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The Green and Digital Twin Transition: EU vs US Firms

Using new and unique survey evidence on digitalisation activities and investment in climate change of non-financial firms in the EU and the US, this article documents the trend towards twin digital and green investment in the corporate landscape after the COVID-19 pandemic. We use information from the 2021 European Investment Bank Investment Survey on firms' use of advanced digital technologies and their investments to tackle physical and transition risks from climate change. We show that a substantial share of firms is not implementing any state-of-the-art digital technologies, has not invested to tackle climate change, and furthermore has no plans to invest in the near future. At the same time, numerous firms have made the twin transition by investing in both digitalisation and environmental sustainability and plan to further increase their investments post-COVID-19. Comparing EU and US firms, the pandemic did not help to bridge the digital gap between the EU and the US, with European firms more likely to be stuck on the wrong side of the digitalisation divide. Still, they are more likely to be leading on green investment, including on twinning green and digital technologies.

The COVID-19 crisis has led to wider recognition of the importance of a sustainable and digital transformation. The pandemic forced many firms to fundamentally transform their business in order to prevent disruption, such as organising work remotely and redesigning communication with customers, suppliers and employees. The coronavirus pandemic and its recovery could thus turn out to be a shock that accelerated the twin green and digital transformation

of the corporate sector, helping to make the post-COVID-19 economy more resilient and sustainable. Yet, the uncertainty created by the pandemic simultaneously led many firms to cut investment and postpone further plans to invest.

European policymakers' ambitions on a twin transition are clear. The European Green Deal and the EU's Digital Strategy are the cornerstone of the recovery plan for Europe post-pandemic. Combined with the national recovery and resilience plans, the initiatives are seen as a unique opportunity to transform the EU economy, making it both greener and more digital in a twin transition. The US also has an ambitious recovery plan and plays an important role in the development of new technologies in the digital and green areas. Whether the EU can lead in the twin transition remains to be seen. A close monitoring of the evidence mapping and characterising EU firms on their digital and green technology adoption compared to their international counterparts is needed to identify the shape of the twin transition challenge for the EU economy.

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This paper uses unique data from the 2021 European Investment Bank Investment Survey (EIBIS) covering EU and US firms' investments in digital and green technologies during the COVID-19 crisis, and their post-pandemic plans. It finds that while the US has a higher share of digital firms than the EU, Europe is stronger in green firms and twin firms simultaneously embracing green and digital transition. At the same time, EU firms – more than their US counterparts – express great concerns about future

uncertainties and the impact of climate change on their businesses and the related investments.

The remainder of this paper is organised as follows. We first provide the 2021 evidence from EIBIS on digital and green investments by US and EU firms. We then characterise the profile of EU and US firms by their position on the digital and green technology adoption grid and finally look at barriers to investment faced by EU and US firms, depending on their position on the grid. Throughout the paper, the analysis is purely correlational and cannot be interpreted as causal. The last section concludes with policy implications for the green and digital recovery from the COVID-19 crisis.

Evidence on adoption of digital and green technologies

EIBIS is an annual survey that gathers information on firm characteristics as well as quantitative and qualitative data on firms' investments. In addition, EIBIS also asks questions about expectations and perceptions of firms' management (e.g. plans for future investment, short-term outlook and obstacles to investment).¹ Importantly, EIBIS data are collected for a large number of firms across different countries and sectors, making it possible to carry out a comparative analysis of investment activities across sectors, countries and regions, most notably between European and US corporates.

This paper uses the 2021 wave of EIBIS, covering 11,920 EU firms and 802 US firms to identify firm profiles based on two dimensions:

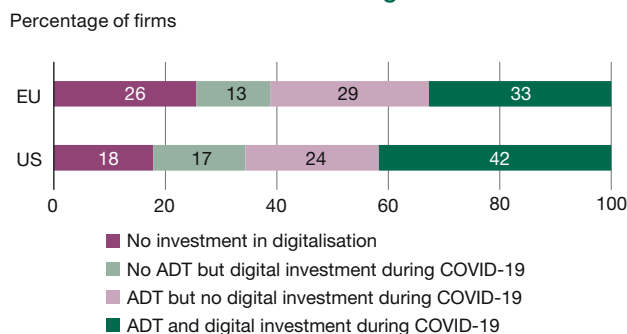
1. their adoption of the digital technologies which are state-of-the-art for their sector²
2. their investment to tackle the impacts of weather events and reduction in carbon emission.

