CHAPTER 7

A FERTILE ENVIRONMENT FOR R&I

CHAPTER 7.1

ACCESS TO FINANCE: THE IMPORTANCE OF EQUITY AND VENTURE CAPITAL

KEY FIGURES

€62.4 billion
of private-equity investments in the EU in 2020

€8.5 billion
of venture-capital investments in the EU in 2020

7 times
more venture-capital capital funding in the US than the EU

1.1 %
of capital raised in the EU venture-capital market captured by EU women-led tech-companies

KEY QUESTIONS WE ARE ADDRESSING

- What are the main challenges faced by EU enterprises in financing their innovation activities?
- How did the EU private-equity (PE) and venture-capital (VC) markets respond to the COVID-19 crisis?
- How big is the gender financing gap in the EU?
- What are the latest trends in the diffusion of alternative financing instruments, FinTech and green technologies in the EU?

KEY MESSAGES

What did we learn?

- The EU financing system continues to be strongly bank-dependent and equity investments still play a relatively minor role.
- Intangible assets are more effectively financed by non-bank financing, given the difficulties in using them as collateral for bank lending
- EU VC investments were only marginally hit by the COVID-19 crisis.
- Nevertheless, the EU still struggles to attract more risk-taking and more patient investments, especially at the scale-up stage.
- Digital finance activities are becoming increasingly popular in the EU, and investments in FinTech and green technologies have expanded over time.
- The EU VC market is characterised by a significant gender gap.

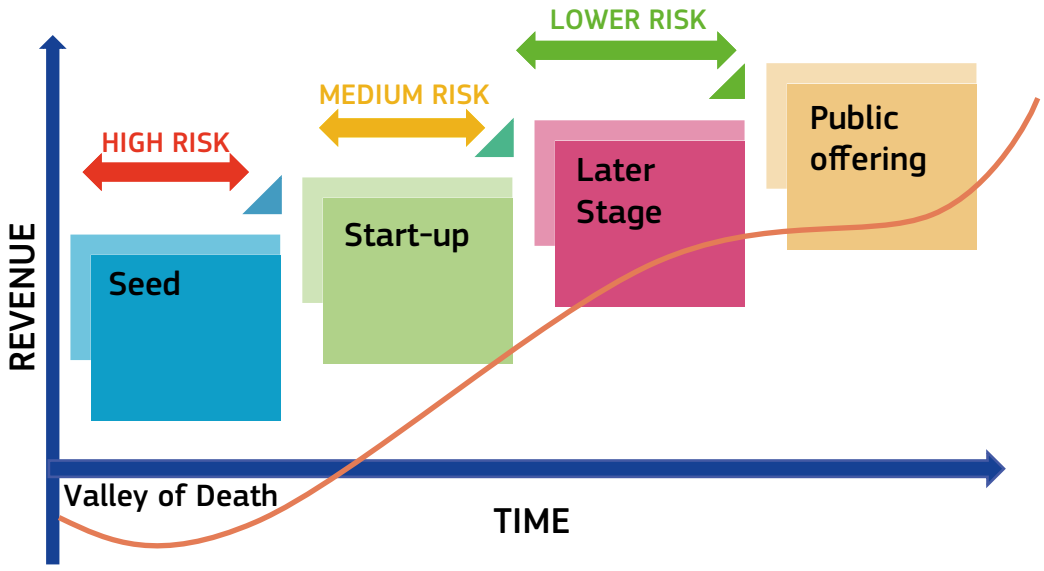
What does it mean for policy?

- Switching to a green and digital economy requires a significant amount of financing. Further progress in the EU capital markets union would particularly benefit innovative firms operating in intangible-intensive sectors. New financing tools also need to be targeted towards more innovative EU businesses, while ensuring coherence with the existing financial instruments available to EU firms.
- Integrating sustainability criteria into business financing is essential to the decarbonisation of the economy.
- The increasing financing opportunities from online finance must be balanced by policies to reduce the fragmentation of the Digital Single Market and to facilitate digital innovation, while ensuring consumer protection.
- Providing financial support to women in innovation and entrepreneurship is essential to create fair, inclusive and prosperous European R&I ecosystems.

Financing innovation is particularly challenging. First, the output from innovation activities has public-good properties and is partly non-rival and non-excludable, i.e. other economic actors can benefit without paying for it (Hahn et al., 2019). As a result, the risk of not being able to reap the full return of innovation investments may discourage firms from allocating resources to R&D spending. Second, innovation activities typically result in the production of technological knowledge, which is a non-tangible asset. As such, it cannot be easily deployed or sold (Hall and Lerner, 2010). In addition, innovation projects are typically riskier as they can lead to both positive and negative outcomes (Hahn et al., 2019). The uncertainty naturally embedded in innovation activities typically leads to financial frictions that limit the ability of firms to secure financial resources from external investors (Hall et al., 2016).

It is possible to distinguish four financing stages along a firm's development path: seed financing, start-up, later-stage development and public offering. Seed financing is required at the preliminary stage of a company's development process, before the firm becomes commercially viable. Funding at this stage is typically used to finalise product definition or product design. Investments at seed stage are thus highly risky and accompanied by negative cash flows (Invest Europe, 2021). This phase represents the most delicate moment in a company's path to growth and is typically referred to as the 'valley of death'. The start-up stage (or early stage) refers to businesses that are about to start the commercialisation of their products. In this case, financial resources are typically used to cover capital expenditure. Later-stage investments usually target fully operating companies, which can also decide to go public to raise additional funding on the stock market (Figure 7.1-1).

Figure 7.1-1: Venture Capital Investment Cycle



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit

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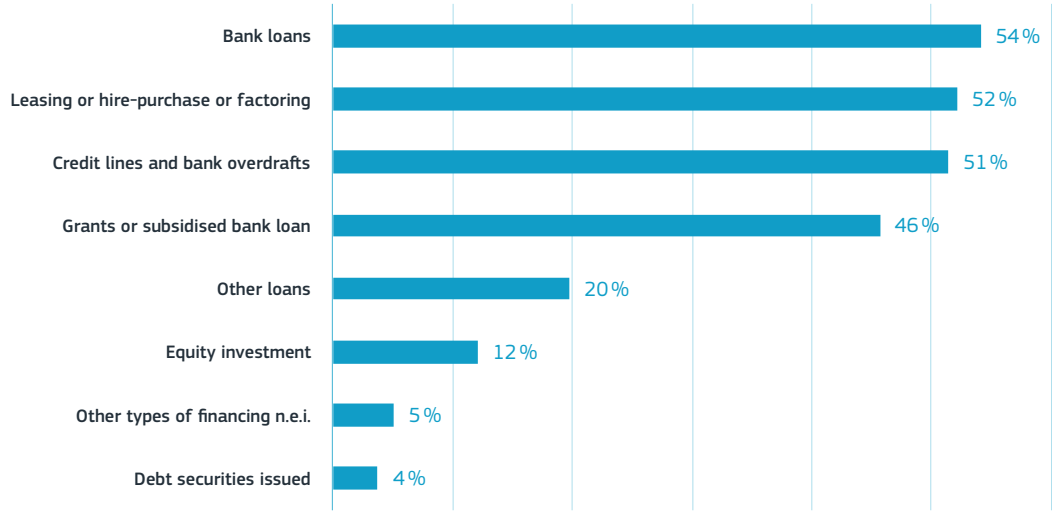
The short-term character of traditional financing systems is an important constraint on innovation investment. As noted by Mazzuccato (2016), the declining trend in innovation investment observed in Western countries in recent decades can be partially attributed to the increase in short-term investment in the private sector. Patience is a key ingredient in innovation investments as innovative activities typically take time to deploy their results, in terms of both market products and financial returns. The lack of 'patient capital' (long-term investment) represents an important constraint on financing innovation (Mazzuccato, 2016).

1. The EU private-equity and venture-capital market

The financing of EU companies remains strongly bank-driven. As reported in Figure 7.1-2, traditional bank products, such as loans, credit lines and bank overdrafts, continue to represent the most relevant sources of external finance for European enterprises. Alternative external resources such as equity investment play a moderate role (12%), but remain critical to helping firms facing specific financial needs and challenges. The availability of new sources of financing is particularly beneficial for innovative start-ups with significant intangible assets as it supports them to boost their performance. This is highly relevant in the context of the twin transition, for which new financing instruments are becoming increasingly popular.

Figure 7.1-2: **Share of relevant external sources of finance for enterprises in the euro area, 2020**

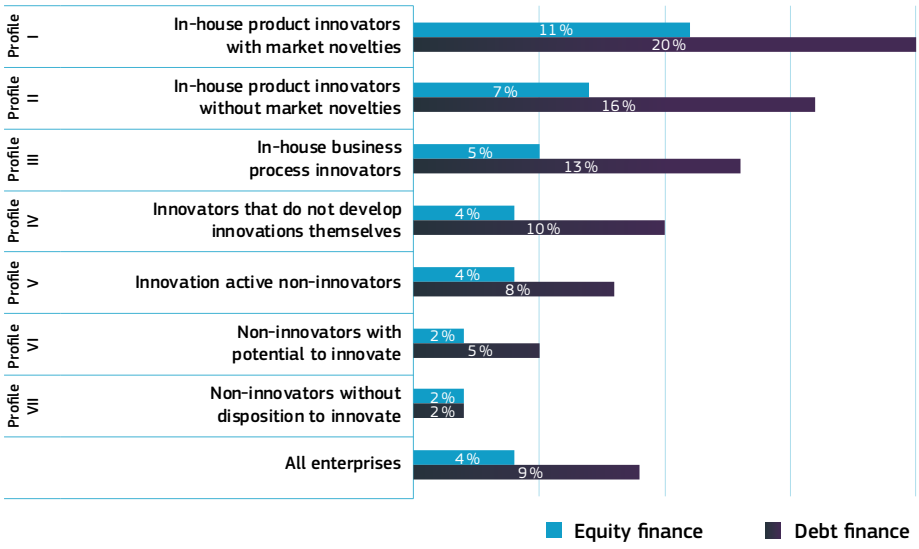


Science, Research and Innovation Performance of the EU 2022

Source: ECB, SAFE survey (2021)
Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-2.xlsx

Furthermore, EU firms prefer to rely on internal resources (e.g. retained earnings) to finance their innovation activities. When looking at the financial behaviour of innovative firms, it is possible to distinguish seven different innovation profiles[1], based on the conditions that allow innovation to occur within the different businesses (see Chapter 6.3 – Innovation output, and societal and market uptake). For each identified profile, the use of external financing sources (either debt or equity finance) appears to be very limited (Figure 7.1-3). **On average, EU firms make more use of debt finance to finance their innovation activities** (9% against the 4% using equity finance). Equity finance is mostly used by enterprises identified as product innovators, namely enterprises identified as in-house product innovators with market novelties (profile I) (Figure 7.1-3). This is partially due to the fact that innovative firms are typically active in intangible-intensive sectors, and non-tangible assets are difficult to pledge as collateral for bank lending (Demmou and Franco, 2021).

Figure 7.1-3: Use of equity and debt finance by innovation profile(1), 2016-2018



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit, based on Community Innovation Survey (CIS).

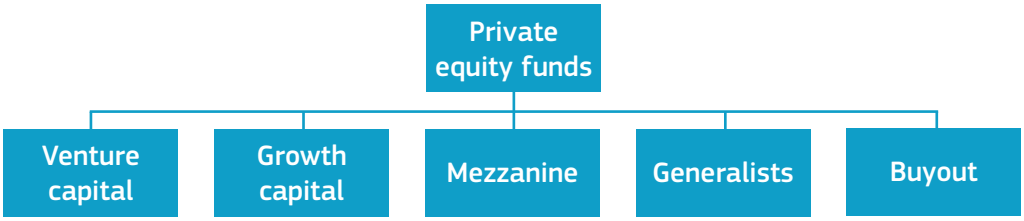
Note: (1)Based on 20 EU Member States for Equity finance and 19 EU Member States for Debt finance.

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-3.xlsx

1 I: In-house product innovators with market novelties, including all enterprises that introduced a product innovation that was developed by the enterprise and that was not previously offered by competitors; II: in-house product innovators without market novelties, including all enterprises that introduced a product innovation that was developed by the enterprise but that is only new to the enterprise itself; III: in-house business-process innovators, including all enterprises that did not introduce a product innovation, but that did introduce a business-process innovation that was developed by the enterprise; IV: innovators that do not develop innovations themselves, including all enterprises that introduced an innovation of any kind but did not develop it themselves (enterprises without significant own-innovation capabilities); V: innovation-active non-innovators, including all enterprises that did not introduce any innovation but that either had ongoing or abandoned innovation activities; VI: non-innovators with potential to innovate, including all enterprises that did not introduce any innovation, and which had no ongoing or abandoned innovation activities but that did consider to innovate; VII: non-innovators without disposition to innovate, including all other enterprises, that neither introduced an innovation nor had any ongoing or abandoned innovation activities nor considered innovating.

Equity investments are critical for innovative start-ups to grow, and act at different stages of a firm's development path (Figure 7.1-4). VC funds focus on firms in their earlier stages of development, while generalist funds use selection criteria other than the firm's stage of development. Growth funds make PE investments in relatively mature companies looking for primary capital to expand or to enter new markets, while buyout funds are typically related to acquisitions of firms through the purchase of majority or controlling stakes. Mezzanine funds are hybrid funds that rely on both debt and equity financing (Invest Europe, 2021).

Figure 7.1-4: **The components of private-equity capital**



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit, based on Invest Europe definitions

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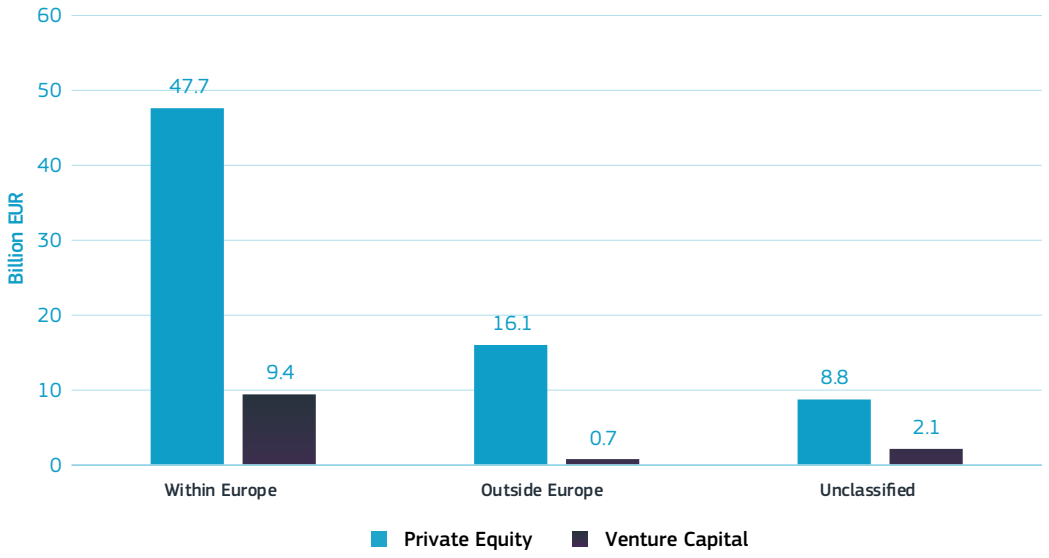
The largest share of PE funds raised by EU companies comes from investors within Europe. In 2021, EUR 72.6 billion[2] of PE funds were raised in the EU (Invest Europe, 2021). Over 68 % of the resources came from funds within Europe (EUR 47.7 billion), whereas EUR 16.1 billion were raised from outside Europe (Figure 7.1-5). The same trend is observed for VC funds, suggesting that non-European VC funds typically decide to invest elsewhere.

In 2020, PE investments in EU portfolio companies experienced a mild contraction before increasing again in 2021. In 2021, PE investments in EU portfolio companies experienced a significant increase, after the mild contraction reported in 2020. Investments from PE funds located all over the world (including Europe) into portfolio companies based in the EU increased by about 41 % between 2020 and 2021, from EUR 64.3 billion to EUR 90.8 billion (Figure 7.1-6).

The number of EU firms receiving PE investments is not homogeneous across sectors. The ICT sectors accounted for the largest share of firms, with over 2 500 companies receiving PE financing in 2021, and total investment of almost EUR 28.8 billion. Firms operating in the consumer goods and services segment follow, with over 1 200 financed companies and total investment standing at EUR 18.4 billion (Invest Europe, 2022). Biotech and healthcare firms rank third in terms of number of firms receiving PE financing, and total amount of investment received (999 firms and EUR 13.7 billion, respectively).

2 The data refers to the incremental amount raised over the year.

Figure 7.1-5: Private Equity funds raised in the EU in 2021, by geographical origin

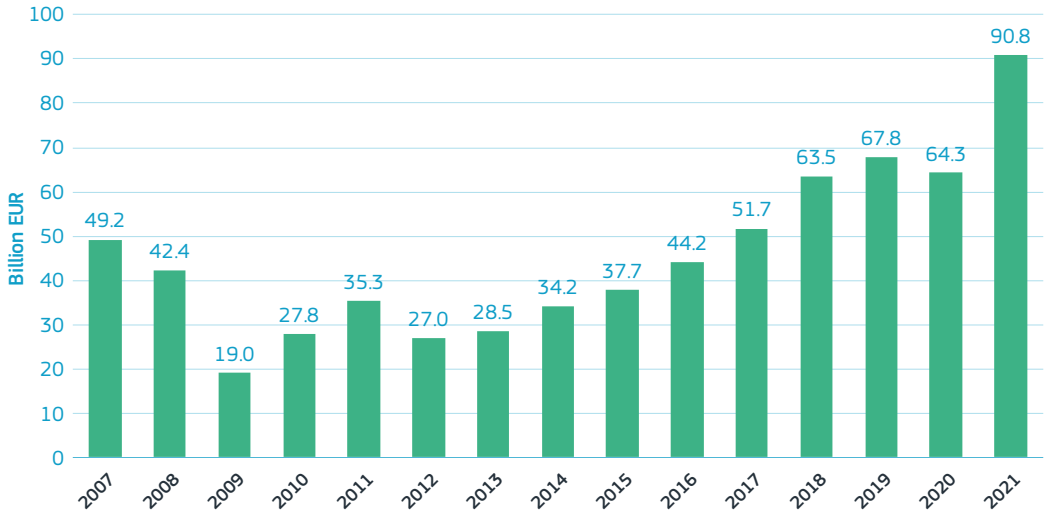


Science, Research and Innovation Performance of the EU 2022

Source: Invest Europe, 2022

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-5.xlsx

Figure 7.1-6: Private-equity investments(1) in EU portfolio companies, 2007-2021



Science, Research and Innovation Performance of the EU 2022

Source: Invest Europe, 2022

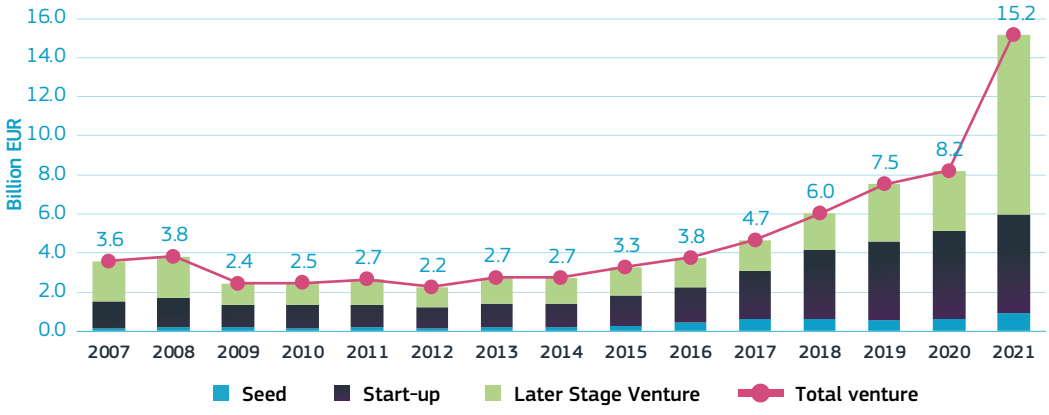
Note: (1)Data are measured following the market statistics approach, an aggregation of the figures according to the country in which the investee company is based, regardless of the location of the PE fund. At the European level, this relates to investments in European companies regardless of the location of the PE firm.

