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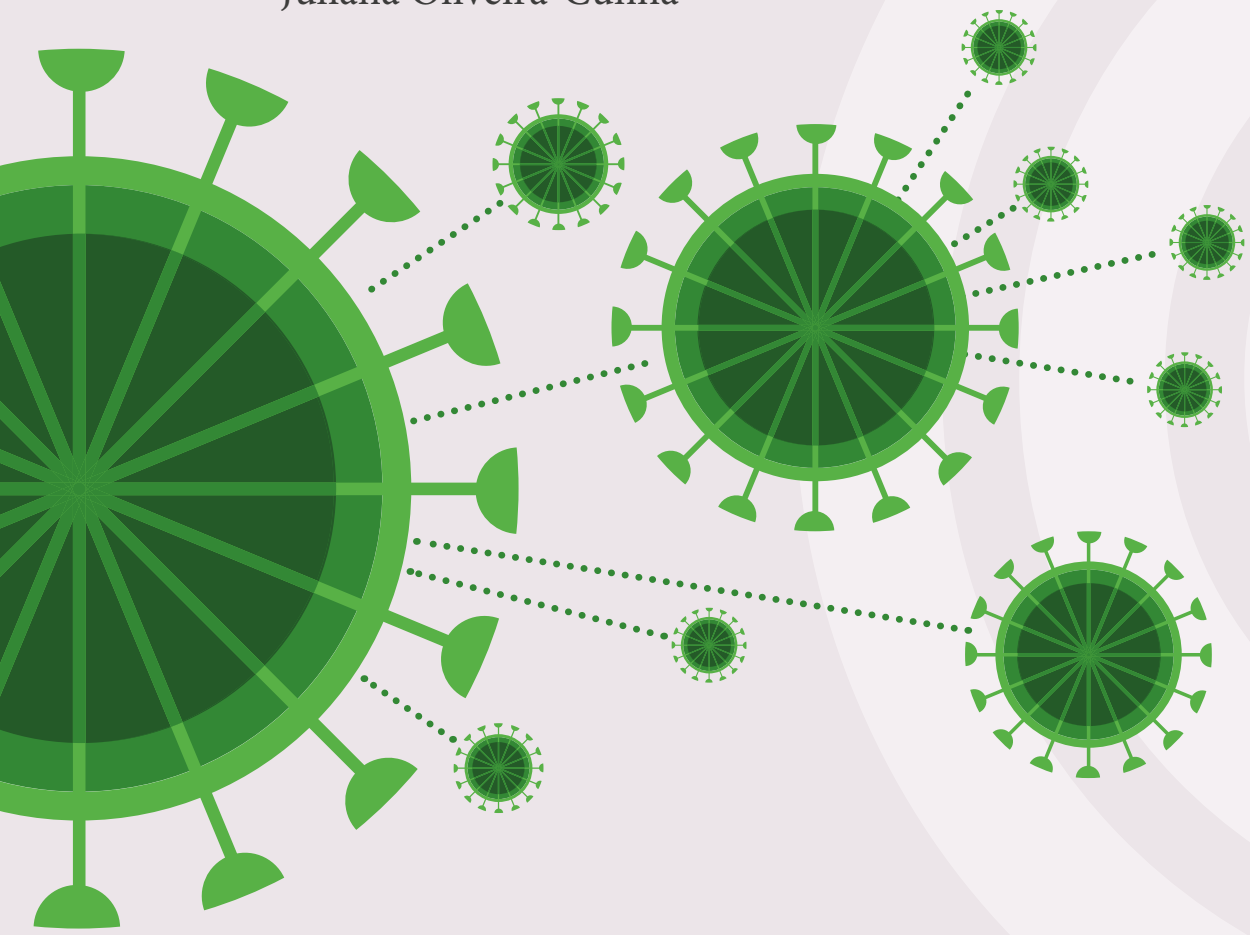
Anna Valero
Capucine Riom
Juliana Oliveira-Cunha



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The business response to Covid-19 one year on: findings from the second wave of the CEP-CBI survey on technology adoption