Investments in advanced digital technologies

When asked about whether their firm adopted any of the digital technologies that can be considered state-of-the-art

- 1 For more information on EIBIS, see e.g. Ipsos (2020), EIB (2022) and Brutscher et al. (2020).
- 2 A firm is identified as "digital" if at least one digital technology is implemented in parts of the business and/or if the entire business is organised around one digital technology. Firms in *manufacturing* are surveyed about the use of: (a) 3D printing, (b) robotics, (c) the internet of things, (d) big data/artificial intelligence. Firms in *construction* are surveyed about the use of: (a) 3D printing, (b) drones, (c) the internet of things, and (d) virtual reality. Firms in *services* are surveyed about the use of: (a) virtual reality, (b) platforms, (c) the internet of things, and (d) big data/artificial intelligence. Firms in *infrastructure* are surveyed about the use of: (a) 3D printing, (b) platforms, (c) the internet of things, and (d) big data/artificial intelligence.

Figure 1
Firms that use advanced digital technologies (ADT) and invested to become more digital



Source: EIBIS (2021).

for their sector, 62% of EU firms reported in 2021 adopting advanced digital technologies; for US firms, this was 66%.³

When asked about their investment in digital technologies, specifically as a response to the COVID-19 crisis, 46% of EU firms reported that they took steps to become more digital – for example, by providing services online. Although this is a substantial share of firms, US firms proved to be even more responsive, with 59% of US firms making investments to become more digital as a response to the crisis.

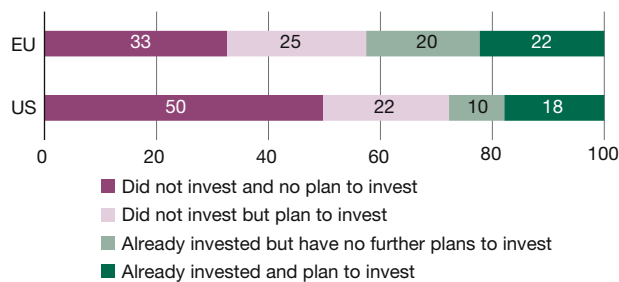
Firms that had already implemented at least one of the advanced digital technologies were more likely to report that they invested in increasing digitalisation in response to the COVID-19 pandemic (32.7% of companies adopting were already digitally active). This suggests that the pandemic, while stimulating digitalisation across the board, has also led to a widening of the digital divide across firms. Already digitally leading firms were more likely to accelerate digitalisation, while digitally lagging firms were less likely to transform during the crisis (Rückert et al., 2021). Fifty-three percent of EU firms that had already adopted advanced digital technologies invested further to become more digital during the pandemic. This compares to only 33% for EU firms that were non-digital.

A widening digital divide also emerges within the US: 49% of US firms that were non-digital before the pandemic used the crisis as an opportunity to start investing in digital technologies, compared with 64% of US firms that had already adopted advanced digital technologies pre-crisis. Yet, non-digital US firms showed a higher responsiveness to the crisis than their EU counterparts, leaving the share of firms which are consistent digital laggards much higher in

- 3 To make the sample representative of the economy, firms in EIBIS are weighted with value added.

Figure 2
Climate technology investment behaviour

Percentage of firms



Source: EIBIS (2021).

the EU (42%) than in the US (26%) and the share of persistent digital investors much smaller in the EU (18%) than in the US (33%) (Figure 1). Even though many firms adopted digital technologies during the COVID-19 crisis, it did not help to bridge the digital gap between the EU and the US.

Overall, although the data show that firms responded to the COVID-19 crisis with more digital technology investments, it was quite uneven, with digital technology-leading firms forging ahead and US firms being more responsive.

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

EIBIS also asks firms if they have already invested or if they plan to invest in the next three years to tackle the impacts of weather events and to deal with the process of reduction in carbon emissions, which are labelled as adoption of green technologies. In 2021, 42% of EU firms reported that they have already invested in green technologies compared to only 28% in the US, confirming the EU’s lead in adopting green technologies (see Figure 2). Half of US firms did not invest, nor did they plan to do so in order to tackle the impacts of climate change; in the EU, 33% of firms did not invest, nor plan to invest.