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-6.xlsx

VC is a type of PE investment focusing on start-up companies with high growth potential (Flachenecker, 2020). VC support is not limited to the provision of financial resources but may include non-financial support such as management advice, technical assistance, networking and expertise (Testa et al., 2022). The latter aspect is particularly relevant for technological start-ups, such as those operating in the AI and blockchain sectors, which are typically considered to be very complex by potential investors (Testa et al., 2022).

VC investments in the EU increased from 2013 onwards, with investments in later-stage ventures accounting for the largest increase between 2019 and 2021. In 2021, VC investments almost doubled as compared to 2020 and reached about EUR 15.2 billion. Differences are observed across different development stages. VC capital financing targeting firms at the seed stage[3] slightly increased after having remained more or less stable between 2017 and 2020. Financing allocated to later-stage[4] ventures increased considerably, rising from EUR 2.9 billion to EUR 9.2 billion between 2019 and 2021. Investments in start-up stage ventures also recorded a positive performance, increasing from EUR 4 billion to EUR 5 billion over the same period (Figure 7.1-7).

Figure 7.1-7: Venture capital investments(1) in the EU by development stage, 2007-2021



Science, Research and Innovation Performance of the EU 2022

Source: Invest Europe, 2022

Note: (1)Data are measured following the market statistics approach, an aggregation of the figures according to the country in which the investee company is based, regardless of the location of the PE fund. At the European level, this relates to investments in European companies regardless of the location of the PE firm.

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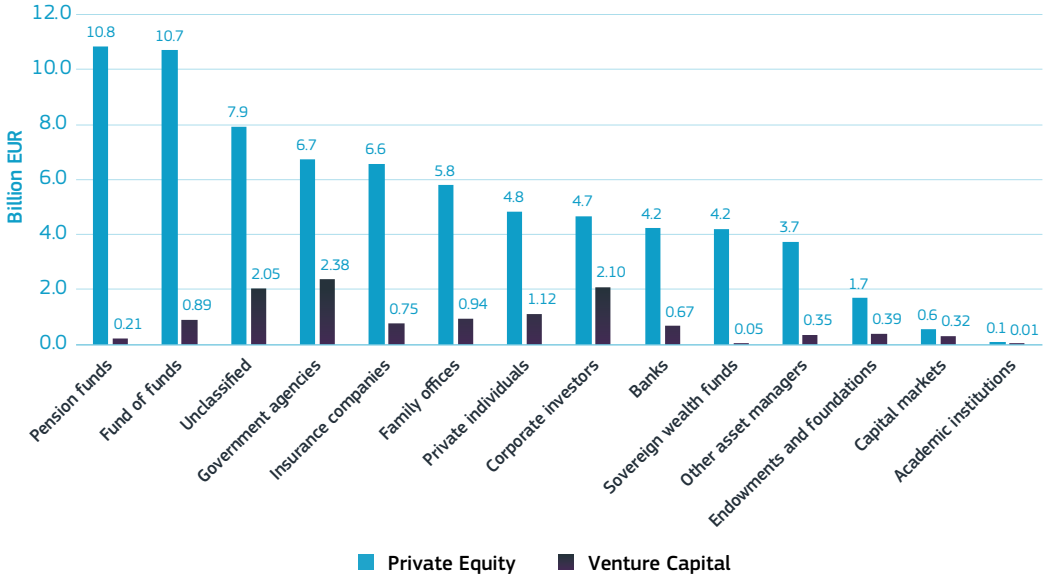
3 Funding provided before the investee company has started mass production/distribution with the aim to complete research, product definition or product design, also including market tests and creating prototypes. This funding will not be used to start mass production/distribution.

4 Financing provided for an operating company, which may or may not be profitable. Late-stage venture financing tends to be financing into companies already backed by VCs, typically in C or D rounds.

Nevertheless, large institutional investors continue to avoid riskier investments in the EU. Pension funds and insurance companies represent an important player in the EU VC landscape, although their involvement in European VC remains highly underdeveloped (Kraemer-Eis, et al., 2021). Pension funds in European ventures account for less than 0.018% of their total assets (Atomico, 2021), and in 2021 capital raised from pension funds and insurance companies accounted only for about 7.9% of the total VC funds raised in the EU in 2021. In contrast, VC raised from government agencies in the EU increased significantly between 2019 and 2020. In 2020, capital raised by governments accounted for about 31% of total VC funding in the EU (Invest Europe, 2021). In 2021, VC capital raised from government agencies still accounted for the largest share of total VC funds raised in the EU (about 19.4%, approximately EUR 2.4 billion), although reporting a decrease compared to the 2020 levels.

VC in the EU is mainly concentrated in a few EU Member States that are either 'innovation leaders' or 'strong innovators' as classified in the European Innovation Scoreboard. VC investors are often regional actors (Kraemer-Eis et al., 2016) or appear to focus only on some European regions and countries, thereby limiting the capacity of raising capital from across the entire EU. As shown in Figure 7.1-9(a), most VC investments are concentrated in a few EU countries, such as Germany and France (approximately EUR 3.8 billion and EUR 3 billion, respectively), which altogether received about 46% of VC financing in 2021. The Netherlands and Spain rank third and fourth in terms of absolute amount of VC investments received, with about EUR 1.8 billion and EUR 1.3 billion, respectively. The rest of the EU countries received a significantly lower proportion of VC financing, pooling together about EUR 4.1 billion, (approximately 27% of the overall VC resources directed to EU companies). When considering countries' economic size, VC investments represent only a tiny percentage (< 0.5%) of EU Member States' GDP (Figure 7.1-9(b)).

Figure 7.1-8: Private Equity and Venture Capital Funds raised in Europe in 2021, by investor type



Source: Invest Europe, 2022

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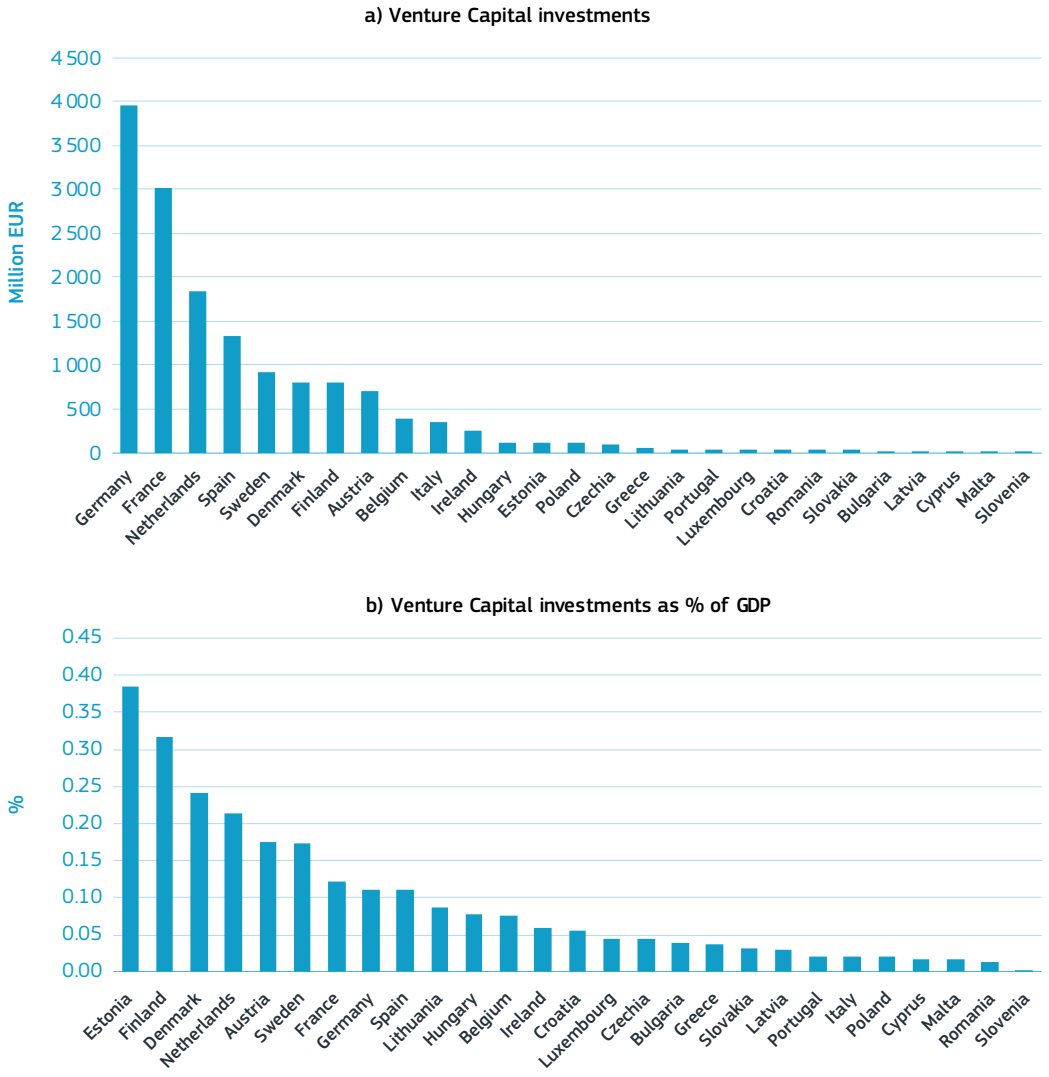
Figure 7.1-9: Venture Capital investments[1] in EU Member States in million EUR and as % of GDP, 2021



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit, based on Invest Europe, 2021, and Eurostat (online data code: nama_10_gdp)

Note: [1]Data are measured following the market statistics approach, an aggregation of the figures according to the country in which the investee company is based, regardless of the location of the private equity fund. At the EU level, this relates to investments in EU companies regardless of the location of the private equity firm; Data for MT not available.

[2]Other includes SK, SI, HR, LT, LV, EE, EL, CZ, RO, BG.

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The overall positive trend registered between 2019 and 2020 suggests that VC investments were not significantly disrupted by the COVID-19 crisis. In 2020, VC investments stood at EUR 8.2 billion, recording a 9% increase compared to 2019 values (EUR 7.5 billion) (Invest Europe, 2022). The EU VC market has survived the COVID-19

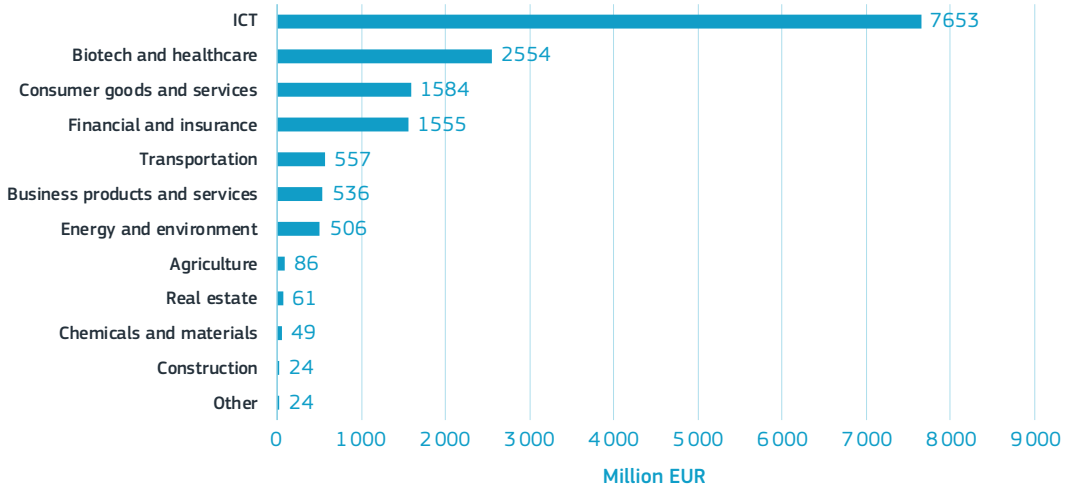
pandemic without major disruptions, showing a significant degree of resilience. As noted by Kraemer-Eis et al. (2021), the set of public support measures issued in reaction to the pandemic played a key role in maintaining such a good performance, preventing the EU VC industry from experiencing serious damage.

Furthermore, EU VC investments appear to be concentrated in specific sectors. VC investments are strongly concentrated in the ICT sector, which accounted for about 50% (EUR 7.6 billion) of the total VC financing received by EU companies in 2021. The biotech and healthcare sector followed with EUR 2.5 billion, while firms in the consumer goods and services segment received EUR 1.5 billion (Figure 7.1-10). Finance and insurance ranked fourth with EUR 1.5 billion. More traditional sectors are less targeted by VC investors.

The sectorial concentration of VC investments helps to explain why the VC market was not significantly disrupted by the pandemic. The sectors most targeted by VC investors (such as the ICT sector) were also not significantly hit by the pandemic. Homogeneous effects were observed across different stages of VC investment, as well as across different ages of companies receiving the funding. Notably, the only exception was the healthcare industry, which recorded a 77% increase in total volumes invested after the onset of the pandemic (Crisanti et al., 2021).

VC investments mostly focus on SMEs. As noted by Bellucci et al. (2021), the median profile of firms receiving VC investments are typically SMEs with between 8 and 15 employees. It follows that this type of firm is most likely to be affected by policies to incentivise VC financing in the market (Bellucci et al., 2021). Furthermore, Bellucci et al. (2021) provide evi-

Figure 7.1-10: Venture capital investments[(1)] in the EU per sector, 2021



Source: Invest Europe, 2021

Note: [(1)]Data are measured following the market statistics approach, an aggregation of the figures according to the country in which the investee company is based, regardless of the location of the private equity fund. At the EU level, this relates to investments in EU companies regardless of the location of the private equity firm.

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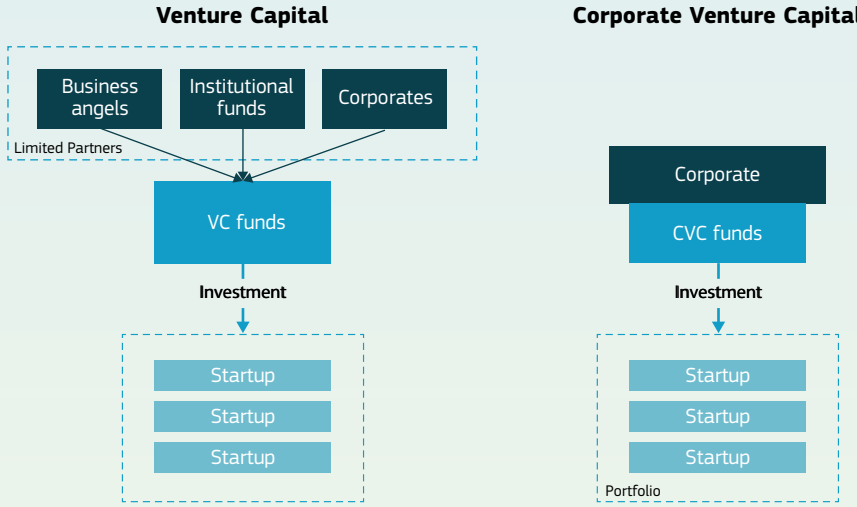
dence of a correlation between the size and financial maturity of firms. They find that VC instruments such as accelerators, business angels and VC seed investments are typically directed towards micro-enterprises, which have less than 10 employees and less than EUR 2 million in total assets. Later-stage VC investments typically target small enterprises, as defined by the European Commission. In terms of age, 3-year-old firms turn out to be the main target of all VC-backed instruments (Bellucci et al., 2021).

Box 7.1-1: Corporate venture capital

Corporate venture capital (CVC) is becoming increasingly important in the global entrepreneurial financing landscape. Corporate venture funds are VC funds with only one limited partner, typically a company that fully owns the fund and wishes to invest in start-up companies (Figure 7.1-11)[5]. The ability of CVCs to foster innovation is an established fact in the economic literature. Chemmanur et al. (2014) focus on the patenting outcomes of firms receiving VC financing, finding that CVC-backed firms are typically more innovative than independent venture capital (IVC)-backed companies. Napp and Minshall (2011) show that CVC activities produce beneficial effects on both start-ups and large companies targeted by the investment. Such beneficial effects are not only limited to the availability of financial resources, but are also linked to technical expertise that corporate investors can provide as well as the

Figure 7.1-11: Venture capital vs corporate venture capital



Science, Research and Innovation Performance of the EU 2022

Source: https://techmind.vc/en/corporate-venture-capital-vs-venture-capital-whats-the-difference/
Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-11.xlsx

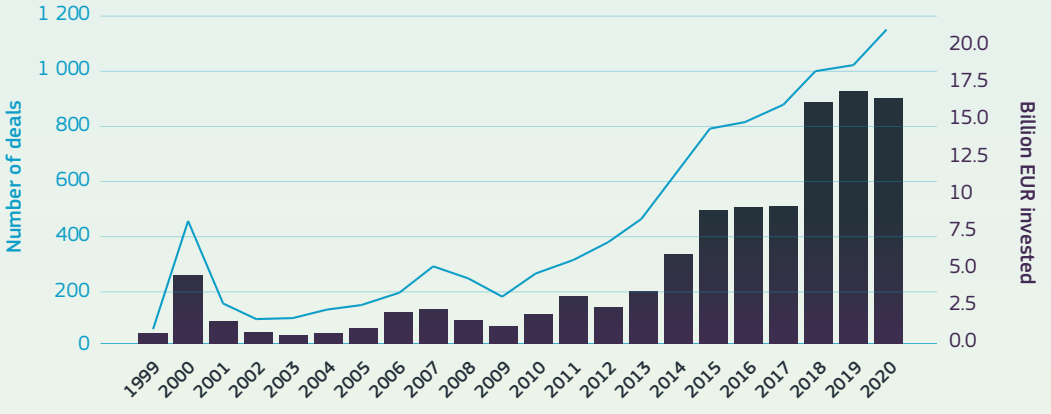
5 Corporate venture capital vs venture capital, what's the difference? (techmind.vc)

possibility of gaining access to complementary technologies that can boost firms' productivity and growth (Flachenecker et al., 2020).

A significant share of CVC targeting start-ups and scale-ups comes from top global R&D investors[6]. In the last two decades, CVC investments by top R&D investors showed an overall upward trend, with few slowdowns (Figure 7.1-12). According to the 2021 EU Industrial R&D Investment Scoreboard, 62 % of the 2 500 companies covered by the analysis invested in start-ups and scale-ups at least once over 2000-2020. In 2019, 22 % of the companies closed at least one start-up deal. Interestingly, most of these companies are placed very high in the scoreboard ranking, with 55 % being in the top 20 % in terms of global R&D. This result suggests that CVC investments play a strategic role in top-innovator companies. As noted by Grassano et al. (2021), investments in start-ups serve different objectives: on the one hand, they complement a company's internal innovation capabilities, helping to address potential internal weaknesses; on the other hand, CVC investments constitute an important part of a company's strategy as they allow the company to rely on and exploit external knowledge, rather than develop it internally.