CEP COVID-19 ANALYSIS

Anna Valero, Capucine Riom and Juliana Oliveira-Cunha

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Summary

- We report results from the second wave of the CEP-CBI survey on technology adoption in response to the Covid-19 crisis, conducted in July 2021.
- **Process innovation has been widespread since March 2020.** 75% of firms have adopted digital technologies, 55% new digital capabilities and nearly 70% new management practices. Over 60% engaged in product innovation.
- **Adoption of digital technologies and management practices occurred early on** (March-June 2020) at many firms, although a **large share of firms continued to innovate beyond the initial lockdowns** (over July 2020-July 2021). In contrast, the share of firms adopting new digital capabilities was constant, while product innovation increased.
- As in our first wave survey (conducted in July 2020), **process innovation was more likely for larger and more technologically advanced businesses**. We also found that **product innovation was more likely in firms with a highly skilled workforce, and those that already introduced new products or services pre-pandemic.** These patterns could widen inequalities across firms.
- **New technologies related to sales and marketing, and people management/remote working business functions were the most frequently adopted** (over 70% and 66% of adopters respectively). **Technologies for remote working (video conferencing or collaboration technologies) were the most adopted 'specific' technology**, either alone or in "bundles" with other technologies including online sales, cloud, data analytics and cyber security.
- **Firms tended to report that new technologies had either positive (or no) impact on business performance and the workforce, although there are differences across types of firms**. For example, older firms were less likely to report increased turnover or profits, and smaller firms were less likely to report improved resilience or increased flexible working. Firms that had adopted new digital technologies prior to the pandemic were more likely to report improved resilience and worker productivity because of adoption during the pandemic.
- **Different technology applications had very different effects on businesses**. For example, businesses that adopted technologies relevant for online sales and marketing were more likely to report an increase in turnover and profits, while those that adopted remote working technologies were more likely to report an increase in worker flexibility and average working hours.
- This evidence suggests that **while there has been an increase in process and product innovation across the board, patterns of adoption and impacts suggest that gaps in performance between more and less digitised firms might be expected to widen in the future.**
- **In terms of barriers to adoption, lack of skills and applicability doubts have risen in prominence** since the first wave. **As before, new financial incentives in the form of tax incentives or grants are the most popular policies to address these**. Policy priorities are similar with respect to product innovation.
- **Businesses are taking environmental sustainability into account in technology adoption and broader organisational decision-making** presenting an opportunity for a joined-up approach to business support policies for a sustainable recovery from Covid-19.

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Centre for Economic Performance
London School of Economics and Political Science
Houghton Street, London WC2A 2AE, UK
Tel: +44 (0)20 7955 7673
Email: cep.info@lse.ac.uk Web: http://cep.lse.ac.uk

UKRI Economic and Social Research Council

Introduction

The pandemic has had a major impact on businesses. Social distancing requirements and changing patterns of demand have induced changes in operations and the introduction of new processes and products. Following years of poor productivity performance in the UK and a number of policies[1] that seek to address this, building a deeper understanding of these changes and what they imply for how businesses will emerge from the crisis in productivity terms is crucial for informing recovery policies.

Technology adoption is central to this. Evidence that emerged early on in the pandemic revealed that, while firms appeared to increase technology adoption versus what might be considered "business as usual". However, the impact of the pandemic on innovation was uneven. The adoption of process innovations, including new digital technologies and capabilities, was more likely in larger firms or those that had previously adopted digital technologies before the pandemic (Riom and Valero, 2020; Rückert et al., 2020; Cirera et al., 2020). Similar patterns have been found in other areas of innovation, including research and development (R&D) (Paunov and Planes-Satorra, 2021). Such unequal patterns could have long-lasting impacts on the economy, perhaps widening gaps between more digitised, innovative businesses and those that lag behind.