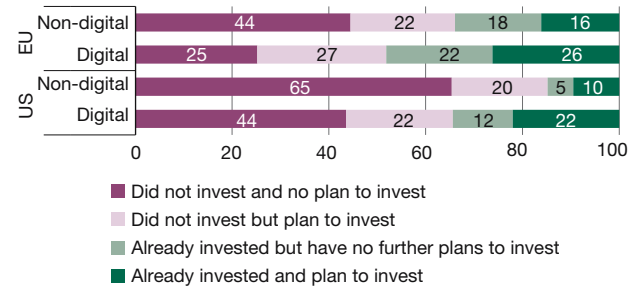
Digital and climate investments: To twin or not to twin?

Consistent with digital technologies being key enablers of the green transition, motivating twin transitions, we find that firms that have adopted advanced digital technologies are more likely to invest to tackle the physical and transition risks from climate change. Digital firms are more likely to report that they have already invested and have further plans to invest in green technologies, both in the EU and the US (Figure 3).

In addition, digital firms tend to invest more in measures to improve energy efficiency. The gap between non-dig-

Figure 3
Climate investment behaviour, by digital intensity

Percentage of firms



Source: EIBIS (2021).

ital and digital firms in energy efficiency investment is most pronounced for firms in the US (Figure 4).

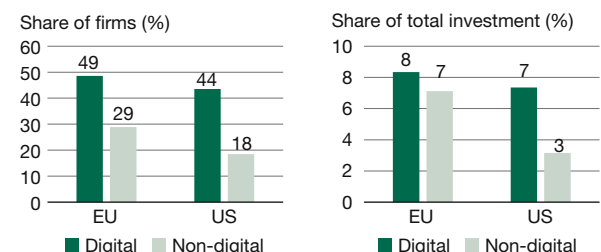
Mapping green and digital technology adoption

To better understand where firms are positioned on digital and green adoption and who is making a twin transition, we classify firms into four profiles based on their 2021 green and digital investments:

- Neither: firms that have invested neither in green nor in digital
- Green only: firms that have invested to tackle the impacts of physical and transition risks from climate change but have not yet adopted digital technologies
- Digital only: firms that have implemented at least one advanced digital technology, but without green investments
- Green and digital twinning: firms that have invested both in green and digital technologies.

Figure 5 maps the EU and US firms on the green-digital grid. As previously discussed, the US has a higher share of “digital only” firms, while the EU has a higher share of firms that are “green only”. Only 5% of US firms are “green only”. Also,

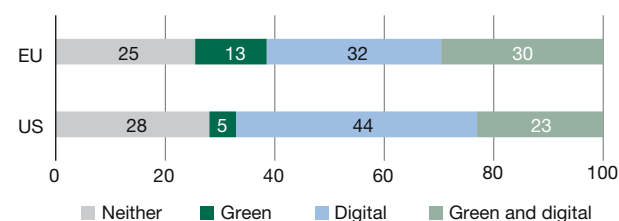
Figure 4
Firms investing in measures to improve energy efficiency and investment allocated to these measures



Source: EIBIS (2021).

Figure 5
Green and digital corporate profiles

Percentage of firms



Note: Firms are classified into four profiles based on their 2021 green and digital investments.

Source: EIBIS (2021).

the share of “green and digital twinning” firms is higher in the EU (30%) than in the US (23%). The share of firms that are “neither” green nor digital is comparable across regions. The data thus confirm the stronger digital profile of the US corporate sector and the stronger green profile of the EU corporate sector, on average. Despite their digital lag relative to the US, the EU has more firms twinning green and digital technologies than the US.

EIBIS evidence on firms’ future investment plans further suggests that the green-digital divide between firms may continue to grow over time, particularly the divide between the “neither” firms and the rest. Looking ahead at the next three years, both in the EU and the US, “neither” firms are more likely to have no investment plans compared to all other firms. About one in five firms falling in the “neither” category report that they do not have any investment plans.

Also the divide separating the “green and digital” profiles, i.e. those making the twin transition, may be sharpened, at least in the EU. When looking at plans to expand capacity, the “green and digital” firms are most active among EU firms, forging ahead compared to not only EU firms that are “neither”, but also to those making only a green or only a digital transition. But when comparing EU and US firms, US firms are the ones more likely to expand capacity, especially the digitally advanced firms (Figure 6).

