increases its likelihood of being greener (implementing more green measures) by 64%.[8] Similarly, firms that set climate targets are 47% more active than those without them. Firms that acknowledge climate change effects are also greener. For example, those that see the transition as an opportunity are 28% more likely to invest in green measures. This impact drops to 12% for firms that perceive the transition as a risk, and to 20% for firms affected by the physical risks. At the same time, firms that have not recovered from the pandemic

8 The increase per numerical quantity of measures is calculated at a compounding rate so that the effect is no greater than one.

invest less in green measures — by 8% — than firms considered to be pandemic "winners." Firms that view the cost of energy as an investment obstacle are 11% keener to invest in green measures than those that do not have these concerns. Firms with credit constraints are about 4% less green than those without, and small businesses are about 14% less green than large firms.

Figure 24
Likelihood of adopting specific mitigation measures (in percentage points)

Source: *EIB staff estimates.*
Note: *The graph presents estimated average marginal effect of several factors, based on logistic regression with robust standard errors. The dependent variable is a binary variable indicating whether a firm has adopted the specific mitigation measure. Regression controls include the fixed effects for countries and sectors. Peer effects have been calculated based on the leave-one-out formula. The rest of the variables have been defined in Figure 17 and 22. The colours green and red represent positive and negative coefficients that are statistically significant, at least at 10%. No colour indicates that the coefficient is not statistically significant at least at 10%.*

A firm's specific situation influences the green measures adopted, although the importance differs from measure to measure (Figure 24). For example, firms with energy cost concerns are 9 percentage points more likely to invest in energy efficiency — almost twice as much as for other mitigation measures, like renewable energy. This highlights the importance of energy efficiency measures in controlling energy costs. Finance constraints appear more relevant for firms considering investment in sustainable transport (a capital-intensive activity). Climate targets are more strongly linked with firms investing in new, less polluting products and services, energy efficiency and sustainable transport. It is likely that firms consider these measures to be the most effective in reducing their carbon footprint. Another interesting finding is that the pandemic "winners" are more likely to invest in renewable energy and in less polluting products and services. Finally, for all mitigation measures except sustainable transport, firms' decisions to invest are positively correlated with the strategies of their peers in the same sector or region, implying that most firms make an effort not to lag behind their peers.

Financial mechanisms to support climate strategies

Finance plays a pivotal role in mobilising capital for green investment and making the European economy more sustainable. This section investigates banks' role in financing green activities and discusses current trends for other financial mechanisms that implement climate initiatives. Findings suggest that the stability of the financial system and its capacity to fund the green transition are interlinked, and that financial instruments focusing on environmental, social and governance (ESG) measures are gaining momentum.

The financial system is a catalyst for green investment

With its key role in allocating resources, the financial system is instrumental for addressing climate change. Whether investors fund "green" or "brown" industries can affect the trajectory of carbon emissions. One strand of literature examines which financial system characteristics are conducive to reducing emissions. De Haas and Popov (2019) find that emissions are lower in economies with greater equity funding, as stock markets reallocate investment towards less polluting sectors and lead carbon-intensive sectors to transition towards greener technologies. Delis et al. (2019) find that banks did not price in climate risk before the approval of the Paris Agreement in 2015. A potential explanation is that banks use the securitisation market to shift climate risk off their balance sheet (Mueller et al., 2022). Market structure can also play a role. Evidence suggests that a more concentrated banking system in a given industry will make fewer loans to green firms, because they risk undermining the value of the bank's portfolio (Degryse et al., 2020).

Combining data from the EIBIS with financial statements taken from Moody's Analytics' BankFocus makes it possible to examine whether firms' climate-related investments are associated with the strength of bank balance sheets. EIBIS 2020 contained a range of questions on firms' climate mitigation activities. Specifically, it asked respondents whether they had already invested in climate or had plans to do so in the next three years. The survey elicited firms' views on obstacles to climate investment, such as whether they saw the availability of finance as an obstacle. For the empirical analysis reported below, data for each firm were combined with bank information. In this way, bank-specific features could be matched with the availability of green finance. Here, banks' return on average assets is taken as a measure of their profitability, and their ratio of non-performing loans to gross loans as a measure of asset quality.