In this policy brief, we present new data from a survey of 425 UK firms conducted in July 2021 in partnership with the Confederation of British Industry (CBI). This is a follow-up to our initial survey conducted in July 2020, providing an updated view on the business innovation response over the year following the first national lockdown in March-June 2020. As in the first survey, our focus is on process innovation: in particular, digital technologies that are typically considered productivity-enhancing in normal times. In this survey, we ask more granular questions on the types of technologies adopted, impacts on firms and workers, and future plans. While the main questions relate to the diffusion of digital technologies, we also ask about investments in digital capabilities and management practices, as well as the extent to which firms have introduced new products or services since the onset of the pandemic. We therefore take a broad view of innovative activity in firms.

In the UK, the economic shock from Covid-19 has occurred at the same time as the country's departure from the European Union, and increasing policy and business focus on the transition to Net Zero greenhouse gas emissions. In our survey, we seek to identify the extent to which innovation has been prompted or accelerated by the pandemic, and explore the interplay between decision-making around technology and environmental sustainability strategies.

We find that technology adoption has been widespread and has continued beyond an initial response to the first lockdown. As expected, remote working technologies have been a key area, but online sales and marketing technologies have also been widespread, together with cloud technologies, data analytics and cyber security. Rather than simply bringing forward investments that would have occurred in the future, firms considered that technology adoption during the pandemic has accelerated future plans for adoption. Overall, firms tended to report positive (or unchanged) impacts on business performance or the workforce. We find similar patterns in terms of the introduction of new products or services. As in our first survey, we find that smaller firms have been less likely to innovate, and previous innovation is a strong

[1] For example, the "BEIS Business Basics" programme, and more recently, the "Help to Grow: Digital and Management" schemes announced in the 2021 Plan for Growth.

predictor of adoption since the crisis, even after controlling for other factors. There is also some evidence of differential impacts of technology adoption, which could suggest that gaps between more and less digitised firms might widen in the future. Impacts also vary by technology application. For example, businesses that adopted technologies relevant for online sales and marketing were more likely to report an increase in turnover and profits, while those that adopted remote working technologies were not only more likely to report an increase in worker flexibility, but also in average working hours.

Our analysis adds to the empirical evidence on the business response to Covid-19, and on the enablers and barriers to innovation. Timely data on these issues are especially important because the impacts of the crisis on technology adoption are theoretically ambiguous (Valero and Van Reenen, 2021). On the one hand, given the nature of the Covid-19 crisis, businesses might have been expected to adopt new technologies in order to deal with the disruption. This appears to have been the case during the pandemic, and key examples would be remote working technologies or online sales, which have enabled businesses to maintain operations. In addition, a crisis might also induce managers to rethink ways of doing things, switching idle resources into reorganising operations. Moreover, looking at the effects on aggregate technology intensity and productivity, it is likely that less efficient businesses will shrink the most following a crisis. If capital and labour are fully reallocated to more productive, higher-technology firms, then overall productivity might rise via a process of "creative destruction" (Aghion et al., 2021). However, if capital and labour are not fully allocated, productivity might rise on average, but many might remain excluded from the economy, which is not a desirable societal outcome.

On the other hand, mainstream economic theory would predict negative effects of a crisis on firm technology adoption. Businesses face lower incentives to adopt new technologies in the context of falling demand (and hence lower returns on investment) or increased uncertainty (e.g., Bloom et al., 2007). Moreover, reduced cashflows and capital market imperfections will constrain investment, and these are likely to apply to smaller firms, in particular. Finally, managerial time diverted to dealing with the immediate fallout from the crisis might prevent effective strategic decision-making on technology-related issues. While our focus in this survey is on process innovation, especially digital technology adoption, we also ask questions about R&D and product innovation, which has tended to suffer in previous downturns, particularly in credit-constrained firms (e.g., Aghion et al., 2012).