Significant differences exist in the regional distribution of CVC investments worldwide. US and Japanese top R&D companies account for the highest share of CVC investments (EUR 9.7 billion and EUR 3.0 billion, respectively), and significantly outperform EU companies. In 2019, the latter made investments in start-up companies to a value of around EUR 1 billion. Such a difference reflects the fact that the VC culture is more developed in other parts of the world than in Europe, and is also related to significant sectoral differences. When compared to other economies, such as the US, the EU has a significantly lower number of companies operating in sectors that typically attract the largest share of CVC investments, such as ICT, financial services and the health sector (Grassano et al., 2021).

Figure 7.1-12: Number of deals (left-hand scale) and investment volume (right-hand scale) by R&D-investing companies and their subsidiaries, 1999-2020(1)



Science, Research and Innovation Performance of the EU 2022

Source: The 2021 EU Industrial R&D Investment Scoreboard

Note: (1)Funding data for 2020 not yet consolidated

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-12.xlsx

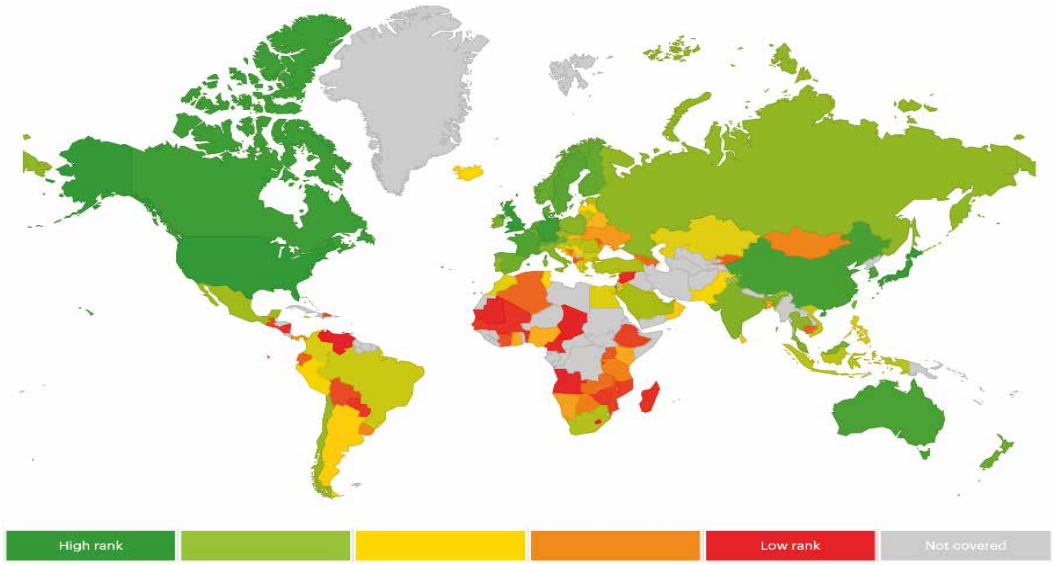
6 Defined following the EU Industrial R&D Investment Scoreboard definition, i.e. the 2 500 companies investing the largest sums in R&D in the world in 2020

2. The EU scale-up financing gap

The US is still the main magnet for investors at the global level, significantly outperforming the EU. According to the 2021 Venture Capital & Private Equity Country Attractiveness Index, the US still ranks first, with a score of 100, followed by the UK (90.3) and Japan (87.4). The EU continues to lag behind with an average score of 77.3.

EU capacity to attract investors is quite heterogeneous across Member States, confirming a significant degree of fragmentation within the EU VC market. Germany and France have the highest capacity to attract investors, with VC attractiveness scores of 87.3 and 83.6, respectively (Figure 7.1-14). The Netherlands, Sweden and Denmark also perform quite well in the EU ranking, with scores well above the EU average of 77.3. Southern countries and Eastern European countries attract investors less well, with scores below the EU average. Croatia, Latvia, Lithuania and Slovakia are among the Member States with the lowest performances, with scores ranging between 53.1 and 47.5.

Figure 7.1-13: **The venture capital and private equity country attractiveness index, 2021**

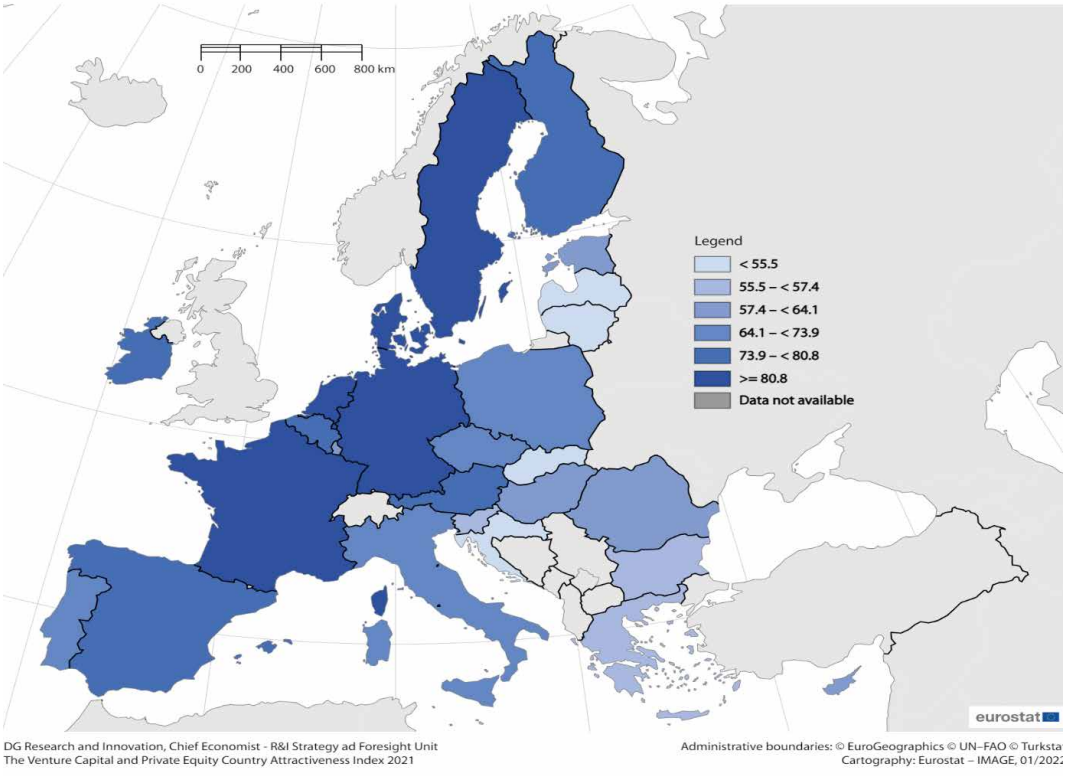


Science, Research and Innovation Performance of the EU 2022

Source: The Venture Capital & Private Equity Country Attractiveness Index, 2021

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-13.xlsx

Figure 7.1-14: The venture capital and private equity country attractiveness index per EU Member State, 2021



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit, based on the Venture Capital & Private Equity Country Attractiveness Index, 2021

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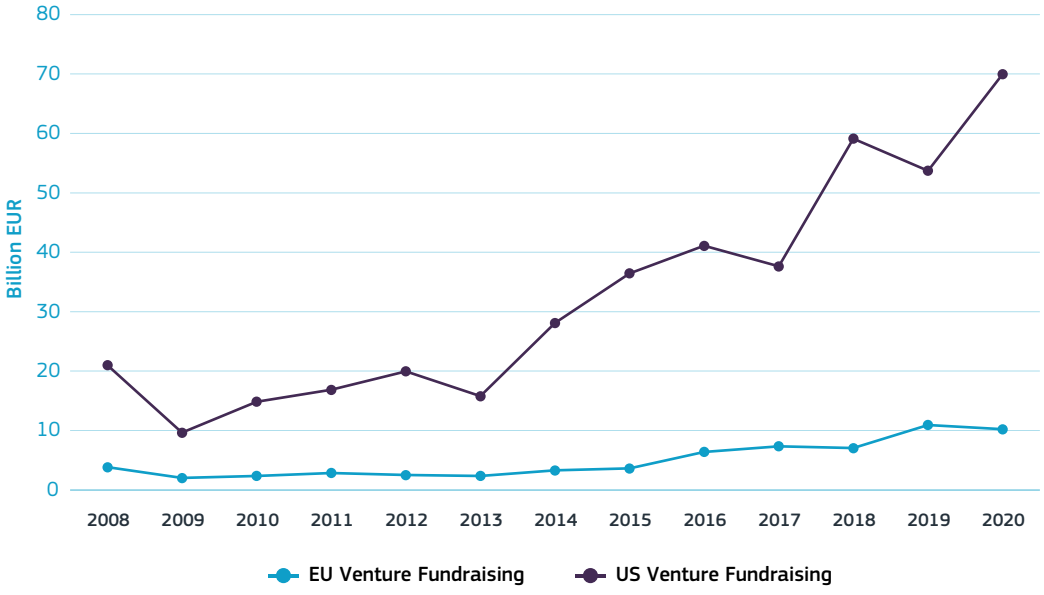
The EU suffers from a financing scale-up gap, and the EU VC market still lags behind its main international competitors. As noted by Kraemer-Eis et al. (2021), European firms have more limited access to financing resources compared to other economies. European start-ups encounter difficulties in surviving the initial stage of their development (see Chapter 4.2 – Business dynamism). The EU VC market significantly underperforms compared to both the US and China (Benedetti-Fasil et al., 2021; Quas et al., 2021).

In the US, almost seven times more VC funding is raised than in the EU. There is little to suggest that this gap will reduce in the near future. Even though funds raised in the EU have increased since 2013 and are currently above pre-crisis levels (rising from EUR 2.3 billion in 2013 to EUR 10.2 billion in 2020), venture funds raised in the United States have also risen from EUR 15.8 billion in 2013 to about EUR 70 billion in 2020 (Figure 7.1-15).

Figure 7.1-15: Venture funds raised in EU vs the United States, 2007-2020



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Source: Invest Europe, 2021

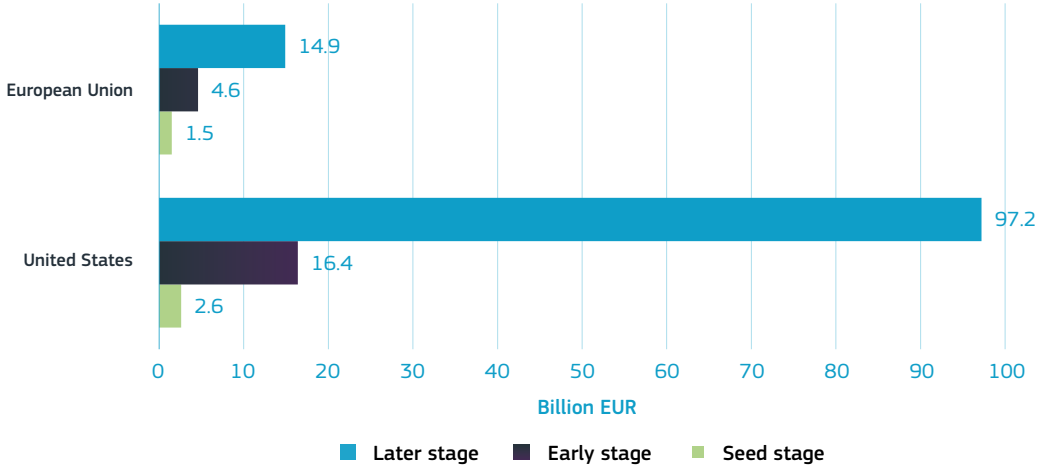
Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-15.xlsx

The financing gap between the US and the EU is particularly striking at the scale-up stage. As reported by Flachenecker et al. (2020), the lack of financial resources to support high-growth firms represents a significant obstacle to the development of a vibrant entrepreneurial system in the EU. Derufle et al. (2017) find that the average investments raised in the EU and the US significantly diverge at the scale-up phase, with US companies receiving on average significantly larger funds. Similarly, Kraemer-Eis and Lang (2017) provide evidence of the existence of an EU-US financing gap at all development stages of firms. As shown in Figure 7.1-16, the EU and the US diverge significantly, especially at the early and later stages of firms' development. The gap at the later stage is the highest, with VC investment levels in the US of EUR 97.2 billion vs EUR 14.9 billion in the EU[7]. At the early stage, US VC investments exceed EU investments by a factor of four, with EUR 16.4 billion and EUR 4.6 billion recorded respectively (Benedetti-Fasil et al., 2021).

Furthermore, a significant gap in late-stage financing exists between the EU and the US. In 2020, the number of funds above USD 100 million in the US was significantly higher than that reported in the EU. The US-EU gap is particularly striking for funds of larger size, namely above USD 250 million, for which the US outperforms the EU by a factor of more than five (Invest Europe, 2021). This signals that despite the increase in late-stage financing experienced by the EU in recent years, a persistent gap still exists as compared to the US.

7 Differences in the investment value reported for the EU across different figures are due to differences in data sources and data-aggregation procedures.

Figure 7.1-16: Venture Capital investments[1] in the EU vs the United States by development stage, 2020



Science, Research and Innovation Performance of the EU 2022

Source: Benedetti-Fasil et al. (2021), based on the Dealroom database

Note: [1]Investment values for each region and stage are calculated considering the headquarter country of the VC-backed company involved in the deal.

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-16.xlsx

Box 7.1-2: Addressing the lack of appropriate tax incentives

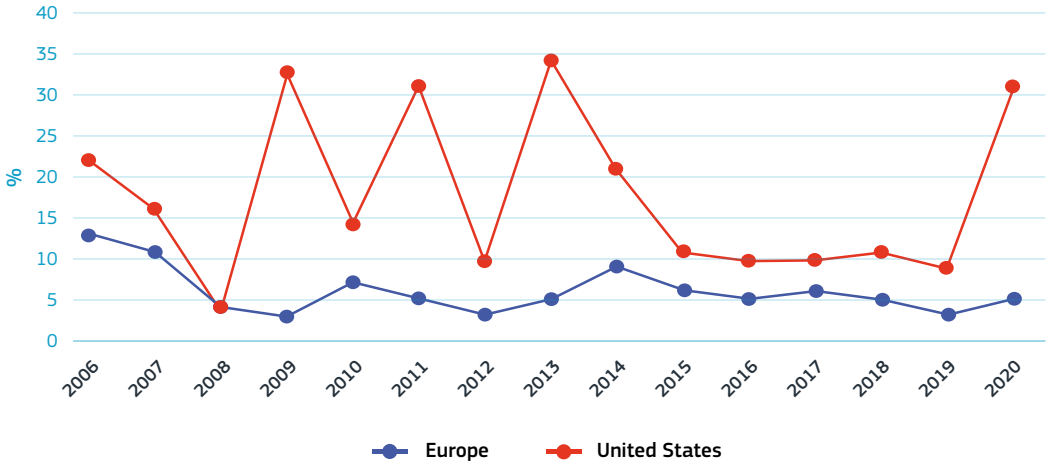
In many EU corporate tax systems, interest payments on debt financing are tax deductible, while the costs related to equity financing are not. Such asymmetric tax treatment induces a bias in investment decisions, making debt financing more appealing despite the potential negative effects of the increase in companies' debt levels. In 2019, total indebtedness of non-financial corporations amounted to almost EUR 14 trillion (99.8 % of GDP in the EU), and the debt-to-equity ratio was 53.3 %[8].

To tackle this tax-induced debt-equity bias, the European Commission launched the debt-equity bias reduction allowance (DEBRA). The overarching objective of the initiative is to encourage companies to rely more on equity contributions and less on debt financing. To do so, the European Commission calls for the introduction of an equity allowance targeting equity-financed new instruments. Legislative initiatives are already in place in six Member States (Belgium, Cyprus, Italy, Malta, Poland and Portugal)[9].

8 DEBRA Inception Impact Assessment - Ares(2021)3879996

9 DEBRA Inception Impact Assessment - Ares(2021)3879996

Figure 7.1-17: Share of IPOs in the total divestment amount (%)



Science, Research and Innovation Performance of the EU 2022

Source: Ambrosio et al. (2021), based on PitchBook data
Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-17.xlsx

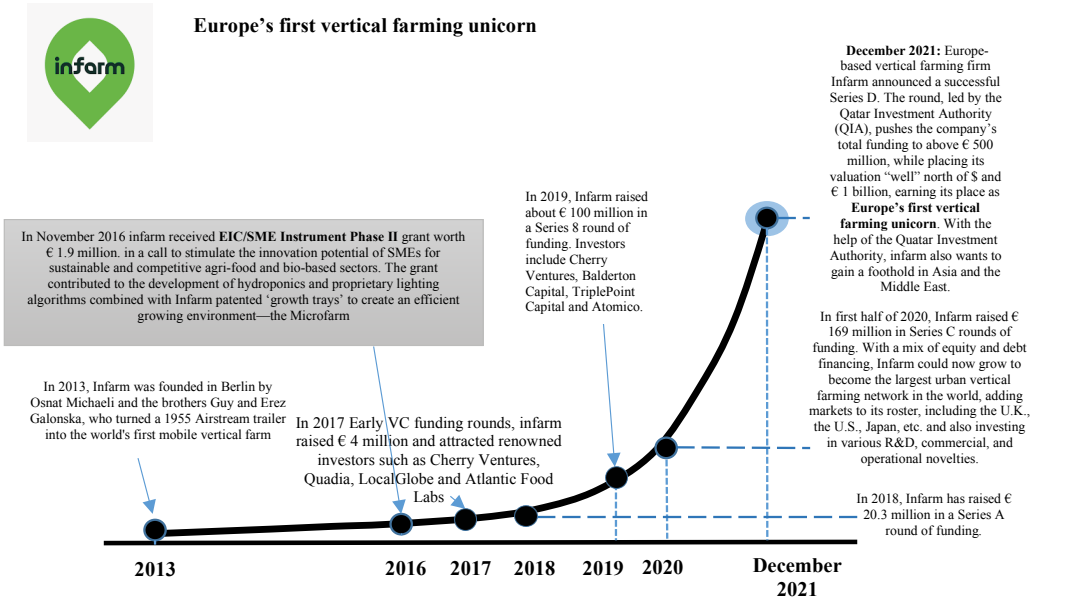
Exit strategies represent another critical step in scale-up investments. Companies have three financing possibilities for scale-up: they can decide to rely on internal funds, to go public or to be fully or partially acquired (Ambrosio et al., 2021). Initial public offerings (IPOs) represent one of the most common exit strategies available to firms. **Nevertheless, EU IPOs play a minor role in scale-up financing compared to in the US.** In the last two decades, the amount of divestment in the US has been significantly higher than in the EU (Figure 7.1-17). In 2020, only 5% of the total divestment took place through IPOs in the EU, as against 30% in the US.

An unicorn investment gap also exists between the EU and its international competitors. The US reported the highest amount of investments in unicorns between 2008 and the first half of 2021, with an average funding per unicorn of EUR 138 million. China and the EU showed the same performance, with average funding of EUR 125 million reported over the same period (Testa et al., 2022). **Furthermore, European unicorns are mostly foreign financed.** Between 2008 and the first half of 2021, three of the top 10 venture capital firms investing in European unicorns were located in the US (Testa et al., 2022).