Table 1

Climate investments and bank balance sheets

	Invest in climate	Invest in climate	Plan to invest in climate	Plan to invest in climate	Finance as obstacle to green investments	Finance as obstacle to green investments
Bank ROAA	1.303**		1.584**		-2.322***	
NPL ratio		-0.095		-0.438**		-0.146
Exporter	0.023	0.023	-0.017	-0.011	-0.016	-0.010
Young	-0.020	-0.025	0.015	0.014	0.039*	0.037
managerial practices in the firms	0.062***	0.061***	0.084***	0.079***	0.003	0.001
Observations	4 596	3 831	4 596	3 831	4 537	3 780
R-squared	0.111	0.105	0.076	0.082	0.100	0.103

Source: *EIBIS 2020 and BankFocus.*

Note: *Bank ROAA refers to bank's returns on average assets. NPL refers to non-performing loans. Young firms are less than ten years old. All regressions control for firm size, exporter status, age, management practices as measured by whether the firm uses a strategic business monitoring system, and control-sector fixed effects. Exporter is an indicator equal to one if the firm exports more than 10% of sales. Standard errors are clustered at the bank level. Statistical significance: *** p-value<0.01, ** p-value<0.05, * p-value<0.1.*

Banks with higher profitability and better asset quality are more likely to fund firms that invest in climate change mitigation and adaptation. Table 1 reports regression results that control for differences in firm size, exporter status, age and management practices (as measured by whether the firm uses a strategic business monitoring system). Columns 1 and 2 show that bank profitability is positively associated with green investment, while there is no such correlation with asset quality. Firms with strategic business monitoring systems are more likely to have implemented green investments at the time of the EIBIS interview. Columns 3 and 4 show that more profitable banks and banks with better asset quality are more likely to fund firms that plan future green investments. Moreover, firms that borrow from more profitable banks are less likely to view finance as an obstacle to green investment (column 5).

The results suggest that the stability of the financial system and its capacity to fund the green transition are interdependent. Alogoskoufis et al. (2021) document the impact of physical and transition risks on bank balance sheets. They also show that these risks are concentrated in banks with a comparatively low likelihood of being able to bear them. To the extent that these risks materialise, they weigh on the balance sheet of banks, especially those that are most vulnerable.[9]

ESG financial instruments are gaining momentum

To reduce greenhouse gas emissions 55% by 2030, compared to 1990 levels, Europe will need to invest an estimated EUR 390 billion more per year in the energy system than during the previous decade. On top of these additional investment needs, Europe will have to spend EUR 300 billion by 2030 to reduce its reliance on Russian energy imports. Public funds will continue to play an important role in unlocking private investment to support the energy transition, via existing programmes under national public investment schemes, NextGenerationEU and the multiannual financial framework.

However, the bulk of the necessary investments will have to come from private funds. Fortunately, sustainable finance activities have increased significantly over the last five years, quantitatively and qualitatively. Those activities range from green debt to equity fundraising for green-tech firms and technologies to mitigate or reverse the impact of human activity on the environment.

Most companies fund their climate strategies through a combination of approaches. The main options for financing firms' climate strategies include bank loans and international capital markets. For funds raised on international markets, firms can use a combination of financial instruments, including:

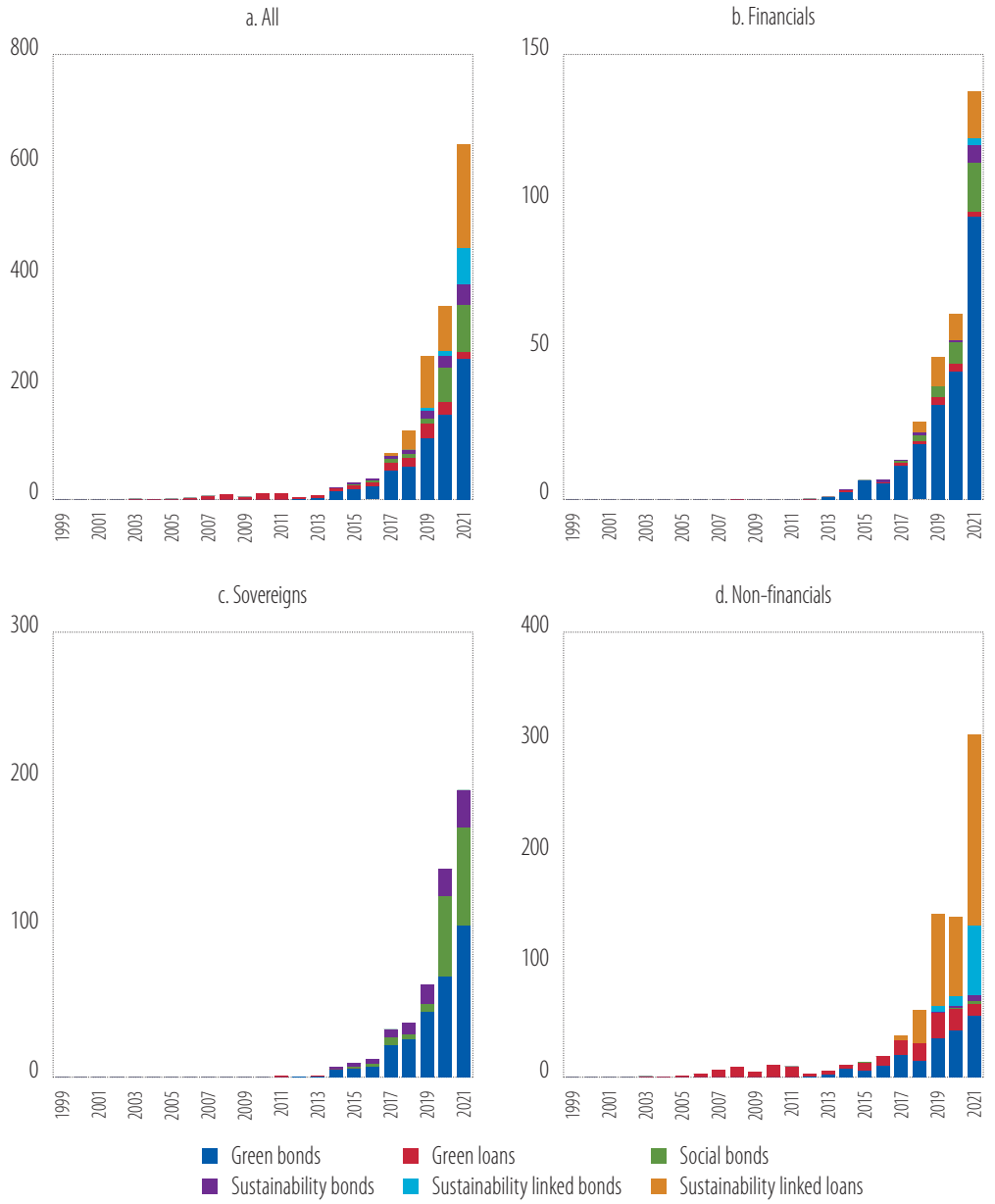
- **Green bonds/loans:** Proceeds from the bonds or loans fund green projects and activities that promote climate change mitigation or adaptation, or other environmental sustainability purposes.
- **Sustainability bonds:** Proceeds go to projects devoted to environmentally sustainable outcomes (eligible projects encompass a combination of green and social activities).
- **Social bonds:** Proceeds go to projects that directly promote social welfare and help underprivileged, low-income, marginalised, excluded or disadvantaged populations.
- **Sustainability-linked bonds:** Proceeds are generated by a bond whose terms are based on a company's (issuer/borrower) performance against predetermined sustainability targets, enhancing the corporate sustainability profile.

Global green bond issuance continued to break records in 2021 driven in part by pandemic bonds, a subset of social bonds. The green bond market more than doubled in 2021, reaching USD 1.7 trillion (from USD 810 billion the previous year). The green debt market has gradually snowballed, from a relatively slow start at its inception to an impressive average growth rate of 67% over the last five years. Reaching annual green debt issuance equivalent to USD 1 trillion has long been viewed as a milestone for green finance. It was first cited as a target for annual green investment at the 2016 United Nations Climate

9 Though the results in Table 1 are not to be interpreted as causal effects, they are consistent with causality in both directions, with banks with strong balance sheets more likely to fund efforts to reduce their borrowers' carbon footprint.

Change Conference (COP22), and there have been repeated calls for policymakers, investors and issuers to support its achievement. Hitting this milestone at the start of the decade is a clear sign that capital is being shifted towards climate solutions at scale, as the world races against the clock. Nevertheless, the current growth trajectory is still below the annual investment needed to achieve net-zero emissions by 2050.

Figure 25
ESG debt issued by European entities (USD billion)**, by debt and issuer type**



Source: EIB staff estimates and Bloomberg.