While the evidence from our first survey and other studies[2] suggests that Covid-19 has accelerated technology adoption, a mix of constraints (including financial) are likely to have limited more widespread diffusion, particularly amongst smaller firms. This view is reinforced by the results of our second survey reported here, and suggests that inequalities in performance between larger, more digitised firms and smaller firms that are slower to innovate. Our work links to the broader literature on Covid-19 on productivity (e.g., Bloom et al., 2020 on the UK; Bloom et al., 2021 on US small businesses) and working from home (e.g. Barrero et al. 2021; Criscuolo et al., 2021). Several studies have found that "digitally resilient" firms performed better during the pandemic, as measured using working from home feasibility in public firms in the US (Bai et al., 2021), analysis of "IT shields" and unemployment (Pierri and Timmer, 2020) and the effects of digital platforms (Raj et al., 2020).[3]

[2] See, for example, Luong and Ri (2021), ERC (2020), Be the Business (2020), CBI (2020), Lloyds (2020), Vodafone (2020), IBM (2020), Rückert et al. (2020), Apedo-Amah et al. (2020), Cirera et al., (2021)

[3] Lamorgese et al. (2021) document the relationship between management practices and resilience.

1. Our survey and sample

Our bespoke survey, in the field over the last two weeks of July 2021, was designed and conducted in collaboration with the Confederation of British Industry's (CBI) economic consultancy division, CBI Economics. The CBI is the UK's leading business organisation, representing 190,000 businesses across sectors and regions of the country.[4] Nearly all firms that responded were invited to participate via e-mails sent by the CBI to its survey panel, which is comprised of both its members and non-members. The survey was also disseminated separately to CBI members, in sectors which are not covered by its survey panel (principally construction). The survey was distributed via a combination of direct e-mailing and promotion on social media by both the CBI and the London School of Economics. The large majority of firms (97%) were recruited through direct communication from the CBI.

Some basic descriptives of the responding firms[5] are reported in the Appendix (Table A1). Overall, the composition of our sample is similar to Wave 1. Firms are relatively established, with 86% of the sample being over 10 years of age. 44% have fewer than 50 employees, and 53% are small in revenue terms (defined as having under £10 million of turnover a year), though these shares are slightly smaller than in Wave 1. 18% of the sample are in London, and over 50% are multi-site businesses. As in Wave 1, around three quarters of businesses had adopted new digital technologies in the three years pre-Covid.

We asked additional baseline innovation questions around engaging in R&D and introduction of new products (54% and 61% had in the last three years, respectively). Furthermore, 44% of businesses considered that digital technologies were already embedded in their business before the crisis. We also gathered additional baseline information to help predict innovation patterns, including exporter status (54% of businesses served customers overseas), perceived competition (67% considered that the business faced intense or very intense competition) and human capital (30% of firms reported that over half of the workforce have a university degree). Finally, we explored the extent to which decision-making was decentralised across hiring, capital expenditure (capex) and technology.

We compare the distribution of our sample to the distribution of the population of UK businesses across size bands, sectors and regions (see Figures A1-A3 in the Appendix). As in the first wave, we find that larger firms and manufacturing firms are over-represented. The sample has good regional coverage across UK's regions. Weighting key results to be more representative of the UK's firm size and sectoral GVA distributions has little impact on our core results (see discussion in Section 3). We report the unweighted data in the main discussion of survey results and explore differences in innovation and impacts by firm types in Section 6.

Of the 425 respondents in Wave 2, 59 firms also took part in Wave 1. Those firms are comparable to the full sample in terms of firm size and sector distribution. We anticipated that it would be challenging to obtain a high share of repeat respondents. Therefore, we asked

[4] Together, the CBI's membership employs nearly 7 million people, around a quarter of the private sector employed workforce. See De Lyon and Dhingra (2020) for an overview of CBI business surveys and recent trends.

[5] We manually verified responding firms to Companies House entries or company websites. Some educational institutions or public-sector organisations are included in our sample. We dropped instances of duplicates or firms that did not answer any of our core questions. The core sample that answered our main technology adoption questions is 425 firms.

questions in our Wave 2 survey that would enable an analysis of the timing of technology adoption since the onset of the pandemic and baseline information about firms before the pandemic.