Tackling the scale-up financing gap remains a top priority in the EU. Ensuring that EU companies get access to the necessary amount of financing resources to scale up is critical to achieving several EU policy objectives. As noted by Quas et al. (2021), tackling the EU scale-up gap would help the EU to secure its technological sovereignty and strategic autonomy. The innovation landscape is constantly changing, and European firms need funds to remain competitive on the global market. Additionally, leading companies in the emerging technological sectors are likely to play a key role in determining future industry standards. Therefore, it is essential to nurture tech leaders within the EU company pool to secure EU strategic autonomy (Quas et al., 2022).

Nevertheless, the EU has several instruments to support companies in their scale-up process, for instance the EIC funds, which have proved to be successful in allowing firms to increase their valuations, including to unicorn status (see Chapter 3.2 – Business dynamism). One example is Infarm, the first European vertical farming unicorn, founded in Germany (Figure 7.1-18).

Figure 7.1-18: An EIC success story: Infarm



Science, Research and Innovation Performance of the EU 2022

Source: European Innovation Council (2022)
Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-18.xlsx

Box 7.1-3: An impact assessment of the EIB venture debt instrument

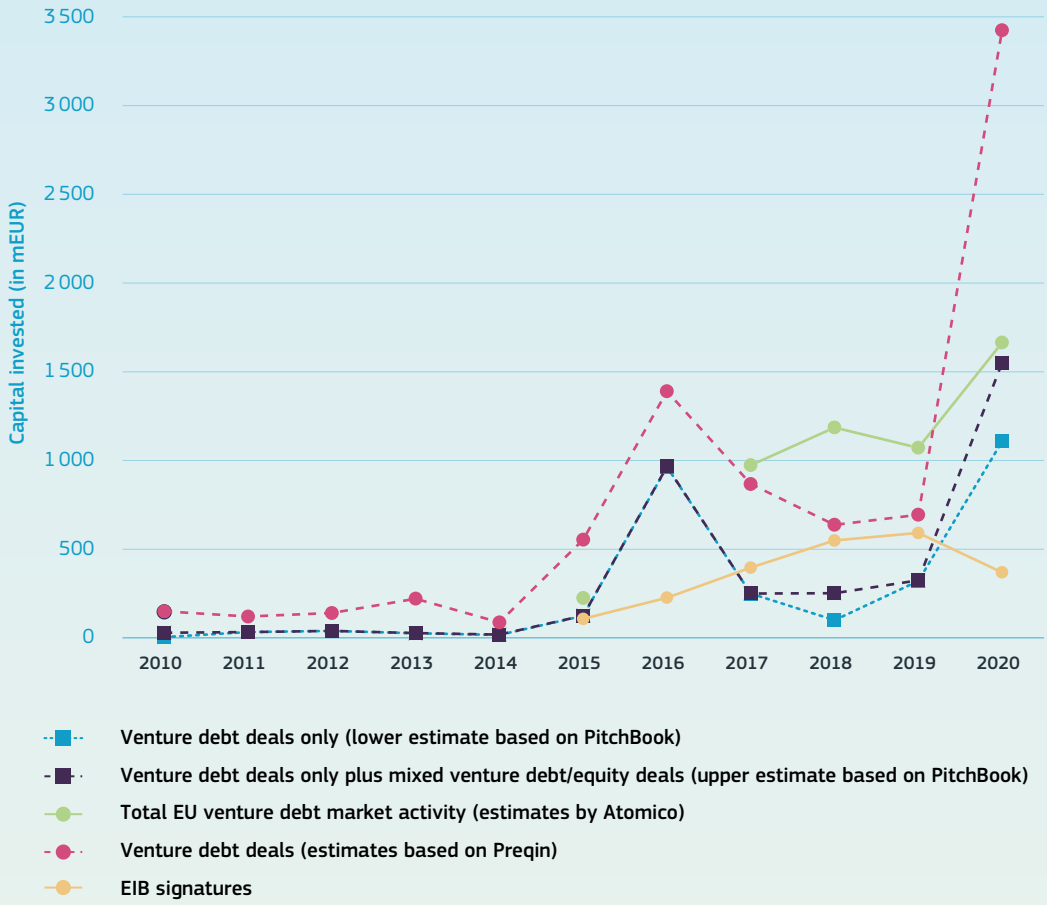
Authors: Matteo Gatti, Wouter Van Der Wielen, Sebastian Schich and Emily Sinnott

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 series B or C) and that want to avoid the dilution costs associated with additional equity injections.

The EU venture debt market has grown considerably over the last few years and the EIB has played a significant role in its expansion. Figure 7.1-19 shows the evolution of the EIB venture-debt portfolio compared to alternative market size estimates (there is no single authoritative source for data). The EIB venture debt impact assessment focuses on the loans signed between January 2015 and June 2021, which total EUR 2.65 billion[10]. This amount corresponds to approximately 0.8% of the total EIB portfolio and to 3.8% of the EIB's special activities. The key mandate behind the venture debt instrument is the European Fund

10 This horizon aligns with the period when the EIB signed its first venture debt contracts in 2015 until the cut-off for the analysis in June 2021.

Figure 7.1-19: European venture debt market



Science, Research and Innovation Performance of the EU 2022

Notes: Estimates of capital invested in million euro in EU countries (not including the United Kingdom) from different sources. Estimates by Atomico (2020, 2021) and data from Preqin converted from USD to EUR using exchange rates as reported by the OECD.

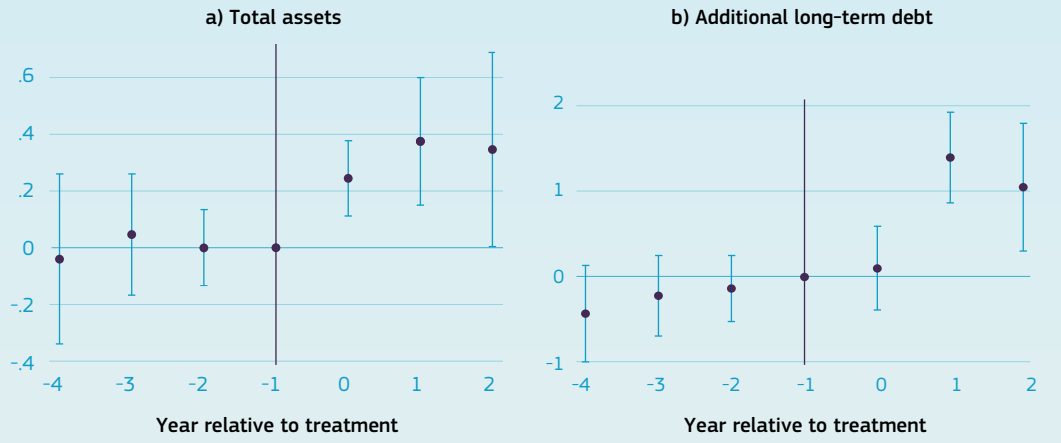
Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-19-.xlsx

for Strategic Investments (EFSI). With the roll-out of the latter, the EIB increased its special activities, and venture debt is a subset of such special activities. The EIB portfolio has a strong focus on social goods, including health – for example COVID-19-vaccine development – e-mobility and sustainability.

A recent assessment of the effectiveness of the EIB's venture debt[11] is one of the first studies to estimate the impact of this instrument on firms' growth and performance. The paper compares 133 EIB beneficiaries to a control group made of firms that are similar to the ones that received venture capital but did not receive any venture debt (although these firms may still receive other forms of finance). Comparability

11 EIB, 'Impact Assessment of EIB Venture Debt' Economics Impact Studies Series (forthcoming in 2022).

Figure 7.1-20: Impact assessment results



Science, Research and Innovation Performance of the EU 2022

Notes: Estimations based on EIB allocation data linked to corporates' financials in ORBIS Bureau van Dijk

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between EIB beneficiaries and the control group is also ensured by the fact that firms in the control group have been selected to match beneficiaries' financials, innovativeness and age. The estimation relies on an econometric model that compares differences between EIB beneficiaries and the control group, before and after receiving venture debt.

The results in Figure 7.1-20 show a strong and positive impact of EIB venture debt on firm growth. Dots in red 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.

Panel (a) shows that EIB venture debt beneficiaries report on average a third higher total assets compared to firms that did not sign any venture debt contract. Panel (b) shows instead 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 crowding-in of additional debt.

The analysis also shows positive and significant results on firms' value added, while results on turnover, employment and innovation are positive but not statistically significant. While venture debt may not lead to strong positive results on all these variables, some of these insignificant results may be due to lack of available financial data. Finally, as venture debt is a recent product with data for a limited number of years after venture debt signature, the study only considers a short-term horizon (one-to-three years).

3. Gender gap in VC markets

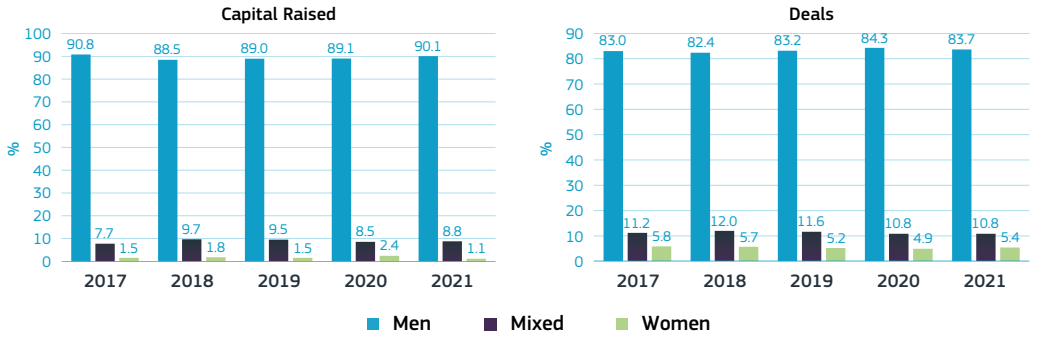
Female-led companies still receive less funding compared to male-led companies and female-male co-funded companies, suggesting that investment policy is biased against female-led businesses. Over 2014-2020, the global VC volume going to enterprises with only female founders was significantly less than that reported by companies with mixed-gender founders (Crunchbase, 2020).

The gender financing gap in Europe remains persistent. In 2020, only 1.7% of the capital raised in European VC markets was captured by tech companies with only female founders. The difference between male-led companies and companies with mixed/female founders remains significant both in terms of capital and number of deals (Atomico, 2021). In 2021, male-only firms accounted for respectively about 90% and 84% of capital and deals concluded, against 1.1% and 5.4% reported for women-led companies, respectively (Figure 7.1-21). The gap also remains huge when considering companies with male-female co-founders, which captured only 8.8% of the capital raised in 2021.

Women-led tech companies struggle to raise capital exceeding USD 50 million. In 2020, no deal over USD 50 million was closed by companies with only female founders. However, women-led companies performed better than in 2019 in rounds of up to USD 20 million. Female-led companies were able to close 6.3% of the deals for rounds of less than USD 10 million, and 3.4% of those between USD 10 million and USD 20 million, confirming difficulties female CEOs encounter in raising high volumes of capital on the market (Figure 7.1-22). A modest improvement was also reported in 2021, when women-led companies managed to close deals in each round size, including those above USD 100 million (1%) (Atomico, 2021).

Women investors are keener to back women-led companies. In 2018, 54% of women investors supported at least one business funded by women, while 20% invested in 3-10 women-led companies. In contrast, male investors showed a lower appetite for backing women-led enterprises. In this regard, a potential cause of the lack of finance available to women is the relatively lower number of women investors (Wa4e, 2018).

Figure 7.1-21: **Share of capital and deals raised by tech companies in Europe, per founding-team gender composition, 2017-2021**



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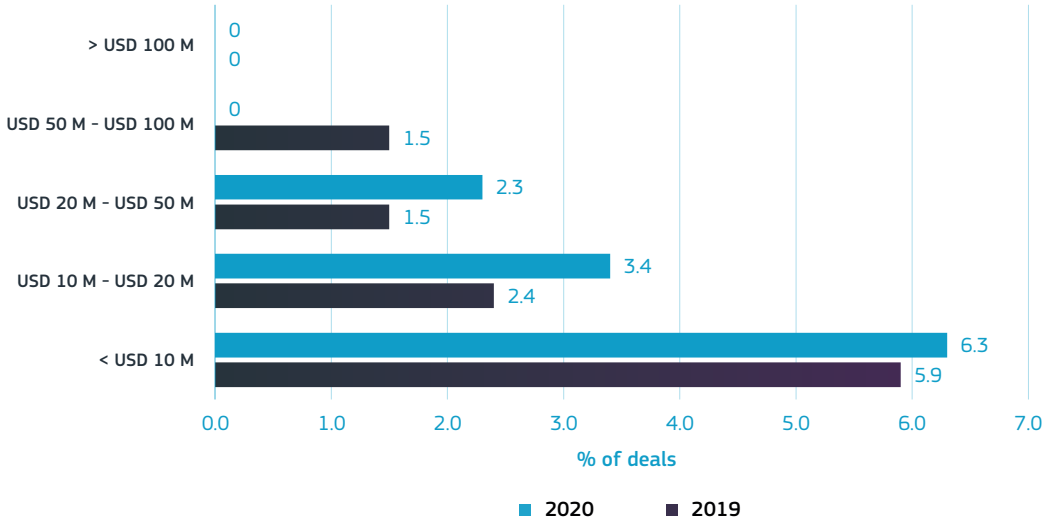
Source: Atomico (2021), based on the Dealroom database

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-21.xlsx

Figure 7.1-22: Share of deals by round size for women founding teams, 2019 vs 2020



Science, Research and Innovation Performance of the EU 2022

Source: Atomico (2020), based on Dealroom database

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-22.xlsx

Women angel groups represent an important source of financing for female-led businesses. Women business angels are more likely to invest in women-owned businesses (Harrison and Mason, 2007). Nevertheless, relevant barriers remain against fully unlocking the potential of angel investing to tackle the gender financing gap in the EU. Results from a survey conducted by Wa4e in 2018 suggest that a lack of understanding of the core process of angel investing and a low awareness of available risk mitigation strategies are some of the main challenges perceived by female entrepreneurs looking for business angels. From a policy perspective, **increasing the visibility and number of women business angels** would help to address these issues, thereby contributing to attracting additional deal flows by female entrepreneurs (Wa4e, 2018).

Another important obstacle to addressing the gender investment gap is the **scarce availability of data**, making it difficult to accurately quantify the magnitude of the financing gap between women-led businesses and those of their male counterparts. Better data are necessary to understand fully the magnitude of the phenomenon and to put in place efficiently a system to monitor the gender dimension of EU investment, thereby improving the design of policy initiatives to tackle this issue.

Box 7.1-4: EU Initiatives for women entrepreneurs

Gender equality is at the heart of the Horizon Europe programme and its Pillar III, 'Innovative Europe', which seeks to create fair, inclusive and prosperous R&I ecosystems in Europe. A full toolbox of measures and programmes to support women in innovation and entrepreneurship is being deployed under this pillar, especially those of the European Innovation Council (EIC).

- The EIC Business Acceleration Services recently launched the **EIC Women Leadership Programme**. This programme is a skills enhancement and networking scheme to help EIC-supported women entrepreneurs and researchers to advance in their careers, create their own spin-offs or spin-outs, and take leading positions in existing companies, through training, coaching and mentoring, and networking.

- The new **Women TechEU initiative** supports women-led deep tech start-ups, tackling the underrepresentation of women entrepreneurs in a key innovation sector that remains dominated by men. The programme offers financial support during the initial steps in the innovation process and during the growth of the company. Moreover, beneficiaries will receive access to mentoring and coaching provided by the Women Leadership Programme, including dedicated networking and pitching events.

- The **EU Prize for Women Innovators** is awarded to women innovators each year for outstanding achievements, and features a 'rising innovator' category for women innovators under 30. The prize is an important recognition of the role that women play in developing game-changing innovations, and provides role models for aspiring women innovators.

- The target for **women-led companies invited to pitch** their projects in the second stage of the EIC Accelerator was raised to 40%;

- Integration of the **gender dimension** into the relevant **EIC Challenges** to make sure that breakthrough innovations can benefit all people concerned, regardless of their gender.

- The **newly-appointed EIC Board** is gender balanced, with 10 out of 20 board members being women. The EIC Fund Investment Committee and pools of EIC evaluators and business coaches will also remain gender balanced.

- The EIC Work Programme 2022 features a **Pilot European innovation gender and diversity index**, which will aim at improving the availability and benchmarking of gender and other relevant diversity data across the innovation ecosystem (e.g. start-ups, scale-ups, investment funds);

- The European Institute of Innovation and Technology (EIT) launched the new **Women2Invest** initiative, where recent graduates and young professionals coming from STEAM fields will become familiar with the fundamentals of venture capital through paid internships or entry-level positions in a venture capital fund, a corporate venture capital fund, or a corporate venturing unit.

Regarding support for female investors, **InvestEU**, the flagship investment Commission programme under the 2021-2027 Multiannual Financial Framework, will promote the presence of women on several fronts:

- InvestEU will aim at increasing the amount of financing flowing to funds having gender targets. In particular, the joint equity product of the Research, Innovation and Digitisation Window and the SMEs Window will put an emphasis on supporting funds that target gender diversity in their investment strategy. The Guarantee Agreement with the European Investment Bank (EIB) features an **indicative goal of 25% of all Equity Intermediaries** with whom the European Investment Fund (EIF) has entered into Equity Operations **to follow the Gender Criteria** set out in the agreement;
- The InvestEU Advisory Hub will provide targeted capacity building and project advisory support, which will include specific actions to increase women's representation in the investment community and improve access to finance for female-founded and female-led companies.
- The **InvestEU Advisory Board** features a dedicated **sub-group on Gender Equality**.
- The EIF will introduce an **indicator[12] to track investments supporting gender equality** (as defined by the EIB policies and procedures) under its key performance and monitoring indicators for impact of financing supported by InvestEU.

12 This includes the number of equity intermediaries complying with gender criteria and the amount invested in equity intermediaries complying with the gender criteria set out in the agreement.