Environmental, social and governance debt issuance by European entities also continued to rise, reaching USD 642 billion in 2021 (from USD 348 billion the previous year), an 84% increase (Figure 25). Over the last five years, ESG debt issuance in the European Union has grown by an average of 79% annually. Now, 36% of the world's ESG debt is issued by EU entities, compared with 25% half a decade ago. Among that debt issuance, green bonds remain the most important asset class by issuance volume,

followed by sustainability-linked loans and social bonds. For 2021, sustainability bonds increased the most, followed by sustainability-linked loans and green bonds, signalling the growing relative importance of sustainability bonds and loans in ESG issuance in the European Union.

Social bonds continued to rise in 2021, but to a lesser degree than the previous year. Pressure from the pandemic on healthcare and welfare systems eased as COVID-19 vaccinations increased. The significant increase recorded in sustainability-linked bonds was mainly driven by non-financial firms, and sustainability-linked bonds constituted 20% of non-financial firms' ESG issuance in 2021 (vs. 6% the previous year). Financial firms and national governments prefer to issue green and social bonds, while non-financial firms mostly issue sustainability-linked loans and bonds.

Uncertainty over the global economic outlook caused by rising inflation and the impact of the Ukraine war is expected to weigh on green bond issuance in 2022. International investors are faced with significant uncertainty, as most central banks are hiking interest rates to tame inflationary pressures, and financing costs for green bond issuers are rising. The high-quality of green debt makes it more sensitive to changes in interest rates, hampering bond returns and issuance.

Green bond issuance has soared in recent years, but demand continues to outstrip supply. The strong demand is reflected in the premium paid for green bonds, with green bonds offering a lower yield than non-green bonds. For government bonds, the green premium is estimated to be anywhere from 2 to 9 basis points. Most green government bonds now trade at lower yields compared to conventional debt than when they were first issued, while more recently issued long-dated bonds trade closer to conventional debt (Standard and Poor's, 2021). Supply explains part of the difference. Newer bonds, those issued in 2022, tend to have longer maturities, with recent issuers. In corporate bond markets generally, green premium estimates vary from 0 to 25 basis points (around 5 basis points on average).

Green premiums paid for corporate debt depend on the debt's maturity (Neuberger, 2021). Based on euro-denominated corporate debt issuances completed in 2020 and 2021, the median green premium to date is 2 basis points (it can be much higher depending on the when the debt was issued). Similar levels of green premiums are reported by other studies. IHS Markit reported a modest green premium of around 2 basis points for euro-denominated senior corporate bonds that were investment grade. That premium was more pronounced, around 3 basis points, when compared to the narrower iBoxx EUR Green Bonds Select Index (IHS Markit, 2021). Due to the lack of high-yielding securities within green bond indices, like the Bloomberg MSCI Green Bond Index, higher-yielding, lower-rated bonds tend to have significantly higher premiums — more than 10 basis points (Natixis, 2021).