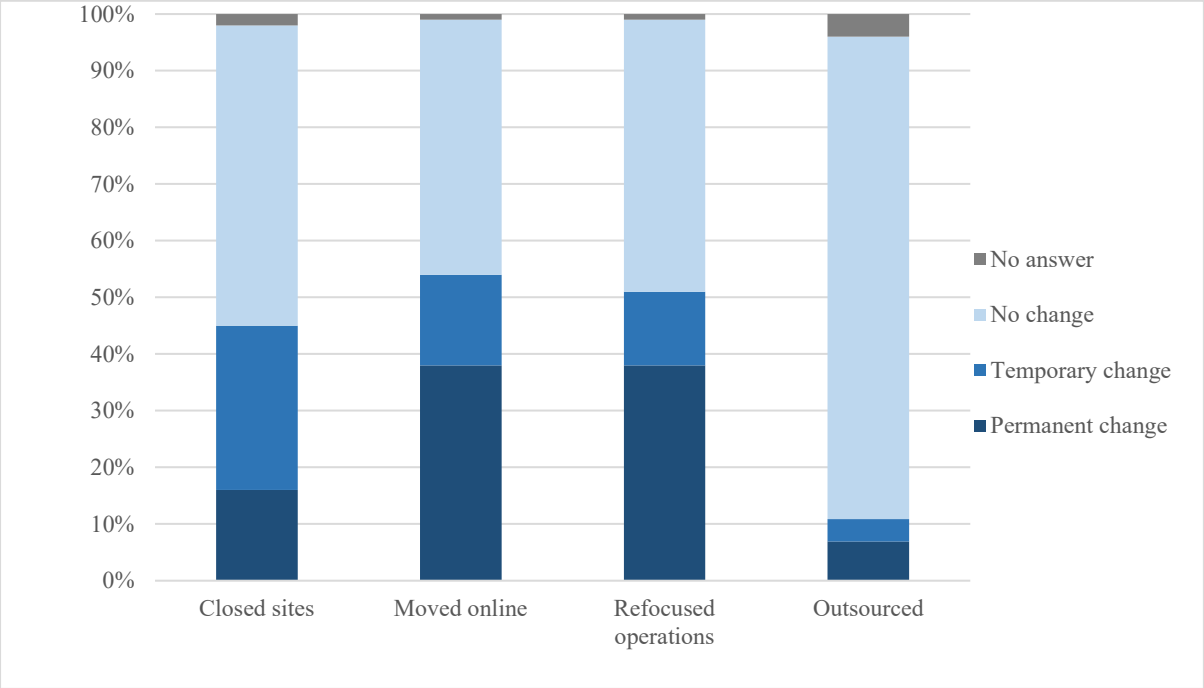
2. Overall impacts of Covid-19 on business operations and performance

Covid-19 has changed business operations across the economy

In line with our first survey, and other analyses (e.g., ONS BICS and DMP waves run around the same period), a large share of businesses have adjusted their operations due to Covid-19 (Figure 1). Over half of businesses refocused operations or moved operations online due to the pandemic, and the majority say these changes were permanent. Over 40% of firms closed sites, but, of these, less than half say that closures were permanent.

In terms of changes in organisation, only a small share (10%) say they outsourced operations because of the pandemic – though, most of those that did, also say that the change was permanent.