4. FinTechs and alternative financing instruments

Providing enterprises with a more diversified set of financing instruments is crucial to ensuring long-term growth. In order to increase the resilience and efficiency of the EU capital market, it is critical to broaden the range of financing instruments available to EU companies. This is particularly relevant for start-ups and SMEs, which typically struggle to obtain access to the finance needed to increase their ability to innovate and grow (OECD, 2015). Creating an efficient financial system is essential to strengthening the EU's global position. This calls for continuous and increasing efforts to enable the EU financial system to adapt to market changes, thereby allowing EU enterprises to thrive in an increasingly complex and interconnected world. **In this regard, alternative financial instruments (such as digital finance activities[13]) are becoming very popular, as they allow EU firms to overcome the limits typically related to traditional bank products and services.**

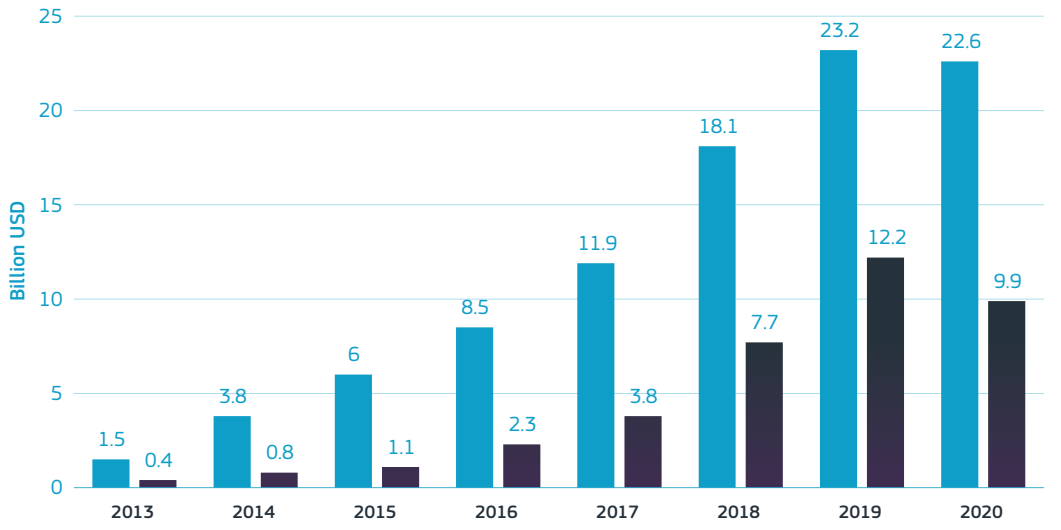
FinTech[14] services have grown considerably in recent years and represent an important part of the financing landscape worldwide and in the EU. By providing alternative financing instruments, FinTech markets have the potential to enhance firms' access to finance (Kraemer-Eis et al., 2021). **Debt-based online activities are the most popular FinTech instruments worldwide, followed by equity crowdfunding and non-investment-based crowdfunding, which however still play only a minor role**. When looking at the global trend in online finance activities, China dominates the international scene in terms of investment volumes raised through online financing instruments (Cambridge Centre for Alternative Finance, 2021). In 2019, the Chinese market volume of online alternative finance stood at USD 83.4 billion, positioning China well above both the US and Europe. Nevertheless, European online alternative finance grew considerably over 2013-2019. Figure 7.1-23 shows the trend in alternative finance volumes with and without the UK. The observed increase is significantly lower in the latter case, suggesting that online finance is more developed in the UK compared to other European countries. The positive trend experienced a halt in 2020, with a drop from USD 23.2 billion in 2019 to USD 22.6 billion in 2020 (-3%). The drop is even larger when excluding the UK (-19%). Nevertheless, despite the substantial decrease observed in 2020, online finance volumes remained above the 2018 values, suggesting a good degree of resilience to shocks such as Brexit and the COVID-19 pandemic (Cambridge Centre for Alternative Finance, 2021).

As regards the different types of online instruments, **debt-based online activities account for about 83% of Europe's online alternative finance** (without the UK), with a total value of USD 8.2 billion. Crowdfunding is another growing online activity, although its performance stagnated between 2020 and 2021 (Kraemer-Eis et al., 2021). The distinctive feature of crowdfunding is to raise external finance from a large

13 Digital finance activities are activities falling outside the spectrum of financial instruments typically supplied by the banking systems. According to the definition provided by the Cambridge Centre for Alternative Finance, online alternative finance models include a wide range of instruments, either debt- or equity-based. These include P2P consumer lending, P2P business lending, equity-based crowdfunding, reward-based crowdfunding, donation-based crowdfunding, and profit sharing, among others.

14 FinTech is a term used to describe technology-enabled innovation in financial services that could result in new business models, applications, processes or products and could have an associated material effect on financial markets and institutions and how financial services are provided.

Figure 7.1-23: European online alternative-finance[1] market volumes, 2013-2020



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Source: Cambridge Centre for Alternative Finance (2021)

Note: [1]Online alternative finance models include a wide range of instruments, either debt- or equity-based. These include P2P consumer lending, P2P business lending, equity-based crowdfunding, reward-based crowdfunding, donation-based crowdfunding, and profit sharing, among others

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audience of investors, not necessarily limited to specialised investors such as banks, business angels and venture capitalists (OECD, 2015). Besides broadening the base of investors, crowdfunding instruments support information sharing and exchange of best practices (OECD, 2015). **In 2019, investment raised by crowdfunding platforms in Europe (without the UK) amounted to USD 4.3 billion and increased to USD 5.2 billion in 2020** (Cambridge Centre for Alternative Finance, 2021).

Investments in European FinTech companies have increased remarkably in recent years. The term FinTech is also used to refer to companies that have the ability to introduce disruptive innovation in traditional financial service mechanisms (Kraemer-Eis et al., 2021). The number of deals closed by EU FinTech companies has increased over 2010-2019. With the outbreak of the COVID-19 pandemic, financing activities targeting FinTech companies in the EU slightly declined, with the number of deals decreasing to 544 in 2020. Nevertheless, the total deal volume continued to increase, suggesting that the pandemic did not impede further growth opportunities for EU FinTechs (Kraemer-Eis et al., 2021). At the end of Q3 2021, the volume of FinTech financing was already twice that reported at the end of 2019 (Kraemer-Eis et al., 2021).

Investment activities in EU FinTech companies remain geographically concentrated. Germany dominates with 139 deals, followed by France (121), Spain (96), Sweden (76) and the Netherlands (50). These innovative hubs together accounted for about 60% of EU deals and 80% of total deal value. When considering the relative size of countries, Luxembourg outperforms other EU countries with a total of 15 deals (EUR 175 million), confirming the efficiency of its well-developed financial system (Kraemer-Eis et al., 2021).

5. Investments in green technologies

Investing in green technologies will be crucial to implementing the EU's net-zero strategy. With the European Green Deal, the EU has made the path towards sustainable growth an overarching priority of its policy agenda. To reach climate neutrality, the EU is putting in place a series of initiatives aimed at changing the way of doing business at its core. Such a process will affect all sectors of the economy and will significantly impact firms' investment behaviour and financial needs. According to Kraemer-Eis et al. (2021), 56% of EU SMEs claim that climate change already has impacted their business in recent years, although the impact is not homogeneous across EU countries. The effects of climate change on the EU corporate sector appear to be more disruptive in Spain, Portugal, Romania and France, possibly due to the higher number of droughts and forest fires occurring in these countries (Kraemer-Eis et al., 2021).

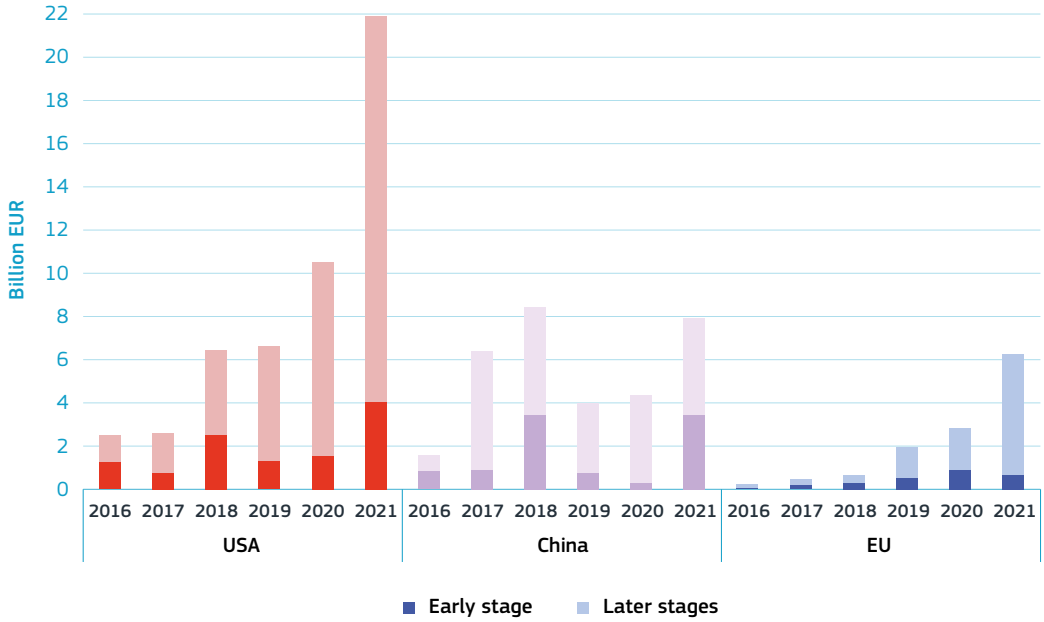
The Fit For 55 package sets the legislative framework within which the European Commission aims to deliver the European Green Deal (European Commission, 2021a). The package embeds an ambition that will determine the nature of the increasing demand for finance, and calls for adequate financing instruments to support businesses in their greening process[15]. In this regard, innovation in green technologies will play a key role by reducing the cost of greenhouse-gas abatement (Kraemer-Eis et al., 2021).

Investments in companies producing green technologies have shown a positive trend from 2016 onwards. After a few years of stagnation between 2013 and 2016, VC and PE investments in European green technology companies have increased significantly since 2017, reflecting growing societal awareness and concerns about environmental and sustainability issues. The number of deals closed increased by 7.2% between 2017 and 2019 (Kraemer-Eis et al., 2021). As with the FinTech sector, companies innovating in green technologies were only marginally affected by the COVID-19 crisis. After a slight slowdown in 2020, green innovation finance started to accelerate again during the first three quarters of 2021 (Kraemer-Eis et al., 2021).

EU climate tech start-ups and scale-ups have attracted an increasing amount of investment over the last 6 years (Figure 7.1-24. In 2021, the EU accounted for 15% of global Climate Tech investments, amounting to EUR 6.2 billion. Despite this positive performance, the presence of structural barriers (e.g. market and regulatory fragmentation) holds back EU climate-tech start-ups and scale-ups compared to other major economies, notably China and the US (European Commission, 2021b). EU early stage investments peaked in 2020 while reaching all-time highs in 2021 in China and the US. Although in 2021 the EU reported a higher later stage investment value than China, it continues to fall

15 An important initiative in this regard is the BlueInvest fund, managed the EIF and aiming at providing financing to equity funds that strategically target and support innovative companies active in the Blue Economy. The Blue Economy sector is often perceived as highly risky by investors. As such, the BlueInvest initiative aims to improve access to finance and investment readiness for start-ups, early-stage businesses and SMEs active in the Blue Economy, mobilising EU funds for financial intermediaries investing in this sector. https://ec.europa.eu/oceans-and-fisheries/news/blueinvest-commission-and-eif-agree-mobilise-eu500-million-new-equity-fund-blue-economy-2022-03-28_en

Figure 7.1-24: Venture capital investments in climate-tech start-ups and scale-ups



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Source: JRC elaboration based on PitchBook data

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-24.xlsx

behind both the US and China in terms of total VC investments. Between 2016 and 2021, EU climate tech firms only attracted 12% of all later stage investments, against the 48.5% and 28.5% received by the US and China, respectively.

Along with the expansion of investments in green-tech companies, the success of the European Green Deal will require all economic actors to significantly increase their investments in reducing pollution. Green bonds and green finance are expected to play a more prominent role in supporting EU enterprises, especially SMEs, in their green transition. In this regard, the low propensity of SMEs to invest in climate adaptation measures is a cause for concern. Results from a recent EIB survey suggest that only one in three European SMEs plans to undertake green investments (EIB, 2021). Potential reasons are limited access to finance (indicated as an obstacle by 55% of SMEs surveyed) and the presence of informational barriers, which calls for policy interventions to improve information sharing within the economy and to increase firms' awareness of investment opportunities (Kraemer-Eis et al., 2021).

Box 7.1-5: EU taxonomy for sustainable activities[16]

At the end of 2016, the Commission appointed a High-Level Expert Group on sustainable finance. In its final report, published in January 2018, the expert group delivered a set of key recommendations for building a strong sustainable-finance strategy for the EU. In the race towards the decarbonisation of the EU economy, it is of paramount importance to direct investments towards sustainable activities.

Sustainable finance, referred to as 'the process of taking due account of environmental and social considerations in investment decision-making'[17] calls for increasing investments in longer-term sustainable activities by making environmental, social and governance (ESG) factors an integral part of the investment decision-making process.

The work of the High-Level Expert Group on sustainable finance was followed by the adoption of the EU Action Plan on Financing Sustainable Growth (European Commission, 2018). The action plan sets the key priorities of the EU efforts to re-shape the way investors decide how to allocate their financing resources. In this regard, the action plan pursued three main objectives:

1. reorient capital flows towards sustainable investment;
2. manage financial risks related to climate changes and major environmental disruptions;
3. increase transparency and long-termism in financial and economic activities.

The strategy set out in the action plan is to provide the EU investment landscape with a clear system to identify green economic activities and, thus, reduce the uncertainty related to this type of investment. This effort resulted in the EU Taxonomy Regulation[18], which entered into force in July 2020. The regulation pursues six overarching environmental objectives (Figure 7.1-25).

Under the umbrella of these objectives, the Taxonomy establishes four conditions that economic activities have to meet in order to qualify as environmentally sustainable (Article 3 of Regulation 2020/852).

1. The activity has to 'contribute substantially' to at least one of the aforementioned environmental objectives.
2. The activity 'does not significantly harm' any of the environmental objectives.
3. Carrying out the activity does not result in the violation of minimum 'social safeguards'[19].
4. The activities comply with technical screening criteria (TSC), which clarify how an economic activity contributes to environmental objectives.

16 https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

17 Commission Communication 'Action Plan: Financing Sustainable Growth' (COM(2018) 097 final)

18 Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088

19 I.e. the activity should respect principles written in the Declaration of the International Labour Organization on Fundamental Principles and Rights at Work, and in the International Bill of Human Rights (Article 18 of Regulation 2020/852).

Figure 7.1-25: **Objectives of sustainable economic activities**

Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-1-25.xlsx

In line with the objectives of the Green Deal and the EU Taxonomy Regulation, Horizon Europe supports R&I activities that respect EU climate and environmental priorities. As such, the new framework programme for R&I incorporates the 'do no significant harm' (DNSH) principle, according to which R&I activities should not result in a significant harm to any of the aforementioned six environmental objectives. Within the framework programme, the DNSH principle is used to assess the activities carried out during the project, as well as the expected life-cycle impact of the innovation at a commercialisation stage (when relevant).

6. Conclusions: financing innovation – towards a green and digital Europe

To switch successfully to a green and digital economy, the EU needs a considerable amount of investment in innovation activities. EU capital markets remain considerably fragmented, pushing EU companies to rely mainly on domestic markets to meet their financial needs. This results into a heterogeneous degree of access to finance within EU territory, as well as different financing costs between EU countries. Furthermore, bank loans remain the predominant financing instruments in the EU, while equity capital still plays a minor role compared to other international economies. Given the specific characteristics of non-tangible assets, **improving access to finance is essential to untap the growth potential of knowledge-based economies**. Intangible-intensive sectors have strong productivity potential, but typically face more financial constraints than the rest of the economy. As such, these are the segments that would benefit the most from further financial development (Demmou and Franco, 2021). Less financial friction would improve firms' ability to finance their innovation activities, thereby improving their productivity performance. Additionally, progress on the EU capital markets union would positively impact market reallocation processes, increasing productive firms' financial opportunities and easing their access to equity financing (Demmou and Franco, 2021). External financing plays a critical role in enhancing investment opportunities, but its use remains limited to the biggest product innovators with in-house competencies. In contrast, internal funding continues to be the primary source of innovation for all European businesses. **Enhancing access to equity, especially for small innovative firms, is thus key to creating growth opportunities**.

Furthermore, the need to increase access to equity markets has become more pressing with the outbreak of the COVID-19 to balance the considerable increase in company debt levels. The achievement of EU policy objectives strongly depends on the EU's ability to enable a large amount of investment to reach strategic economic segments, thereby supporting the development and adoption of innovative technologies critical to the green and digital transitions. At the same time, **ensuring coherence between already existing instruments in essential to innovation funding**.

The integration of sustainability criteria into the financing of firms is at the heart of the EU strategy to achieve a climate-neutral Europe. With the European Green Deal, the EU puts sustainable finance at the centre of its policy action. The fragilities that emerged with the COVID-19 pandemic, combined with the increasing risks related to climate change, will lead to a massive increase in investment demand. Green technologies critical to achieving the EU net-zero emission targets for 2050 are still at a prototype level, and considerable amount of capital will need to be channelled through the economy, not only to support the greening of EU businesses but also to guarantee that the EU does not lose its technological sovereignty in this field (see Chapter 2.1 – Zoom out: technology and global leadership).

The digitalisation of finance can help to increase access to finance. Digital financing activities are becoming increasingly important in the EU and worldwide. Online financing instruments have the potential to enhance access to finance, especially for EU start-ups and SMEs, which typically encounter significant constraints in meeting their financial needs. **Embracing digital finance will support innovation, creating new opportunities to develop better financial products for both businesses and consumers** (European Commission, 2020). Nevertheless, the increasing digitalisation of finance also poses important challenges. In its Communication of September 2020, the European Commission set the key priorities of its digital finance strategy, including tackling fragmentation in the Digital Single Market, adapting the EU regulatory framework to facilitate digital innovation and promoting data-driven finance while ensuring the protection of consumers.

The gender investment gap remains a concern in the EU. Women-led companies remain significantly underrepresented on the VC market. One of the main barriers to investment in female-led businesses is the lack of women investors, who are typically keener to provide financing support to women entrepreneurs. Promoting gender equality is a key objective of the Horizon Europe programme. With Pillar II, 'Innovative Europe', the new framework programme for R&I aim to create a fair and inclusive R&I ecosystems in Europe. As such, the pillar embeds a series of initiatives deployed mainly under the EIC portfolio.

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CHAPTER 7.2

OTHER FRAMEWORK CONDITIONS

KEY QUESTIONS WE ARE ADDRESSING

- How does the functioning of institutions and markets affect R&I?
- What does 'institutional quality' mean?

KEY MESSAGES

What did we learn?

- Good institutions are characterised by political stability, transparency and accountability, and show solid rule-of-law guarantees with a low risk of expropriation and corruption.
- Regulation can be a powerful instrument to foster innovation in the EU.
- Access to efficient digital infrastructure and data is essential to foster the EU digital transition, but the ability of EU firms to invest in digitalisation varies significantly across EU regions.
- The engagement of civil society in science has been a key focus of R&I policies at the EU level.

What does it mean for policy?

- The emergence of new practices, technologies and business models and the pacing problem due to the acceleration of innovation call for more flexible and experimental approaches to regulation, such as regulatory sandboxes.
- A wide use of public procurement on innovation by EU public authorities is hampered by implementation barriers.
- To fully reap the benefits of the digital transformation, it is necessary to create a safe and inclusive digital space for both citizens and EU enterprises.
- Citizens need to be engaged in R&I, as they are critical to enriching it, reinforcing trust in science and facilitating the innovation process and its uptake by industry and citizens.

1. Institutional and regulatory environment

The quality of countries' institutions shapes their innovation and economic performance. Institutions are the 'rules of the game' in a society or, more formally, the humanly devised constraints that shape human interaction (North, 1981). A growing branch of the literature is studying the impact of institutions on economic growth and technological change. The main argument is that since institutions (such as property rights, balance of political power, organisation of markets, democracy, etc.) determine the incentives and constraints of economic actors, they will shape individual behaviour and economic outcomes[20].