Characterising firms along the digital-green grid

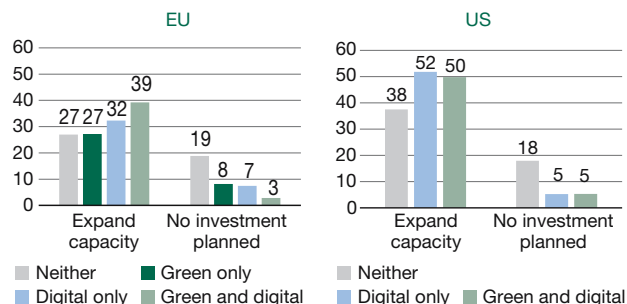
To better understand the green and digital transition challenge for firms, we need to examine where the firms are positioned on the green-digital grid.

Size, age and sector

When looking at firm size, the EIBIS data confirm that larger firms are more likely to be twinning green and digital transitions than small ones, both in the EU and the US (Figure 7),

Figure 6
Investment priority, 2021-2024

Percentage of firms



Notes: Firms are classified into four profiles based on their 2021 green and digital investments. For the US, the category of “green only” has too few observations for reporting.

Source: EIBIS (2021).

which is what we would expect, given that the adoption of these technologies involves high fixed costs and can be risky.

Given firm size, we expect young firms will be more prone to adopt the latest technologies. There are, however, not many differences between age cohorts in the EU. Only in the US, the cohort of young firms that are able to scale beyond 50 employees (medium-large) are significantly more likely to be investing in both green as well as digital technologies: 33% of them are “green and digital” (compared to 24% of old US medium-large and 31% of EU young medium-large).

When looking at sectoral differences, presented in Figure 8, the manufacturing sectors have a higher share of firms that are twinning “green and digital” in Europe (35%). For US manufacturing, this is only 18%. The construction sector has a particularly high share of European firms that invest in neither green nor digital technologies (43%). It is the sector with the highest share of “neither” firms in the EU, a share that is higher than in the US construction sector (33%).

Multivariate analysis⁴ confirms that US firms are significantly more likely than EU firms to be “digital only”. EU firms are significantly more likely not only to be “green only”, but also to be twinning “green and digital”, even when comparing within age-size cohorts and sectors.

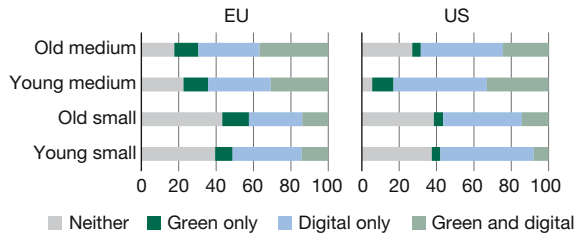
Management practices

Twinning “green and digital” firms tend to implement better management practices than “neither” firms (Figure 9).⁵

⁴ The results from multivariate analyses are not reported in this contribution, but can be found in Veugelers et al. (2022).

⁵ The descriptive evidence also holds in multivariate analyses that controls for the confounding effects of firm size, age, sector and region. These results are not reported but can be found in Veugelers et al. (2022).

Figure 7
Corporate green and digital profile, by firm size-age
Percentage of firms



Notes: Firms are classified into four profiles based on their 2021 green and digital investments. The firm size classes in EIBIS are as follows: micro (5-9 employees), small (10-49 employees), medium-sized (50-249 employees), large (at least 250 employees). Age is split into smaller (young) or larger (old) than 10 years.

Source: EIBIS (2021).

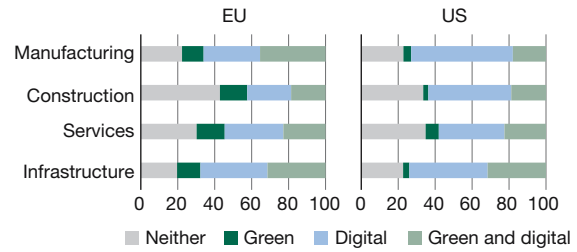
They use formal strategic business monitoring systems (with key performance indicators) more often. Those firms report more frequently that they have set and are monitoring targets on carbon emissions and energy consumption. This result is in line with results from previous studies highlighting the importance of management practices for technology adoption and firm performance (Bloom and Van Reenen, 2007). This adoption of better management practices holds particularly for firms twinning green and digital technologies and for the EU. The EU and its member states have a stronger record on tracking environmental, social and corporate governance (ESG) metrics – an area in which digital technologies may help firms monitor progress.