Figure 1: Change in business operations due to Covid-19

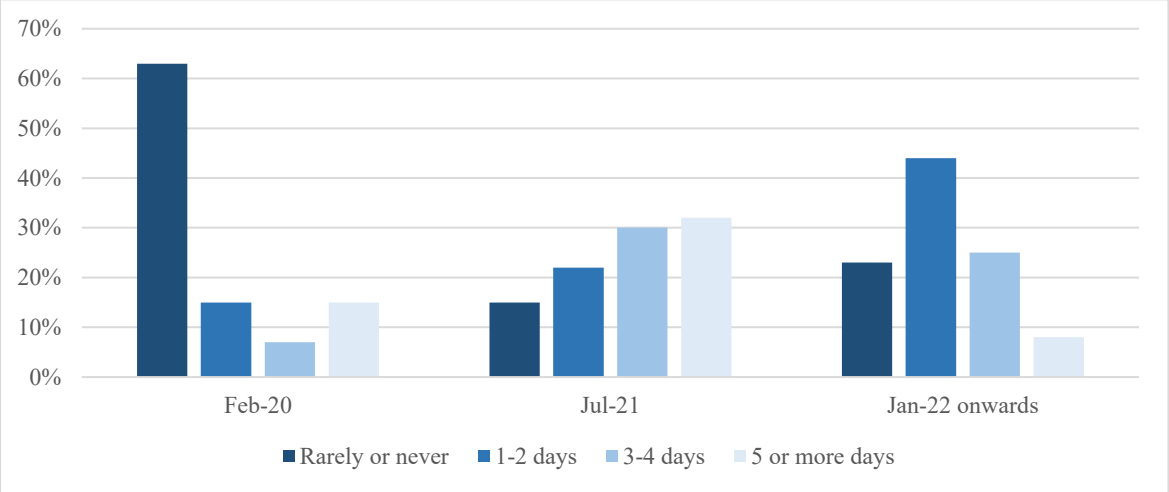


Notes: N=425.

We also asked if there had been any changes in decision-making structures. Whilst most businesses had not made changes in this area, of those that did, a move towards centralisation was somewhat more common (15-18% across hiring, capex and technology decisions) than a move towards decentralisation (under 10% across areas). This pattern might be rationalised if new technologies relate more to communication than information (e.g., Bloom et al., 2014), which is likely to be the case given the prominence of remote working technologies (see Section 4).

In line with other surveys (e.g., Bloom et al., 2021; DMP, 2021), remote working was still prevalent in July 2021, and expectations for January 2022 and beyond look very different to pre-pandemic (with 1-2 days at home most popular).

Figure 2: Patterns of remote working (days per week)



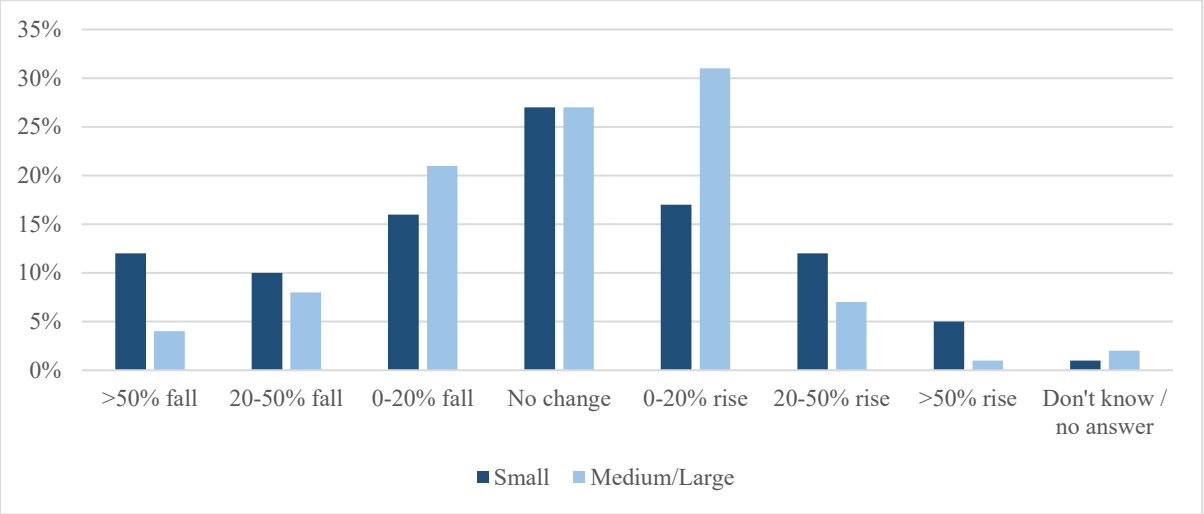
Notes: N=425.

Preferences between managers and workers on remote working policy seem broadly aligned in most cases. Where there is disagreement, it tends to be that employees want more frequent remote work than managers (see Appendix Figure A4).