Good institutions are characterised by political stability, transparency, accountability, and show high degrees of rule of law with low risk of expropriation and corruption. The economic gains of secure property rights stem from the fact that they lower the transaction costs of trade and the costs of monitoring and enforcing contracts. A lack of property right enforcement will increase the likelihood that future profits from current investments may be lost, either through theft or outright government expropriation (Olson, 2000). Individuals and firms are unlikely to risk their own capital and resources if they are unsure about the returns. Countries with strong property rights protection tend to show better economic performance[21]. Nonetheless, China has been able to achieve remarkable economic results despite the absence of credible property rights protection (Li, 2015). Private ownership has drastically increased over the years without the rule of law to provide reassurance on the protection of such ownership. With a one-party political set up and no independent judicial system to protect property rights, private investors seem to be taking big risks. Several explanations have been proposed for how China has been able to compensate its institutional deficiencies and make credible commitments to investors. Research on property rights in China often refers to social networks (Nee and Opper, 2012; Wang, 2014; Tsai, 2002; Wang, 2002; Wank, 2001), fiscal federalism (Oi and Walder, 1999; Qian and Weingast, 1997; Weingast, 1995), or the personnel control system (Li and Zhou, 2005).

During the COVID-19 pandemic, there was a rising consensus among countries to request a temporary waiver of intellectual property rights for COVID-19 vaccines. India and South Africa were among the first proponents[22], however the United States also affirmed its support in principle. The European Union and the United Kingdom opposed the proposal. They argued that intellectual property right played a 'positive role' in generating innovative vaccines and provide an incentive to further work to address new variants of the virus. They suggested less

20 See North (1981), Spolaore and Wacziarg (2013), Acemoglu et al. (2002, 2005), Besley and Persson (2011), Robinson and Acemoglu (2012).

21 Acemoglu et al. (2001) showed empirically how the colonies where European colonisers tried to replicate European institutions, with strong emphasis on private property rights and checks against government power (e.g. Australia, New Zealand, Canada, the United States), performed much better after independence than the colonies where the European settlers established extractive systems without attempting the introduction of similar institutions.

22 See https://timesofindia.indiatimes.com/india/india-south-africa-moot-3-year-covid-patent-waiver/articleshow/82868816.cms

radical measures such as encouraging the voluntary licensing of vaccines to allow others to manufacture doses. Thanks to the remarkable rise in COVID-19 vaccine production, there is currently more of an allocation problem than a supply problem[23], with the rollout of vaccination campaigns in lower-income countries being one of the greatest challenges[24].

Strong institutions help to generate a more innovative environment. Institutional quality is strongly associated to innovation capacity, and this relationship is confirmed for different country samples[25]. Figure 7.2-1 depicts the positive relationship between the Global Innovation Index[26], as well as GDP per capita, and various measures of institutional quality: rule of law[27], regulatory quality[28] and control of corruption[29]. The scatterplots contain cross-country-level data for around 180 nations, from the last available year. Figure 7.2-1 highlights how countries with better performance as regards the rule of law, property rights enforcement and control of government corruption also tend to show better innovation and economic outcomes. Even though the presented plots do not represent causal evidence, they are an instructive descriptive depiction of the relationships at play.

Northern European countries such as Finland, Denmark and Sweden are among the best performers in the world as regards rule of law, private property enforcement and judicial efficiency, ranking above the other EU Member States, as well as many international competitors such as the US, the UK, Japan and South Korea. Among the countries with weaker performance in this respect are Bulgaria and Italy. On average, the EU has a very similar level of rule of law to that of the US. China is a special case, managing to obtain significant economic and innovation success while maintaining relatively low (according to the proposed definition) institutional quality. The explanation behind this is still being debated, from those claiming that it is a short-term exception to those calling for a new paradigm of analysis.

23 See https://www.who.int/campaigns/vaccine-equity

24 See https://www.oecd.org/coronavirus/policy-responses/coronavirus-covid-19-vaccines-for-developing-countries-an-equal-shot-at-recovery-6b0771e6/#endnotea0z8

25 Rodríguez-Pose and Di Cataldo (2015) focus on EU countries; Tebaldi and Elmsie (2013) on a sample of OECD and non-OECD countries; Hussen and Çokgezen (2021) on a sample of African countries.

26 The Global Innovation Index ranks the innovation ecosystem performance of economies around the globe, relying on 81 different indicators ranging from R&D intensity, education, patenting, ICT and infrastructure to political institutions.

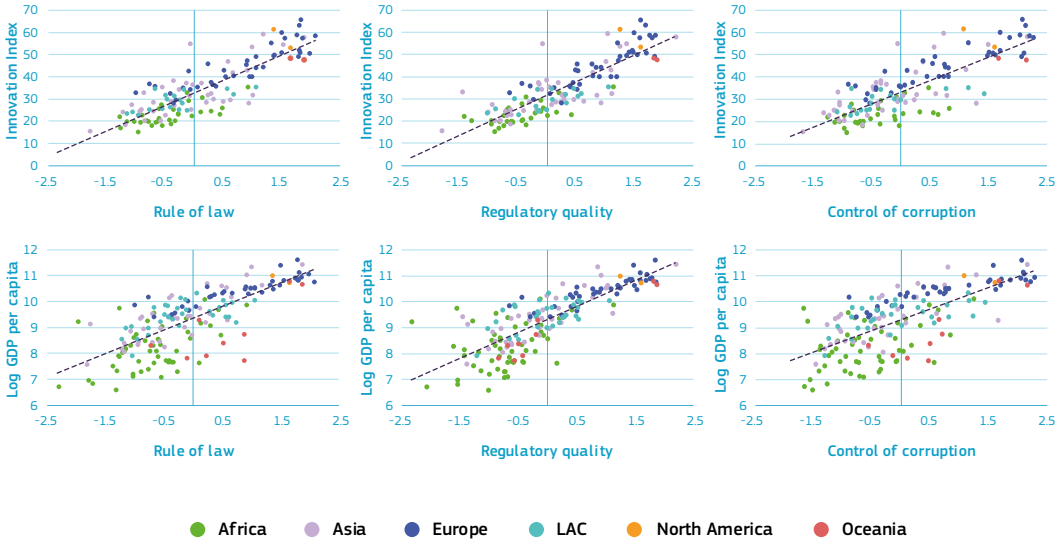
27 'Rule of law' measures the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police and the courts, as well as the likelihood of crime and violence.

28 'Regulatory quality' measures the ability of the government to formulate and implement sound policies and regulations that permit and promote private-sector development.

29 'Control of corruption' measures the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as capture of the state by elites and private interests.

Regulation can both hinder and encourage innovation. Regulation matters at all stages of the innovation process, but the relation between regulation and innovation is complex (Porter, 1990; Porter and van der Linde, 1995; Ashford and Hall, 2011; Pelkmans and Renda, 2014). On the one hand, regulation can be a **barrier to innovation when it is not properly designed.** Ineffective regulation raises compliance costs, using up entrepreneurs' resources and time. Inflexible regulation or regulation that lags behind innovation cycles can, for example, prevent the commercial introduction of an innovative product or its scaling up. Prescriptive regulation may also not generate sufficient incentives for firms to seek improvement of their product or service beyond what is specified in the regulation.

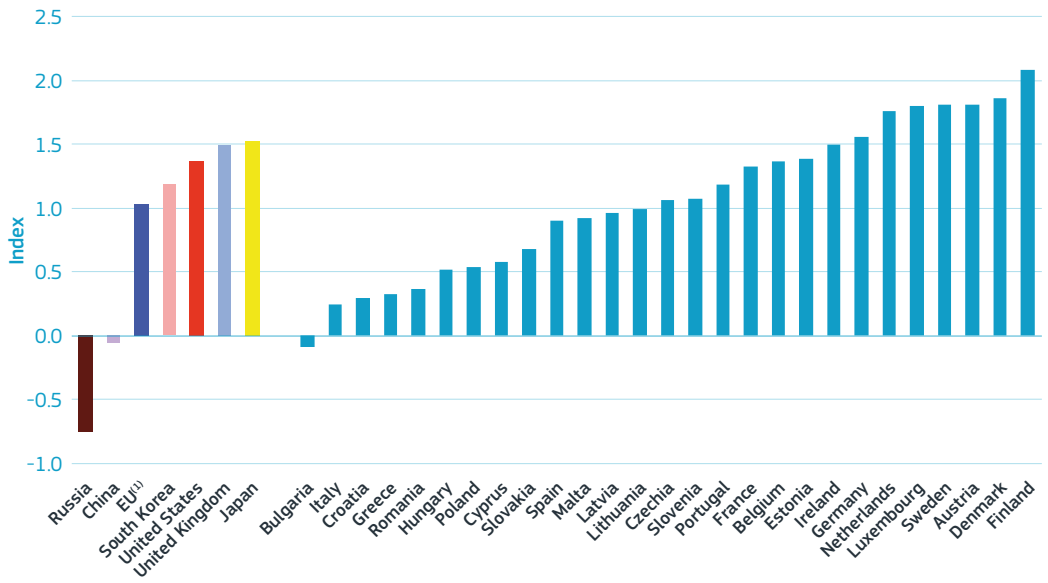
Figure 7.2-1: Institutions vs Economic and Innovation output, 2020



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Unit Service – Chief Economist Unit, own elaboration.
Note: The Global Innovation Index is produced by Cornell University, INSEAD and the World Intellectual Property Organization. GDP per capita, PPP (constant 2017 international dollars) is collected from the World Bank database. The rule of law, regulatory quality and control of corruption measurements are taken from the Worldwide Governance Indicators (WGI) of the World Bank.
Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-2-1.xlsx

Figure 7.2-2: Rule of law, 2020



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Unit Service – Chief Economist Unit, own elaboration based on 'Rule of law' measurements from the WGI of the World Bank

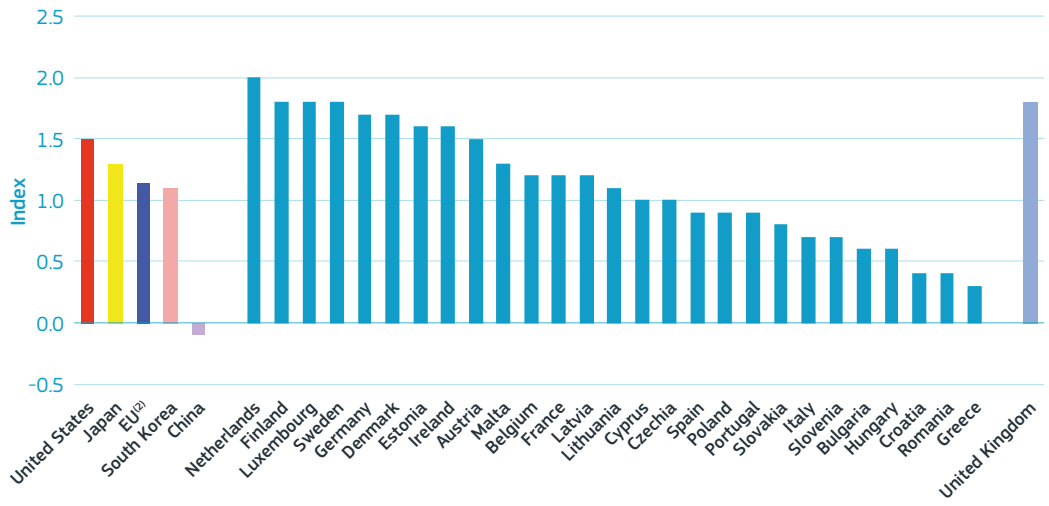
Note: (1)EU is an unweighted average of the 27 Member States.

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-2-2.xlsx

On the other hand, regulation can act as a **major driver of innovation**. It brings stability and certainty, which matter for investment and planning and enable firms to work on safe legal ground. It can also create strong stimulus for innovation through standard setting or regulatory stringency. Standard setting may improve market functioning as it provides guidance to producers for the design of a new and innovative product, while increasing trust among customers in a product that is yet unknown. Stringency can provide strong incentives to businesses to innovate and shift from outdated techniques and procedures to new ones (EPSC, 2016). In particular, strict environmental regulations can encourage innovations that help to improve commercial competitiveness (Porter and van der Linde, 1995). Regulation may also have impacts on innovation at the systemic level, when it shifts investment opportunities to different actors. This could occur, for example, in the context of the twin transition, supported by the European Green Deal and the digital-transformation priorities.

Hence, regulation can be a powerful instrument to foster innovation in the EU. However, several factors can prevent this. On the one hand, the EU is faced with challenges common to other regulatory systems, e.g.: how to ensure that regulation is agile enough to adapt rather than react to the pace of innovation; and when and how to regulate disruptive innovation, while only limited evidence is available. In addition, EU-specific challenges may also come into play. These include the length of the legislative process, risks of market fragmentation if the same innovation is treated differently across Member States, and problems in national implementation of EU regulation (inadequate transposition

Figure 7.2-3: Regulatory quality index[1], 2020



Science, Research and Innovation Performance of the EU 2022

Source: Global Innovation Index, World Bank.

Note: [1]Regulatory quality is a sub-index of the Global Innovation Index, which captures perceptions of the government's ability to formulate and implement sound policies and regulations that permit and promote private-sector development. [2]The figure for EU is an unweighted average of the 27 Member States.

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-2-3.xlsx

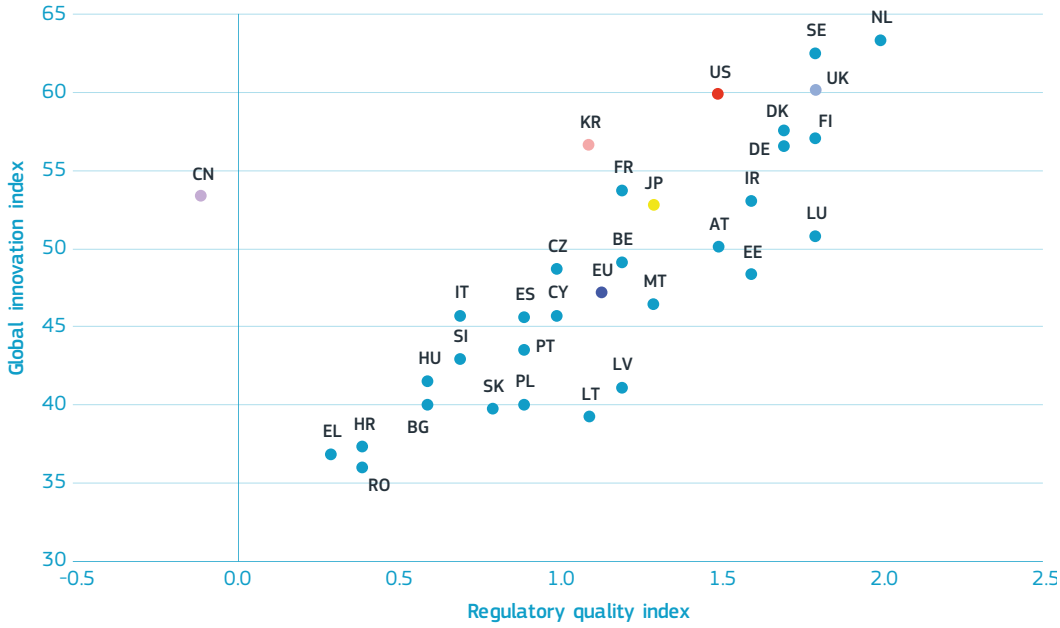
or implementation, gold-plating, burdens or obstacles to the delivery phase of the legislation) (Pelkmans and Renda, 2014; Ashford and Renda, 2016; Peter et al., 2017). These factors can also discourage investment and limit innovation.

Moreover, regulatory quality seems to differ significantly across EU Member States. The (perceived) government ability to formulate and implement sound policies and regulations for promoting private-sector development is highest in the Netherlands, Finland, Luxembourg, Sweden, Germany and Denmark, which also show stronger R&I performance compared to other countries (according to the Global Innovation Index). Countries with lower regulatory quality, such as Greece, Romania, Croatia and Bulgaria, also tend to perform less well in terms of R&I. Compared to the US, EU countries present on average a lower perceived regulatory quality. China shows the lowest score on this indicator, while still presenting a strong R&I performance.

Innovation plays a role in the design of EU legislation. Recent efforts aim to reinforce innovation-related considerations, both in terms of possible impacts of policies on innovation but also the influence that innovation itself can have on the design and implementation of EU policies and legislation. In particular, DG Research and Innovation is stepping up efforts within the European Commission to implement the **innovation principle**[30] at all relevant stages of policymaking and to create future-proof framework conditions for achieving sustainable development. The innovation principle is an approach ensuring that the processes of preparing, revising and implementing EU legislation take into account emerging innovations that are in line with EU policy objectives, facilitating their

30 https://ec.europa.eu/info/research-and-innovation/law-and-regulations/innovation-friendly-legislation_en

Figure 7.2-4: Regulatory quality index and global innovation index, 2020



Science, Research and Innovation Performance of the EU 2022

Source: Global Innovation Index, World Bank

Stat. link: https://ec.europa.eu/assets/rtd/srip/2022/figure-7-2-4.xlsx

development and adoption. This simultaneously requires policy to become more agile – able to adapt and adjust to changing circumstances – while introducing regulatory certainty and relevant legal protection where necessary.

The pacing problem, due to the acceleration of innovation, calls for more flexible and experimental approaches to regulation, such as regulatory sandboxes, which aim to test new solutions or alternative business models in a controlled real-world environment before admitting them to the market. Current regulatory sandboxes in the EU context cover genuine innovations that are expected to deliver consumer and/or wide societal benefits. They allow the regulator some flexibility while maintaining regulatory standards, and they facilitate learning, keeping up with developments in the sector and strengthening ties between regulators from different policy fields (see Box 7.2-1).

In 2021, the European Commission launched the "EU Startup Nations Standard" initiative with the support of Ministers in 27 countries (26 Member States and Iceland. This initiative identified 8 areas of action to ensure that innovators in Europe are provided with framework conditions capable of optimising growth. Among these areas there are regulatory sandboxes, wider use of innovation public procurement, and inclusive digital spaces.

Box 7.2-1: Regulatory sandboxes and other forms of experimentation

Broadly speaking, a regulatory sandbox is a scheme that enables the testing of innovations in a controlled real-world environment, under a specific plan developed and monitored by a competent authority. Sandboxes usually entail a temporary loosening of applicable rules, and feature safeguards to preserve overarching regulatory objectives, such as safety and consumer protection[31]. They are a relatively new phenomenon in most regulatory systems, and experience with implementation of such sandboxes is still limited. At the EU level, initiatives paving the way for sandboxes include the Commission proposal for a regulation on AI[32] and the pilot regime for market infrastructures based on distributed ledger technology (DLT)[33]. At national level, over half of the Member States have set up sandboxes and additional ones are in the pipeline. Applications of sandboxes are mostly in the areas of finance, transport and energy.

Closely connected to sandboxes are experimentation clauses: these enable authorities tasked with implementing and enforcing legislation to exercise a degree of flexibility in relation to innovative technologies, products or approaches, even if they do not conform to all existing legal requirements. Experimentation clauses can serve as the legal basis for sandboxes or simply allow for flexibility under certain circumstances. Other forms of experimentation exist without being a fully-fledged sandbox. Worth mentioning are test beds, living labs[34] and the European Blockchain Services Infrastructure (EBSI) to build a pan-European blockchain infrastructure for the delivery of public services. Finally, innovation deals offer another possibility to tackle real or perceived barriers to innovation[35]. They contribute to future-proof EU legislation by addressing perceived EU regulatory obstacles to innovative solutions. By fostering learning and facilitating the uptake of innovation in line with key policy objectives such as consumer safety and environmental protection, all the above tools can usefully complement traditional efforts to improve regulatory quality.

31 For further details, see, among others, the Council conclusions of 16 November 2020 on regulatory sandboxes and experimentation clauses.