R&D and innovation

Diving further into the correlation of firms’ digital and green investment profile, we also look at their innovation profiles. Following Veugelers et al. (2019), we identify companies as “non-innovation active” if they did not invest in R&D and/or developed or introduced new products, processes and services. We would expect digital technologies to empower innovation and therefore firms that are moving ahead with digitalisation to be also innovation-active. The evidence confirms that those firms not digitally active (“neither” and “green only”) are more likely to be “non-innovation active” (Figure 10).

We can also identify “leading innovators” as those firms that have significant investments in R&D, which allowed them to successfully introduce innovations. Not surprisingly, almost no “neither” firm is a leading innovator. The group of firms that is most likely to be “leading innovators” are the firms adopting advanced digital technologies, confirming that these technologies enable firms’ innovative strategies. While the innovation enabling the adoption of green technologies is less pronounced than for digital technologies, the evi-

Figure 8
Corporate green and digital profile, by sector
Percentage of firms



Notes: Firms are classified into four profiles based on their 2021 green and digital investments. The sector classification in EIBIS is based on the NACE classification of economic activities: Manufacturing: group C; Construction: group F; Services: group G (wholesale and retail trade) and group I (accommodation and food services activities); Infrastructure: groups D and E (utilities), group H (transportation and storage) and group J (information and communication).

Source: EIBIS (2021).

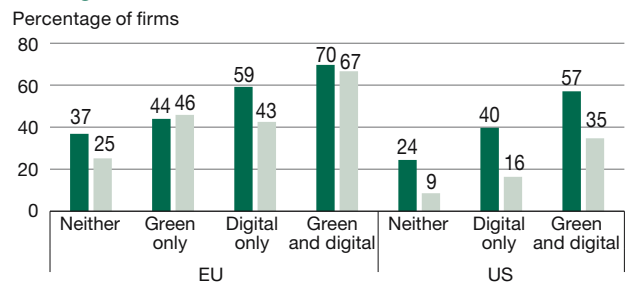
dence does suggest an added innovation benefit for those firms twinning green and digital technologies, at least for the EU. In the EU, 10% of “green and digital” twinning firms are innovation leaders in their sector (compared to only 6% for the US; and compared to 8% for “digital only” and 4% for “green only” in the EU).⁶

Labour markets: Employment growth and employee training

As many economists argue that digitalisation can have an impact on shifting demand for labour, particularly reducing the demand for low-skilled routine workers (Acemoglu and Autor, 2011; EIB, 2018; Acemoglu and Restrepo, 2020), we also look at the employment profile of the various types of

6 The descriptive evidence reported in this section also holds in multivariate analysis that controls for the confounding effects of firm size, age, sector and region.

Figure 9
Management indicators

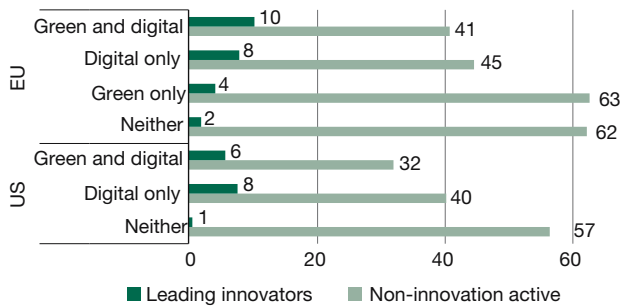


Notes: Firms are classified into four profiles based on their 2021 green and digital investments. For the US, the category of “green only” has too few observations for reporting.

Source: EIBIS (2021).

Figure 10
Innovation profiles

Percentage of firms



Notes: Firms are classified into four profiles based on their 2021 green and digital investments. For the US, the category of “green only” has too few observations for reporting. Non-innovator: no investment in R&D in the previous financial year and no introduction of new products, processes or services. Leading innovator: significant investment in R&D in the previous financial year and introduction of new products, processes or services that are new to the market (not only new to the company).

Source: EIBIS (2021).

firms. By comparing the current number of employees with the number of employees in the beginning of 2020 (before the introduction of coronavirus-related restrictions), Figure 11 shows that “twinning” firms are more likely to have increased employment during the pandemic. At the same time, those that invested neither in tackling climate change nor in adopting advanced digital technologies were more likely to downsize. The results also highlight that the reduction of employment was less common in firms in the EU than in the US.