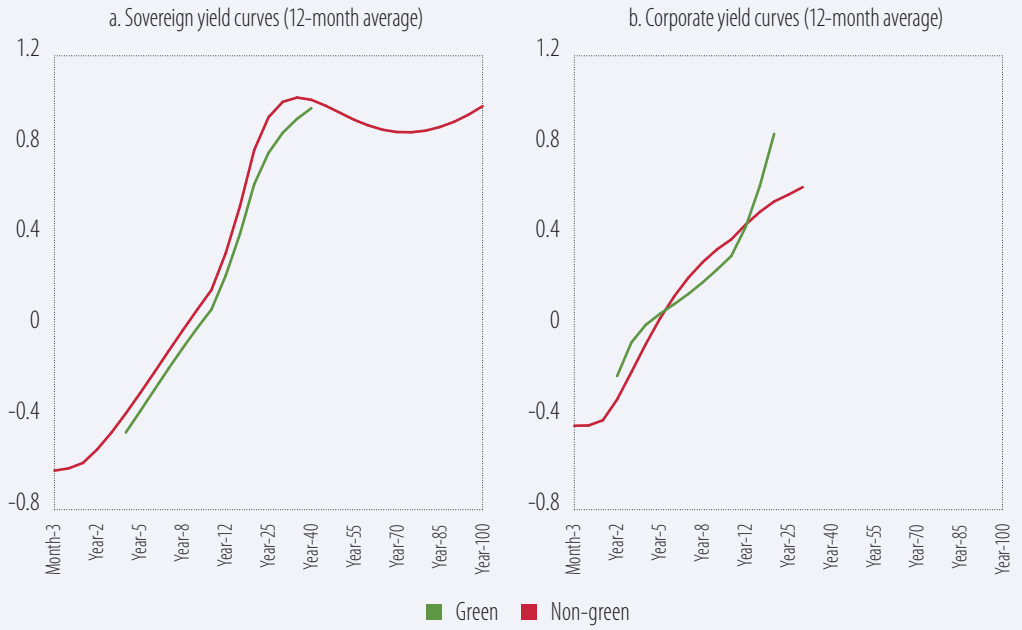
Box C

Sovereign debt attracts a higher green premium than corporate debt

This analysis examines the existence of a green premium on the secondary market, looking at bonds issued in recent years by governments and firms. All euro-denominated, bullet, fixed-coupon and investment grade bonds issued over the last two years by EU governments and firms are split into two groups. The first is the green group, which includes bonds bearing Bloomberg's Green Bond instrument indicator (net proceeds go towards green projects and activities that promote climate change mitigation or adaptation, or other environmental sustainability purposes). The second group is the non-green group, which includes bonds without the green bond instrument indicator. For each of the two groups, a yield curve is fitted for the daily yields using the Nelson-Siegel method to construct a parametric term structure of interest rates.[10] A pair of green/non-green yield curves is calculated for EU governments, and another pair for EU firms. Both pairs of curves are shown in Figure C.1.

10 The method is based on Nelson and Siegel (1987). It uses a long-term yield rate, curve slope, curvature and time-decay factors to generate a standard best-fit model that is widely used in academia and by central banks to calculate yield curve constant maturity points.

Figure C.1
Yield curves (in %)**, by institutional sector**



Source: EIB staff estimates and Bloomberg.

For EU government debt, the green premium is found across the yield curve, while it is more pronounced towards the long end of the yield curve at 30-year tenors. For EU government debt, the green premium averages 10 basis points, and 6 basis points for firms. This finding confirms similar findings in the available literature, where sovereign green bonds have lower interest rates than their non-green peers (ING, 2021). While the existence of a green premium is confirmed for EU corporate bond issues, the premium is only evident for maturities of 5 to 10 years (Natixis, 2021). Comparing green yield curves between EU governments and firms, it becomes clear that the maximum tenor of green bonds is higher for government debt than for firms (as is also the case for non-green bonds).

Conclusion and policy implications

The energy crisis has laid bare Europe's dependency on Russia and on fossil fuels. Volatile energy markets have pushed energy prices to multi-year highs, and they are unlikely to return to stable low levels. Europe needs to fully replenish gas stores before the winter of 2024 to be able to effectively fend off another crisis, if one emerges. Governments, regulators, energy suppliers and consumers will have to cooperate closely to optimise their access to scarce energy resources and avoid rationing. Unfavourable weather conditions — a persistent element of uncertainty — and infrastructure bottlenecks could arise and strongly impact energy consumption, potentially disrupting economic activity and social cohesion.

Although this energy crisis is being felt throughout Europe, the intensity of the shock and the degree of resilience to it differ across EU members, reflecting the fragmented state of the energy market. Stark differences in domestic electricity and gas prices among EU countries pre-date the energy crisis. Differences in the domestic mix of fuels and in the policies applied to energy producers and network operators are to blame. Domestic conditions may also differ across countries, such as market openness and strategies to diversify imports. More generally, diverging trends in electricity and gas prices across Europe signal that energy systems are vulnerable to systemic shocks and lack resilience (caused, in part, by insufficient integration).

While the energy shock calls for governments to act to protect industries and households in the short term, it is crucial that governments preserve and strengthen incentives for a greener, more efficient and better integrated energy market. Firms show an appetite for investing in the green transition and adapting to changing environmental conditions. More than half of firms are already investing in climate action, with 88% taking steps to reduce their carbon footprint, while one-third have developed or invested in measures that help build resilience to physical climate risks. The high cost of energy is driving corporate climate investment, enhancing firms' energy efficiency and increasing their investment in renewables. At the same time uncertainty, decelerating growth and tightening financing conditions are pushing companies to invest less.