32 The proposal provides a common framework for the establishment and implementation of AI regulatory sandboxes by one or more Member-State competent authorities or the European Data Protection Supervisor, and the coordination of those schemes within the European Artificial Intelligence Board (Article 53). Article 54 also provides the legal basis for the further processing of personal data for the development of certain innovative AI systems in the public interest subject to certain conditions.

33 Proposal for a Regulation of the European Parliament and of the Council of 24 September 2020 on a pilot regime for market infrastructures based on distributed ledger technology (COM(2020) 594). This proposal is part of a package of measures to further enable and support the potential of digital finance in terms of innovation and competition, while mitigating the risks. Together with a bespoke regime for crypto-assets (proposal for a regulation of the European Parliament and of the Council of 24 September 2020 on markets in crypto-assets, and amending Directive (EU) 2019/1937, (COM(2020) 593)), they represent the first concrete actions in this area, seeking to provide appropriate levels of consumer and investor protection, legal certainty for crypto-assets, to enable innovative firms to make use of blockchain, DLT and crypto-assets, and to ensure financial stability.

34 For an overview, see Alonso Raposo et al. (2021).

35 Innovation deals are a stakeholder-led voluntary process to create a shared understanding between innovators and policymakers on to what extent existing EU legislation accommodates beneficial innovations. For further details, see Tool #22 on research and innovation in the 'better regulation' toolbox.

The European Commission is set to analyse the state of play regarding regulatory sandboxes and to create an overview of main experimentation clauses in EU law. A stocktaking exercise[36] was completed under the Slovenian Presidency of the EU. Experimentation clauses and regulatory sandboxes are already mentioned in the 'better regulation' toolbox as a means of encouraging innovation. At the same time, experimentation in innovation agencies was supported by pilot projects under the Horizon 2020 programme. Experimentation for policy development is also included in the Horizon Europe Strategic Plan 2021-2024. Finally, it is tackled under the widening of the European Research Area agenda.

Competition law is a key element of ensuring well-functioning markets and innovation. Markets need rules to operate well and to be competitive. Competition law helps to foster free and open competition. The functioning of markets is closely interlinked with innovation performance. Aghion et al. (2005) find strong evidence of an inverted-U relationship between product market competition and innovation, with most sectors being located at the upward sloping segment of the curve, where increased competition fosters innovation. Non-competitive markets, with barriers to starting and operating a business, hamper the innovation potential of economies. The negative impact of malfunctioning markets on innovation becomes more pronounced when financial markets are not sufficiently developed and cannot provide alternative financing to young and new companies, especially those based on intangible assets that face more difficulties in providing collateral. At the same time, innovative activities require adequate protection through intellectual property rights. Although intellectual property can be overused and misused (see Boldrin and Levine, 2002), it remains an important pillar of successful innovation policies.

Competition policy has contributed to preserving and fostering the EU's economic prosperity. Vigorous competition enforcement has served European consumers, citizens and businesses, by empowering them to make choices in the marketplace and benefit from innovative products and services at affordable prices. The European Single Market, together with the continuous use of all competition instruments (merger law, antitrust law and state-aid control) will be crucial in leading EU industries toward the twin transitions while allowing consumers a fair share of the resulting benefits. EU competition policy helps to set the right incentives for companies to use resources efficiently, avoid stranded assets and innovate their production processes towards greater sustainability. Indeed, regulators need to remain vigilant, including in light of the increasing market power of some firms and the acceleration of this trend during the COVID-19 pandemic.

The potential of public procurement to bring innovative solutions to the market is not fully exploited in Europe. Public buyers in the EU spend around 17% of GDP on public procurement every year, amounting for more than €2.3 trillion per year[37]. Procurement represents a key source of demand for firms in sectors such as construction, health care, space and defence systems, energy and transport. The public sector can employ innovation procurement as a powerful demand-side instrument for tackling societal challenges (Lember et al., 2014), and this use of public demand as an engine for the development, uptake and diffusion of innovation has attracted interest both at EU and national levels. In 2004, France,

36 https://data.consilium.europa.eu/doc/document/ST-10338-2021-INIT/en/pdf.

37 www.eafip.eu. This spending consists of €1 765 billion (13% GDP) of public procurement performed by public authorities, €436 billion (3,5% GDP) by public procurers in the energy, transport, postal, water and waste management sector and €75 billion (0,5% GDP) by defence procurers.

Germany and the UK issued a position paper (French, German, UK Governments, 2004) to the European Council calling for the use of public procurement across Europe to spur innovation, which was continued by various calls of the Council of the European Union[38]. In 2015, the European Research Area and Innovation Committee (ERAC) in the Council adopted a position with 5 concrete recommendations to mainstream innovation procurement across Europe: creating national strategies and action plans, financial incentives, national competence centres, EU wide knowledge sharing and an EU wide monitoring system for innovation procurement with an indicator in the EU Innovation Scoreboard.

In order to address these challenges, several actions have already been taken at national and EU level. At national level, 10 Member States have meanwhile setup **national action plans or strategies for innovation procurement**, 12 have national competence centres, 13 provide national financial incentives and 9 setup national monitoring. 11 Member States have already implemented policies that encourage public buyers to leave IPR ownership in public procurements as much as possible with contractors in line with the recommendation of the EU IPR action plan. At EU level, the European Commission has gradually reinforced since 2013 **EU financial incentives for innovation procurement**. Grants in EU funding programmes such as Horizon 2020, Horizon Europe, COSME, Innovation Fund, CEF, Digital Europe Program and the European Structural Funds have already co-financed hundreds of innovation procurements and the new Recovery and Resilience Facility will fund many more to come. The EIB has also provided loans to Member States for innovation procurement programs. The Commission also funded the creation of a **European network of national competence centres on innovation procurement**[39] and a **European Assistance For Innovation Procurement**[40]. In 2021, the Commission also published the first **EU-wide benchmarking on national policy framework and investments on innovation procurement** and is preparing to launch the second one to take stock of progress made meanwhile[41] and is preparing to launch the second one to take stock of progress made meanwhile.

Evidence has also been building up on the positive impacts of innovation procurement both for public buyers and participating companies and researchers. Literature suggests that innovation procurement has a positive impact on private spending on research and innovation activities and innovation commercialisation success (Edquist and Zabala-Iturriagagoitia, 2012), and it also appears that innovative public procurement may be more effective than R&D grants in stimulating private expenditure on innovation (Guerzoni and Raiteri, 2015). EU funded pre-commercial procurements have proven to decrease costs of innovative solutions with 20% for public buyers, increase interoperability of solutions with 50%, open up 20 times more cross-border sales opportunities for companies, almost triple the amount of contracting from SMEs and more than double their commercialisation success rate[42]. Similar effects have been observed in such procurements across Europe[43]. A 2004 Eurobarometer survey also showed that com-

38 See in particular: COMP Council Conclusions (30 May 2008, 26 May 2010, 21 Feb 2014, 27 May 2016), EU Council Conclusions (4 Feb 2011, 26 April 2012 and 25 October 2013) and EP resolution on PCP (3 Feb 2009)

39 https://procure2innovate.eu/home/.

40 www.eafip.eu provides local innovation procurement assistance to public buyers across EU Member States.

41 Impacts of EU funded Pre-Commercial Procurements, published on EU webpages

42 Impacts of EU funded Pre-Commercial Procurements, published on EU webpages

43 Comparison of impacts of national and EU level pre-commercial procurements, published on EU webpages

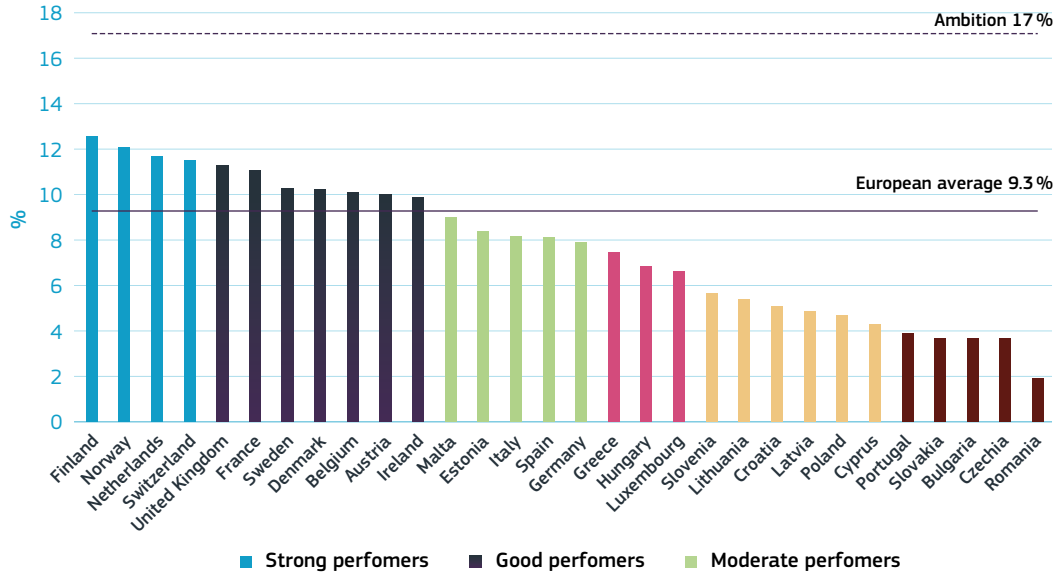
panies that participated in a public procurement of innovative solutions, were four times more likely to win additional procurement contracts later (European Commission, 2004). It is also argued that a healthy economy needs approximately 20% of its public procurement expenditure to be devoted to innovation procurement investments in order to reach a sufficient level of early adopters that are needed to encourage the rest of the market to widely adopt the innovations afterwards (3% to public procurement of R&D to trigger the development, pilot deployment and testing of innovations, and 17% to public procurement of innovative solutions to stimulate early adoption of solutions)[44].

Despite the efforts, public buyers across Europe are still not widely implementing innovation procurement (Figure XX). Benchmarking across 30 European countries212 demonstrated that in 2018 these countries devoted 9.6% of their total public procurement expenditure (10.6% when including defence) to the purchase of innovative solutions, an equivalent of €265 billion excluding defence and €305 billion including defence. This consisted of €16,6 billion of R&D procurement (€10,2 billion excluding defence) and €288 billion of procurement of innovative solutions (€255 billion excluding defence). This means that R&D procurement investments were still only at 0,6% instead of 3% of total public procurement expenditure, while investments in public procurement of innovative solutions were at 9,3% instead of 17% of total public procurement. While a doubling of overall innovation procurement investments is needed to reach 20% of public procurement expenditure, the biggest increase (with a factor 5) is needed for R&D procurements.

The underlying factors explaining underinvestment are linked to the status of development of national policy frameworks for innovation procurement. On average, the 30 countries around Europe have so far only deployed one quarter (26,6%) of the potential measures to stimulate innovation procurement. However, countries with stronger national policy frameworks that have deployed a more comprehensive set of policy measures also achieve higher national investments in innovation procurement, and as a result faster public sector modernisation and faster industrial growth. The benchmarking therefore concluded that additional EU and national efforts are needed to substantially reinforce both policy frameworks and investments in innovation procurement.

44 See Commission notice on innovation procurement C(2018)3051, based on the Bell innovation curve for conservative sectors

Figure 7.2-5: Benchmarking of national procurement for innovative solutions out of total public procurement expenditure (including defence), 2018



Science, Research and Innovation Performance of the EU 2022

Source: European Commission (2021a).

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2. Economic freedom and the flexibility of the labour market

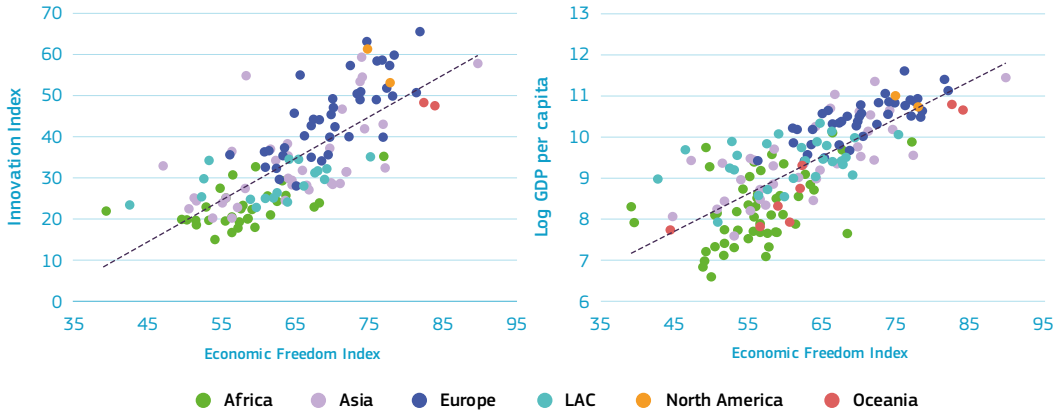
Economic freedom[45] leads to greater prosperity and innovation. The freedom of individuals to work, produce, consume and invest according to their preferences, within a clear, simple and supportive regulatory environment and with cohesive political institutions promoting common interests, is a crucial prerequisite for socioeconomic growth (Robinson and Acemoglu, 2012; Besley and Persson, 2011). The empirical literature on the impact of economic freedom on economic growth is wide, with most studies finding a positive association between measures of economic freedom and economic growth (Berggren, 2003; De Haan et al., 2006). Other studies report evidence on the relationship between economic freedom and innovation. For example, Zhu and Zhu (2017) uses firm-level data in the US to find a positive association between economic freedom and corporate innovation (measured by patent filings and citations), while controlling for other factors. At the same time, Kuckertz et al. (2016) shows how economic freedom has a greater explanatory power for economies in the earlier stages of development than for innovation-driven economies. According to the authors, this happens because economic freedom eases necessity-driven entrepreneurship (NDE) more than opportunity-driven entrepreneurship (ODE).

Figure 7.2-6 depicts the positive relationship between the Index of Economic Freedom[46] and the Global Innovation Index, as well as GDP per capita. The scatterplots contain cross-country level data for around 180 nations, highlighting how countries with a higher overall degree of economic freedom perform better in terms of prosperity and innovation. Even though the presented plots do not represent causal evidence, they are an instructive descriptive depiction of the relationships at play.

45 Gwartney and Lawson (2003) define economic freedom as a multidimensional concept composed of 'personal choice, voluntary exchange, freedom to compete, and protection of persons and property'. Gwartney and Lawson (2008) extend the concept of economic freedom to consist of five elements: (1) the size of government (government spending, taxes and government enterprises), (2) property rights enforcement, (3) sound money (monetary and inflationary policies), (4) open trade policies, and (5) regulation of business, labour and credit markets. An explanation of the theoretical mechanisms according to which each of these components may affect economic performance can be found in Justesen (2008).

46 The Economic Freedom Index is a composite index produced by The Heritage Foundation in collaboration with The Wall Street Journal. It ranks countries based on their degree of economic freedom using 12 variables that can be grouped into four broad categories: (1) rule of law (property rights, government integrity and judicial effectiveness), (2) government size (government spending, tax burden, fiscal health), (3) regulatory efficiency (business freedom, labour freedom and monetary freedom), (4) open markets (trade freedom, investment freedom, financial freedom). In a similar analysis, Carlsson and Lundström (2002) discuss critically the benefits and drawbacks of using such composite indices of freedom.

Figure 7.2-6: Economic Freedom Index[1] and Global Innovation Index[2] (left panel), and GDP per capita[3] (right panel), 2020



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Unit Service – Chief Economist Unit, own elaboration.
Note: [1]"Economic freedom index" measurement is taken from The Heritage Foundation in collaboration with The Wall Street Journal (2021 edition). [2]The Global Innovation Index is produced by the Cornell University, INSEAD, and the World Intellectual Property Organization. [3]GDP per capita, in PPP (constant 2017 international $) is collected from the World Bank database.
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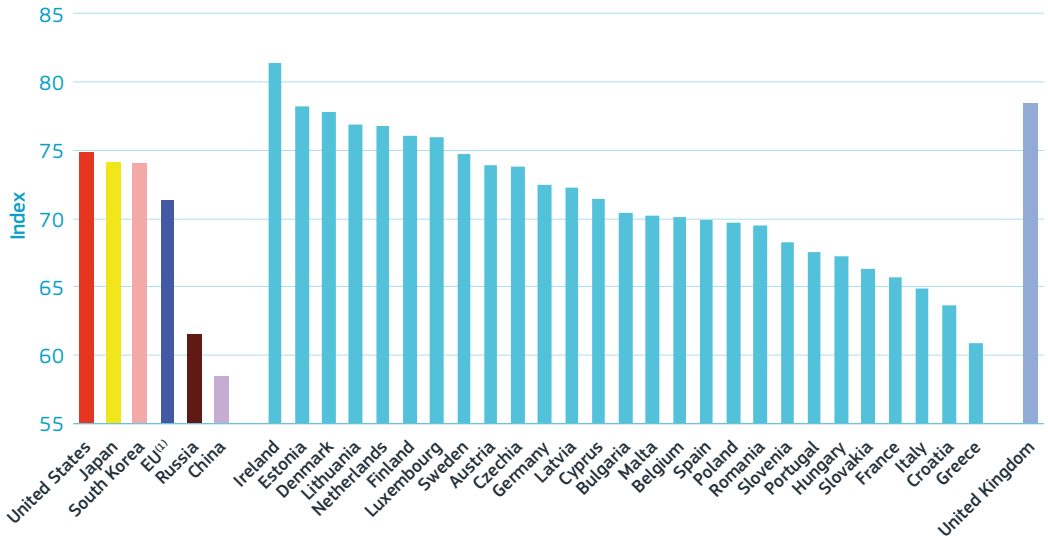
Ireland and the UK present the highest level of economic freedom in Europe, closely followed by Nordic countries such as Denmark, Lithuania, the Netherlands and Finland. Noticeably, northern European countries present higher levels of economic freedom than the US, Japan and South Korea. The social contract in these Nordic countries combines relatively high taxation and generous welfare state provisions with highly liberalised markets, secure property rights and rigorous public-spending discipline. European nations with less economic freedom are Greece, Croatia and Italy. Contrary to the general pattern, China has a strong innovation and economic performance despite its low degree of economic freedom.

A more flexible labour market is generally associated with more efficient resource allocation, higher employment and productivity. The facilitation of hiring and reduction of dismissal costs provides firms with incentives to hire workers and invest, especially when engaging in innovative activities with highly uncertain outcomes. Rigidities in salary structures and complex firing practices have negative bearings on firms' investments and may discourage the adoption of innovation, hampering growth prospects (Tressel and Scarpetta, 2004; Thum-Thysen et al., 2017). At the same time, it is necessary to underline that 'flexible' shall not be misunderstood as 'unregulated' or 'unfair', as unregulated markets rarely lead to optimal outcomes.

Figure 7.2-7: Economic Freedom index, 2020



Science, Research and Innovation Performance of the EU 2022

Source: DG Research and Innovation – Common R&I Strategy and Foresight Unit Service – Chief Economist Unit, own elaboration based on the economic freedom measurement from The Heritage Foundation in collaboration with The Wall Street Journal (2021 edition).

Note: (1)EU is an unweighted average of the 27 Member States.