In addition, firms undertaking structural transformation through green measures and digital technologies invest to train workers. The firms leading the green and digital transitions more often invest in employee training, compared to firms that do not invest in green or only in digital (Figure 12).

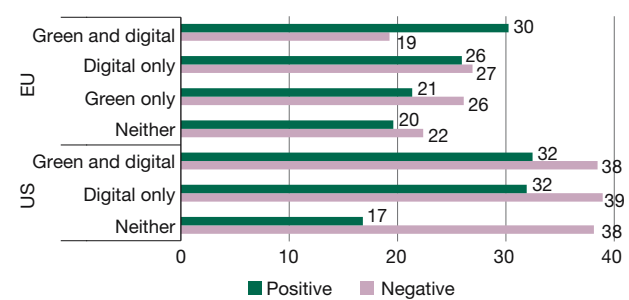
Perceived obstacles to investment along the digital green technology investment map

When activating policies aimed at stimulating digital and green investments, it is important to get a view on which factors most impede corporate investments. In particular, identifying the barriers impeding firms that are neither green nor digital is relevant to the development of policies that will help move these firms out of their “neither” status. EIBIS survey data allow us to look at the different barriers that firms report when making investment decisions.

The EIBIS results presented in Figure 13 show most clearly that the availability of staff with the right skills is the most important constraint for investment. This holds irrespective of where the firms are located on the green-digital grid, i.e. for “neither” as well as for “green and digital” profiles.

Figure 11
Employment growth

Percentage of firms



Notes: Firms are classified into four profiles based on their 2021 green and digital investments. For the US, the category of “green only” has too few observations for reporting.

Source: EIBIS (2021).

And this holds both in the EU as well as in the US, perhaps somewhat more so for US “green and digital” profiles.

Next in line as an obstacle for investing for EU firms is uncertainty in the business environment. Although this holds across the green-digital grid, it is more outspoken for “neither” firms: 44% of EU “neither” firms report it as a major obstacle compared to 35% of “green and digital” EU firms. Closely following “uncertainty” as an investment barrier are business and labour market regulations, and this again across the green-digital grid and for EU as well as US firms.

The most marked differences between EU and US firms in the perception of major obstacles to investment are energy costs, access to digital infrastructure and access to finance, which are much more marked as major obstacles for EU firms than for US firms. Energy costs are a stronger barrier not only for EU “neither” firms, but also for EU “green and digital” firms. Access to digital infrastructure, but especially access to finance is an investment barrier that stands out particularly for EU “neither” firms. And this holds for all size categories among EU “neither” firms (25% of small EU “neither” firms report access to finance as a major impediment for investing, 20% of bigger EU “neither” firms).

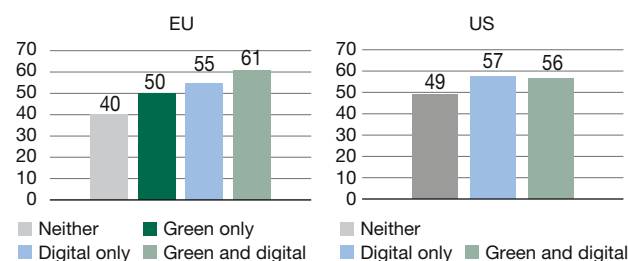
As uncertainty is one of the major impediments perceived by firms for investing, particularly for laggards and in the EU, the current high uncertainty and high energy costs can have serious negative implications for corporate investment in digital and green technologies. This affects “neither” firms in particular and exacerbates the corporate divide.

Conclusion

Using unique data from the 2021 EIB Investment Survey covering EU and US firms’ investment in green and digital

Figure 12
Firms investing in training

Percentage of firms



Notes: Firms are classified into four profiles based on their 2021 green and digital investments. For the US, the category of “green only” has too few observations for reporting.

Source: EIBIS (2021).

technologies during the COVID-19 crisis and their post-COVID-19 plans allows us to map and characterise EU firms on their green and digital technology adoption profiles compared to their US counterparts.