Supporting firms' investment requires a combination of policies that reduce uncertainty. EIBIS findings underscore that reducing uncertainty is crucial, including policy and regulatory uncertainty concerning decarbonisation. Here, instruments that reduce financial risk and protect investors could be beneficial. Policies to manage the crisis in the short term should avoid measures that reduce incentives to invest in the green transition. Complementary relationships between public and private investment also play a role, as does pressure within different economics sectors or from regions.

This crisis should serve as a turning point towards a cleaner, more secure future in which European economies are well shielded from energy market turbulence. National and local governments, financiers and firms must all seize the opportunity presented by the energy crisis and make European energy systems more secure and climate resilient. The successful implementation of the REPowerEU plan — and the recent announcement of the tightening of Europe's goal of to reduce emissions 55% by 2030 — will lessen Europe's dependence on gas and bring the European Union one step closer to carbon neutrality. Structural reforms and the overhaul of existing energy pricing rules to accommodate cleaner electricity sources are under discussion, and these reforms could help bring competitively priced energy to consumers and ensure adequate revenues to finance the green transition. Fast-tracking the licensing of renewable energy projects, upgrading and reinforcing network infrastructures, establishing new industrial partnerships, greening supply chains with secure access to critical raw materials and targeted measures to ensure a fair transition are among the initiatives that policymakers should prioritise.

The financial sector has a role to play in the green transition and in tackling the crisis. Financiers' appetite for clean energy projects is gaining momentum, and they are putting innovative financial tools at the disposal of firms looking to roll out climate strategies. In addition to traditional bank loans, most companies now have a combination of instruments they can tap to fund their climate investments,

including green bonds and loans, sustainability bonds and social bonds. In recent years, green bonds, which can be issued by governments and businesses alike, have helped push down financing costs for companies' green investments. However, greenwashing remains a risk. Initiatives like the European Green Bond Standard should give investors greater clarity about which activities truly qualify as sustainable.

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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 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.

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 12 000 companies across the European Union 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 seventh wave in 2022, with interviews held between April and July 2022.

Using a stratified sampling methodology, the EIBIS General Module is representative of all 27 Member States of the European Union 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.

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.

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.
12 021	firms in the European Union participated in the last wave of the survey.
800	US firms participated in the last wave of the survey.
44%	of all firms participating in the last wave responded in at least two consecutive waves.
89%	of firms surveyed in 2022 agreed to be contacted again for next year's survey.

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.[1]

In an 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 Co-operation 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 Kingdom[2] 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]

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.

1 The EIBIS included the United Kingdom from 2016 to 2019. It has not covered the country since it left the European Union.

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.

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.

EIB Municipality Survey 2022

In 2022, the EIB Municipality Survey polled 750 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 2022. As part of the survey, 750 municipalities were interviewed in all 27 Member States, split across the following country groupings (regions).

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.

Regional and European Union-wide figures are weighted based on the urban population in each country to take size differences into account.

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

4 The Kolmogorov-Smirnov (KS) test is a non-parametric 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.

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 for firms that reflect 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 Organization (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), 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 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 match the EU taxonomy nomenclature: 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 2021. 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 more efficient models that are more expensive than conventional models. 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

Transport investments combine rail and inland waterways. The OECD International Transport Forum (ITF) collects data annually from its member countries as well as other key emerging economies including China, 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 cross-country comparisons. 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 gross domestic product (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 (ITF, 2013). Data are available from ITF/OECD until 2020 for most countries and is extrapolated to 2021 using a constant ratio to total gross fixed capital formation (GFCF) for both rail and inland waterway investments.

For the United States, the data sources have changed since 2004. The data cover 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 (GFCF) in forestry up to 2019 are available for the European Union. Data are extrapolated to 2021 assuming a constant ratio to total GFCF whenever data availability allows, or derived from GFCF and value added for the aggregate sector agriculture, forestry and fishing when forestry data are missing, preserving GFCF and value-added ratios between forestry and the aggregate sector. 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 and are available until at least 2020. 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 and are available until 2019. The data were made available in current prices in billions of euros rounded to the nearest hundred thousand. Missing data are extrapolated by assuming, for example, a constant R&D to GDP ratio or a constant share to total R&D by research and innovation priority.

Inflation and exchange rates

Data are presented in real 2021 EUR million. Source data are on different bases and the following procedures were used to convert them to real 2021 EUR million.

- IEA investment data

IEA investment data are in real 2021 USD billion. These were converted to real 2021 euros by applying the average 2021 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 2021=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 2021 euros using the applicable GDP deflators. The country-by-country deflators are derived from the Eurostat data and rebased to 2021=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.