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The relationship between labour market flexibility and innovation is more nuanced. On the one hand, a more flexible and competitive labour market may allow more efficient allocation of resources and reduction of barriers to entry, possibly leading to more innovation activity. On the other hand, more employment security can facilitate research projects that typically require longer-term commitments from researchers and management. Empirical research has found that the impact of labour market flexibility on innovation depends on the type of innovation and the sector (Bassanini and Ernst, 2002; Arvanitis, 2005; Lucidi and Kleinknecht, 2010; Wachsen and Blind, 2016; Hoxha and Kleinknecht, 2020). For example, Cetrulo et al. (2019) find a negative correlation between temporary employment and innovation in those sectors where tacit firm-specific knowledge is crucial for the innovation process.

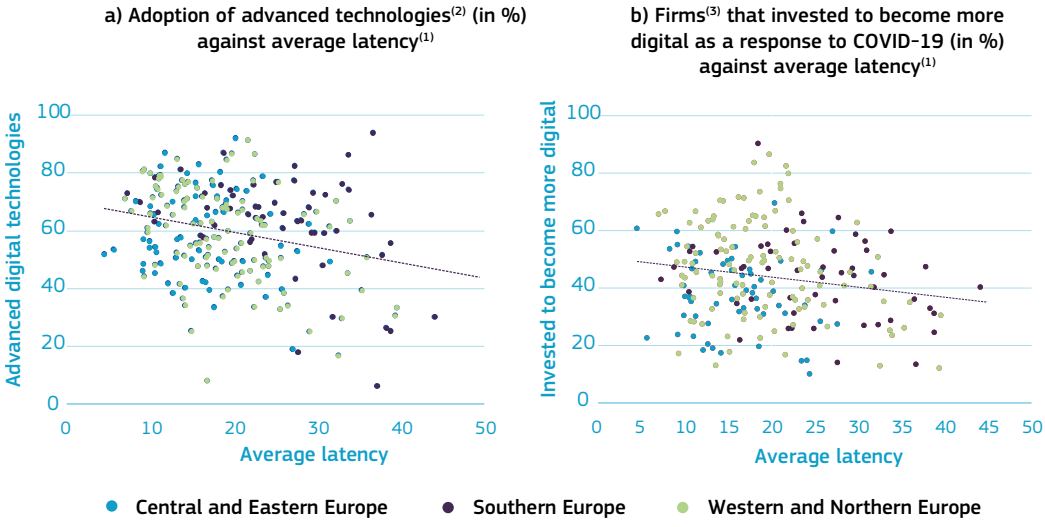
Labour mobility, particularly mobility of R&D workers, can positively impact innovation. Mobility of researchers facilitates knowledge circulation and expansion of research networks. For example, for Sweden, Braunerhjelm et al. (2020) find that knowledge workers' mobility has a positive and strongly significant impact on innovation output, as measured by firms' patent applications. Kaiser et al. (2015) also find positive effects on innovation (measured as patenting) of R&D workers' mobility, in Denmark. Furthermore, knowledge flows to inventors' former workplaces are approximately 50% greater than to other firms, indicating the importance of networks (Agrawal et al., 2006).

3. Digital infrastructures and access to data

The pandemic pushed forward the digitalisation process of many EU businesses, accelerating the uptake of digital technologies (see Chapter 5.3 – The ICT sector and digitalisation). To fully reap the benefits of the digital transformation, it is necessary to create a safe and inclusive digital space for both citizens and EU enterprises, safeguarding EU values and protecting citizens' fundamental rights, while enhancing Europe's digital sovereignty.

In this regard, access to efficient digital infrastructures is essential to foster the digital transition. This is particularly relevant in the context of the EU post-pandemic economic recovery. According to the EIBIS 2022 carried out by the EIB between April and July 2021, 16% of EU firms indicated that access to digital infrastructure was the main obstacle to investment (EIB, 2022).

Figure 7.2-8: The quality of digital infrastructure and digital adoption in the EU during the COVID-19 pandemic, by NUTS region



Science, Research and Innovation Performance of the EU 2022

Source: EIBIS (2021), firms in EU and European Data Journalism Network (2021)

Note: (1)Latency is the time it takes for data to be transferred between its original source and its destination, measured in milliseconds. (2)See note to Figure 3 in the report for the definition of the adoption of advanced digital technologies. (3)Firms are weighted with value added.

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The ability of firms to invest in digitalisation varies significantly across EU regions, depending on the quality of the underlying operating environment. Using average latency[47] as a proxy for quality of the internet connection, the results from EIBIS 2022 show that EU regions having low average latency typically report higher uptake of digital technologies. As illustrated by Figure 7.2-8, firms operating in regions with better access to digital infrastructure also invested more in digitalisation after the onset of the pandemic, confirming that the presence of a well-functioning operating environment plays a key role in steering firms' investments into digital solutions (EIB, 2022).

A second important enabling condition for the digital transformation concerns the availability of people with appropriate levels of digital literacy. Firms active in countries in which a higher share of the population have digital skills tend to report a higher uptake of advanced digital technologies, as well as a higher level of digital investment (EIB, 2022). As such, improving digital education and training systems is essential to foster the digital transition in the EU (for more on digital skills, please refer to Chapter 4.3 – Skills in the digital age).

As new digital technologies become available, so does the amount of data to manage and process. In this regard, **the creation of a secure digital market in which data sharing and USge is performed in accordance with EU common values is at the top of the EU policy agenda.** In November 2020, the European Commission presented its first legislative initiative in this sense, the Data Governance Act (DGA). This act aims to promote data availability and reuse across sectors and EU borders, thereby guiding the creation of EU-wide common interoperable data spaces in strategic sectors such as energy, mobility and health.

In building an inclusive and secure digital market, increased attention is paid to the role and functioning of online platforms. Increasing the transparency of the rules governing digital services is the underlying objective of both the Digital Services Act (DSA) and the Digital Markets Act (DMA). These two legislative acts ultimately aim to create a safe digital space in which EU citizens' fundamental rights are also protected online, and to regulate the behaviour of large online platform, thereby ensuring a level playing field for EU businesses, which is essential to boost innovation and growth.

47 Latency is defined as the time necessary for data to be transferred between its original source and its destination, measured in milliseconds (EIB, 2022).

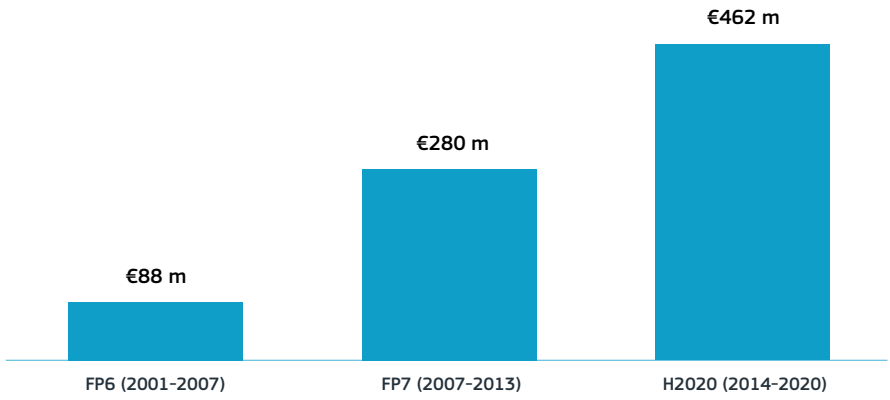
4. Towards a framework for open science and engagement of citizens

Engagement of civil society in science is critical to enrich science, reinforce trust in it and facilitate innovations and their uptake by industry and citizens. Finding the relevant framework conditions to encourage and develop the engagement of society in science is a key part of the success of R&I policy programmes. As recalled by Mariya Gabriel, the European Commissioner for Innovation, Research, Culture, Education and Youth, 'interaction between citizens, scientists and policymakers is essential to enrich research and innovation and reinforce trust of society in science' (European Commission, 2020a). It requires opening up the R&I system to the participation and collective intelligence of society, embedding high integrity and ethics standards, raising interest in science and supporting Europe's brightest minds to engage in scientific careers. Europe cannot thrive without ensuring the best possible match between the immense potential achievements science has to offer and the needs, values and aspirations of citizens (European Commission, 2020b).

Co-creation and engagement of civil society are key pillars of Industry 4.0 and 5.0. An open and ecosystem-based approach, embedding co-creation rather than a linear supply-chain approach has been proven more relevant when dealing with Industry 4.0 solutions (Benitez et al., 2020). Besides, adding co-creation as an antecedent condition leads to trust in business-to-business relationships (Franklin and Marshall, 2019). To address the inherent complexity in innovation ecosystems, economists, sociologists, policy analysts, management scholars and technologists will find it to their advantage to increase collaboration for joint elaboration of conceptual categories, as well as theoretical and empirical approaches that can better describe emergent phenomena, parameters and patterns. The interdependence between technological and social changes and the growing complexity in technological systems, generating complexity in societies and economies, calls for more cocreation (Russell and Smorodinskaya, 2018).

Engagement of civil society in science is a key focus of R&I policies at the EU level, and is included in the R&I framework programmes of the European Commission, as well as in the European Research Area. Citizen science is a powerful tool for public engagement and empowerment in policymaking and for raising awareness, notably when environmental issues and policies are concerned (European Commission, 2020). Under the seventh framework programme for R&I (FP7) (2007-2013), the Commission funded several projects involving citizen science, including Socientize, an initiative to promote and support citizen science. Under the eighth framework programme (2014-2020), **the Horizon 2020 'Science with and for Society' sub-programme aimed to build effective cooperation between science and society, foster the recruitment of new talent for science and couple scientific excellence with social awareness and responsibility.** A budget of EUR 462 million was allocated to this sub-programme. Since its start, 150 projects have been funded for a total budget of EUR 319 million.

Figure 7.2-10: Evolution of budget allocated to 'Science with and for Society' in EU R&I framework programmes



Science, Research and Innovation Performance of the EU 2022

Source: European Commission. Warin C., Delaney N. (2020). Citizen Science and Citizen Engagement - Achievements in Horizon 2020 and recommendations on the way forward.

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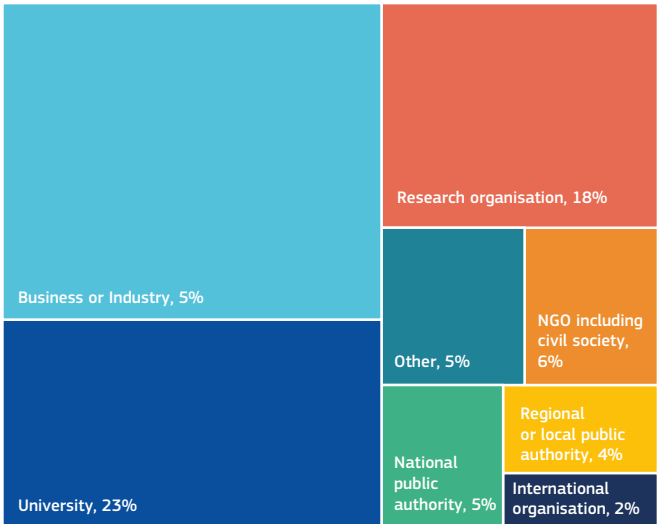
Horizon 2020 also funded citizen science under its ICT programme, in particular through collective awareness platforms for sustainable and social innovation (CAPs). This included crowd and citizen-sensing initiatives such as the Making Sense project, supporting the creation of online platforms to raise awareness of sustainability problems and to put in place collective, cooperative solutions by enabling people to share knowledge, make better-informed decisions as consumers, nudge collective environment-aware behavioural change and establish more participatory democratic processes. Another important example is **the 'citizens' observatories' and their second generation, which were funded under the 'Earth observation' topic in Horizon 2020**. The observatories are community-based environmental monitoring and information systems covering, e.g., air pollution, flooding, drought or water quality. They enable the public to monitor the quality of the environment, e.g., through innovative Earth-observation apps.

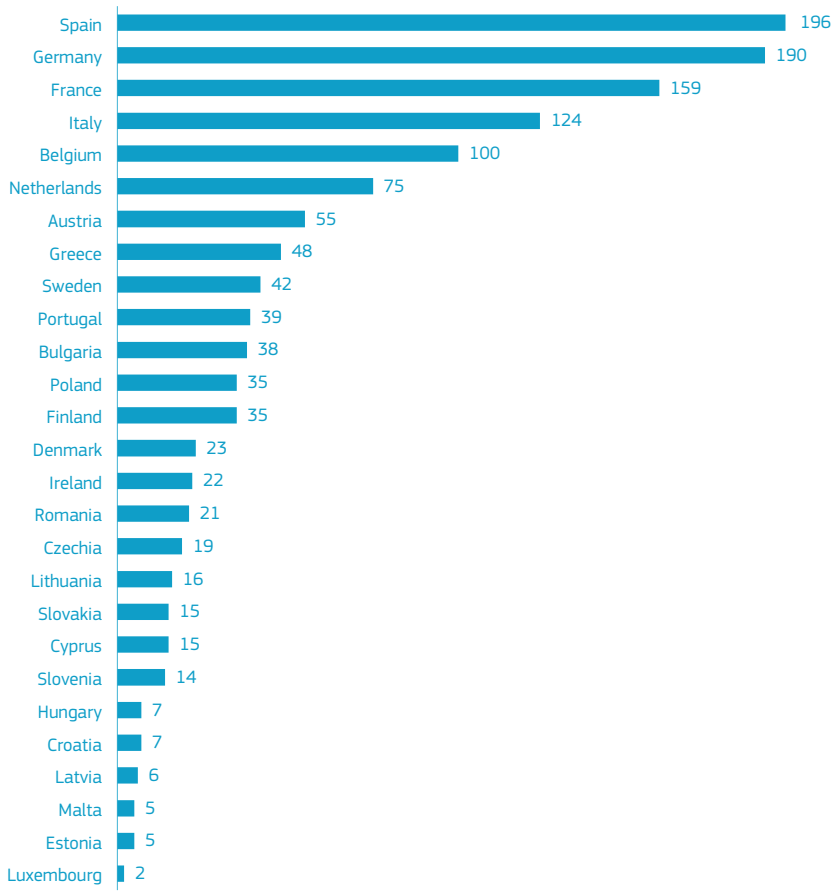
In Horizon Europe, citizen engagement has become even more prominent. It has been envisioned as taking place in terms of co-design (e.g. developing research agendas), co-creation (e.g. involving citizens and/or end-users in developing new knowledge and innovations), **and co-assessment** (e.g. continual contribution to governance), taking the concept of responsible R&I further. The strategic plan of Horizon Europe has been co-designed, in particular through a web-based consultation and views expressed by participants in the European Research and Innovation Days. In total, the views of more than 10 000 respondents across 64 countries – from universities, research organisations, industry and civil society and covering all Member States – were integrated into the strategic planning (European Commission, 2019).

Figure 7.2-9: Co-design of the strategic plan for Horizon Europe, origin of respondents in the EU and across sectors to the web-based consultation, 2019

a) Share of sectors in the co-design of the strategic plan for Horizon Europe



b) Origin of the respondents in the EU (absolute number)



Source : DG R&I based on reports from the European Commission on Horizon Europe Co-design

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Since its development, open innovation has been described as a 'new imperative for creating and profiting from technology' (Chesbrough, 2003). In a closed innovation model, firms internalise their firm-specific R&D activities, and commercialise them through internal development, manufacturing and distribution processes. In contrast, an open innovation model is characterised by the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively. West and Gallagher (2006) identified three fundamental challenges for firms in applying the concept of open innovation: finding creative ways to exploit internal innovation, incorporating external innovation into internal development, and motivating outsiders to supply an ongoing stream of external innovations.

Table 7.2-1: **Models of innovation and resulting managerial issues**

Innovation model	Management challenges	Resulting management techniques
Proprietary (or internal or 'closed')	1. Attracting the 'best and brightest' 2. Moving research results to development	1. Provide excellent compensation, resources, and freedom. 2. Provide dedicated development functions to exploit research and link it to market knowledge.
External	1. Exploring a wide range of sources for innovation. 2. Integrating external knowledge with firm resources and capabilities	1. Carefully scan the environment. 2. Develop absorptive capacity and/or use alliances, networks and related consortia.
Open	1. Motivating the generation and contribution of external knowledge (motivating) 2. Integrating those sources with firm resources and capabilities (incorporating) 3. Diversifying the exploitation of IP resources (maximising)	1. Provide intrinsic rewards (e.g. recognition) and structure (instrumentality) for contributions. 2. As above 3. Share or give away IP to maximise returns from entire innovation portfolio.

Source: West and Gallagher (2006).

Open science through the sharing of knowledge, data and tools in the R&I process, in open collaboration with all relevant knowledge actors, is another key element of Horizon Europe. Horizon Europe features 'research infrastructures', which will support the development and consolidation of the European Open Science Cloud (EOSC) through a dedicated Partnership (European Commission, 2021b). Marie Skłodowska-Curie Actions will also promote the diffusion of open-science practices and will support the development of appropriate skills among researchers. **The European Missions of Horizon Europe will connect all relevant actors through new forms of partnerships for co-design and co-creation and involvement of multiple sectors and actors.** Horizon Europe will also support European partnerships with EU countries, the private sector, foundations and other stakeholders. The aim is to deliver on global challenges and industrial modernisation through co-creation and concerted research and innovation efforts.

The European Research Area will also increase coordination, exchange of good practices and tools, development of guidance and training, implementation of institutional changes, and consolidation of evidence on impacts. Furthermore, the Widening Participation and Strengthening the European Research Area part of Horizon Europe will support the further development of the open-science policy and adoption of open-science practices. **The Open Research Europe (ORE) publishing platform will also provide Horizon 2020 and Horizon Europe beneficiaries with the possibility of using a high-quality open-access peer-reviewed publishing venue, at no cost to them, during and after the end of their grants.** This will not only help beneficiaries to meet their open-access obligations, it also will further incentivise pre-prints and open peer-review. It is also expected that a new multidisciplinary, cloud-based and open repository for research materials from Horizon Europe projects will be developed, offering services at no cost to its beneficiaries.

Finally, **one of the nine Key Impact Pathways of Horizon Europe, 'strengthening the uptake of innovation in society', starts with projects in which members of the public and end-users co-create R&I content**. A section under 'reforming and enhancing the European R&I system' focuses on citizen science.

5. Conclusions: an innovation-friendly environment

Setting the correct framework conditions to allow innovation and knowledge to flourish is an important prerequisite for success in R&I in Europe. The overall framework conditions in which companies operate are fundamental as they set business incentives and shape the innovation capacity of economies. Good framework conditions positively affect business-investment decisions, ease access to markets for new and innovative companies, and contribute to reallocating resources towards more productive and innovative activities. Political stability, transparency, accountability, and a high degree of rule of law with a low risk of expropriation and corruption allow transaction costs of trade and the costs of monitoring and enforcing contracts to be reduced. Within such an environment, firms are incentivised to innovate and to take calculated risks for innovation.

Economic freedom, within a clear and simple regulatory environment and with cohesive political institutions promoting common interests, is essential to foster prosperity and innovation. Regulation can act as a major driver of innovation, as it brings stability and certainty, which foster investment and planning and enable firms to work on safe legal ground. Flexible labour markets are more efficient at allocating resources, leading to higher employment and productivity. However, 'flexible' is not to be misunderstood as 'unregulated', as unregulated markets rarely lead to optimal outcomes.

The emergence of new practices, technologies and business models and the pacing problem due to the acceleration of innovation call for more flexible and experimental approaches to regulation. Furthermore, citizens need to be engaged in R&I as they are critical to enriching it, reinforcing trust in science and facilitating the innovation process and its uptake by industry and citizens. To ease citizens' participation, it is necessary to create a safe and inclusive digital space for both citizens and EU enterprises, fostering up-skilling, reskilling and life-long learning.

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