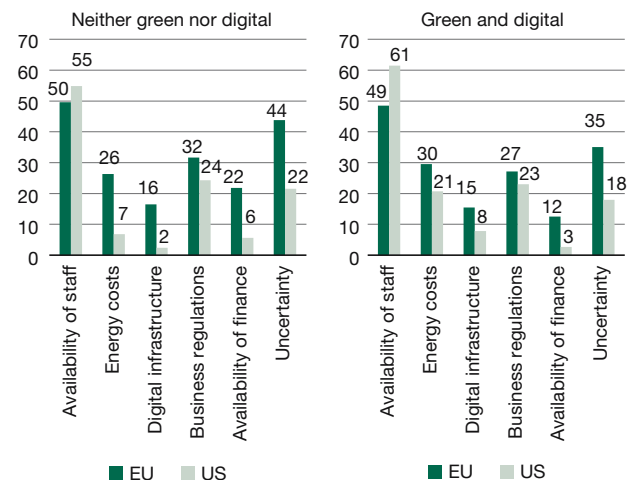
Our results provide evidence that EU firms are more likely to be stuck on the wrong side of the digitalisation divide than their US counterparts, but are more likely to be on the right side of the green investment divide. European firms are leading at the intersection of green and digital, with a higher share of EU firms twinning the green and digital transition. These green and digital twinning firms are more likely to be larger firms and in the manufacturing sector. Controlling for size, sector and region, “twinning” firms have better management practices, they are more likely to be innovation leaders and expand and train their workforce. These twinning firms are also the most likely to further expand their capacity in the future, while firms that have invested neither in green nor in digital are likely to have no plans to do so in the future.

As the potential for technological advancements in these areas further accelerates, the EU should be well-placed to maintain its lead at the crossroads of green and digital technologies, building on its twinning firms. But nothing should be taken for granted. The EIBIS evidence provides some early warning signals as the US, although still behind in hosting green-digital twinning firms, has more of its young firms twinning green and digital investments compared to the EU. It also shows that US firms are more likely to expand their investment in the future and face fewer other major obstacles when investing than their EU counterparts, with the exception of the omnipresent skills barrier.

To avoid the twin transition leading to a twin polarisation, firms that are neither green nor digital (often smaller firms), cannot remain inactive. As firms that are neither

Figure 13
Major obstacle to investment for firms

Percentage of firms



Note: Firms are classified based on their 2021 green and digital investments.

Source: EIBIS (2021).

green nor digital are also less likely to start investing, it is important for policymakers to remove the barriers that trap these firms in persistent inactivity. Lack of access to finance represents a particular impediment for EU firms that are neither green nor digital. Addressing this could therefore go a long way towards fixing the EU’s corporate green-digital twinning divide.

References

- Acemoglu, D. and D. H. Autor (2011), Skills, tasks and technologies: Implications for employment and earnings, in O. Ashenfelter and D. E. Card (eds.), *Handbook of Labor Economics*, 4B, 1043-1171, Elsevier.
- Acemoglu, D. and P. Restrepo (2020), Robots and jobs: Evidence from US labor markets, *Journal of Political Economy*, 128(6), 2188-2244.
- Bloom, N. and J. Van Reenen (2007), Measuring and explaining management practices across firms and countries, *The quarterly journal of Economics*, 122(4), 1351-1408.
- Brutscher, P.-B., A. Coali, J. Delanote and P. Harasztosi (2020), EIB Group survey on investment and investment finance – A technical note on data quality, *EIB Working Paper*, 2020/08.
- EIB (2018), Investment Report 2018/2019: Retooling Europe’s economy, European Investment Bank.
- EIB (2022), Investment Report 2021/2022. Recovery as a springboard for change, European Investment Bank.
- Ipsos (2020), EIB Group survey on investment and investment finance, Technical report, European Investment Bank.
- Rückert, D., R. Veugelers, A. Virginie and C. Weiss (2021), COVID-19 and the Corporate Digital Divide, *The Great Reset: European Public Investment Outlook*.
- Veugelers, R., A. Ferrando, S. Lekpek and C. Weiss (2019), Young SMEs as a motor of Europe’s innovation machine, *Intereconomics*, 54(6), 369-377, <https://www.intereconomics.eu/contents/year/2019/number/6/article/young-smes-as-a-motor-of-europe-s-innovation-machine.html>.
- Veugelers, R., C. Faivre, D. Rückert and C. Weiss (2022), The green and digital twin transition in the EU and the US, Unpublished manuscript.