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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.
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 (see "climate change adaptation").
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).
Advanced	Firms that have invested in advanced digital technologies but have not taken action to become more digital as a response to COVID-19.
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.
AMECO	The annual macroeconomic database of the European Commission's Directorate-General for Economic and Financial Affairs.
At-risk-of-poverty rate	The share of people with a net disposable income below the at-risk-of-poverty threshold, which is set at the 60% of the national median equivalised net disposable income.
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.
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.
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.
BNEF	Bloomberg New Energy Finance.
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.
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.
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.
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.
Contestable markets	Markets where the following conditions are satisfied
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.
Developed regions	EU NUTS 2 regions with gross domestic product (GDP) per capita above the EU27 average.
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	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.
Digital capability of municipalities	In the EIB Municipalities Survey, digital capability and sophistication comprises the integrity and protection of IT systems, provision of digital or online government services, assessment of adequacy of digital infrastructure, development or use of remote sensors, and staff working exclusively on digitalisation plans.
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.
EIB	European Investment Bank.
EIBIS	European Investment Bank Investment Survey.
EIF	European Investment Fund.
Energy intensity	Energy consumption divided by activity, such as energy/GDP.
ESG	Environmental, social and governance.
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.
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).
FDI	Foreign direct investment.
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.
GINI	The Gini coefficient, also known as the Gini index, is a measure of statistical dispersion intended to measure income or wealth inequality.
Global financial crisis	Refers to the worldwide financial crisis of 2007-2008.
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.
IEA	International Energy Agency.
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).

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 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.
Labour share	Wage bill divided by revenue.
Large companies	Firms with at least 250 employees.
Latency	The time it takes to 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).
M&A (merger and acquisition)	A business transaction in which the ownership of a company is transferred to or consolidated with another company.
Manufacturing	Based on NACE classification of economic activities, firms in group C (manufacturing).
Mark-up	The ratio of the cost of a good or service to its selling price, expressed as a percentage of the cost.
Medium-sized firms	Firms with 50 to 250 employees.

Micro firms	Firms with fewer than ten employees.
More developed regions	EU NUTS 2 regions with GDP per capita above 100% of the EU27 average.
MWh	Megawatt hour.
NACE	"Nomenclature statistique des activités économiques dans la Communauté européenne."
NATO	North Atlantic Treaty Organization.
Neither	Firms that have not invested in advanced digital technologies or in becoming digital as a response to COVID-19.
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 "Digital").
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.
Patent	Documents issued by an authorised agency, granting 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.
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.
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).
Platform technologies	Technologies that connect customers with businesses or customers with other customers.
Production processes	Processes related to actual production, for example machinery and equipment.

PSPP	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.
R&D	Research and development.
Recovery plan for Europe	The NextGenerationEU fund is a European Union economic recovery package to support EU Member States adversely affected by the coronavirus pandemic.
Recovery and Resilience Facility (RRF)	A large grant and loan facility offered by the European Union to its Member States. Part of the recovery plan for Europe.
Robot	Defined in the International Federation of Robotics' database as "automatically controlled, re-programmable and multipurpose machine."
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).
Small firms	Firms with ten to 49 employees.
Smart grids	Electricity supply networks that use digital communications technology to detect and react to local changes in usage.
SMEs	Small and medium-sized enterprises. Firms with fewer than 250 employees.
SMEsec	SME securitisation.
Social infrastructure	In the EIB Municipalities Survey, this comprises healthcare, care for the elderly, childcare, education and training, and 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.
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).
TLTROs	The targeted longer-term refinancing operations are Eurosystem operations that provide financing to credit institutions. By offering banks long-term funding on attractive conditions they preserve favourable borrowing conditions for banks and stimulate bank lending to the real economy.
Total factor productivity	The efficiency in combining production factors to create added value.
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.
Transport infrastructure	In the EIB Municipalities Survey, this comprises footpaths and cycling lanes, intra-urban public, inter-urban and urban-rural transport connectivity, and charging stations for electric vehicles.
UK	United Kingdom.
UNFCCC	United Nations Framework Convention on Climate Change.
US	The United States of America.
VAT	Value added tax.
VC	Venture capital. A type of private equity focused on startup companies with high growth potential.
Western and Northern Europe	Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, the Netherlands and Sweden.

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