In terms of business performance, Figure 3 plots the impact of Covid-19 on monthly turnover relative to "business as usual".[6] Around a quarter of small and larger firms report no change. Smaller firms are more likely to report a large fall or a large increase, compared to medium/large firms. This suggests that impacts on smaller firms were more dispersed, reflecting the disproportionately negative effect of the crisis on smaller firms[7], but also potentially the greater ability of some smaller firms to adapt quickly to shifts in the composition of demand and benefit from larger increase in turnover.

[6] This distribution is similar to the results in the ONS BICS Wave 37 (26 July – 8 August 2021), which found a similar percentage reporting a fall in turnover, but a higher share of firms that reported that they were unaffected or saw a small rise (0-20%). This survey also found that most firms attributed change in turnover to Covid.
[7] See, for example, Lambert and Van Reenen (2021).

Figure 3: Changes in monthly turnover

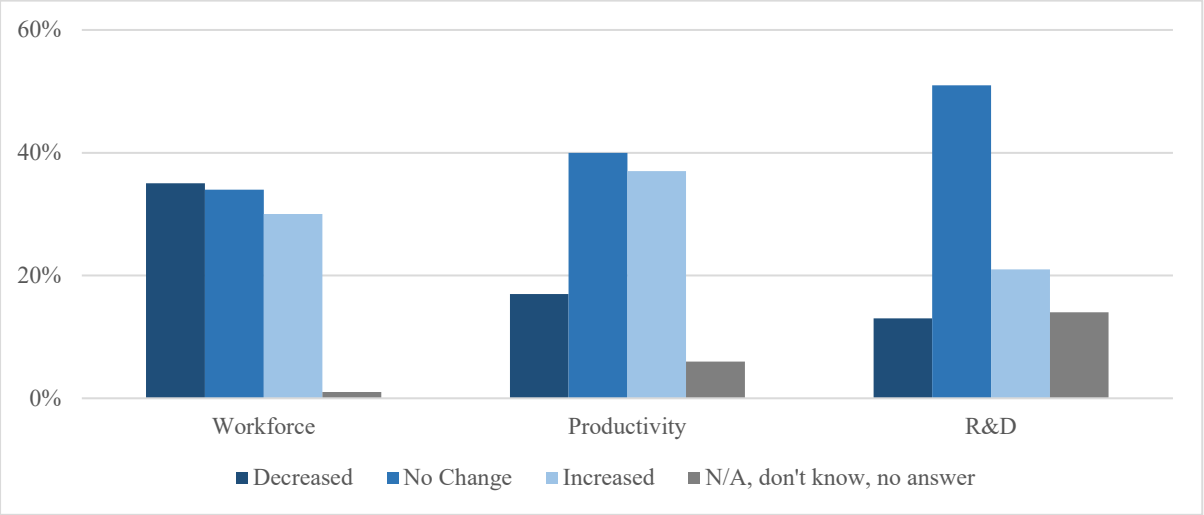


Notes: N=425.

Firms ascribe most change – both positive and negative – to Covid, though the combination of Brexit and Covid explained c.30% of reported revenue falls.[8]

More firms report a negative change in employment than productivity since the onset of the pandemic (Figure 4). The highest share of firms report no change in productivity and R&D investments, and a higher share report a rise than a fall in both these areas.[9]

Figure 4: Changes in employment, productivity, and R&D



Notes: N=425.

A large majority of firms took up government support schemes. Consistent with our first wave, as well as other surveys[10], the Coronavirus Job Retention (furlough) scheme was by far the most popular, with around three quarters of our sample reporting take-up (Figure A5). Over 25% of firms took up tax deferrals and support schemes, and just over 20% of respondents took up the Coronavirus Business Interruption Loan Scheme.

[8] This pattern of responses is consistent with ONS BICS (2021).
[9] The finding that more firms raised R&D than cut it is consistent with the Decision Makers Panel (2021).
[10] For example, ONS BICS.

As at the second half of July 2021 when our survey was in the field, around the time of the so-called "Freedom Day" (19th July) when Covid restrictions were eased significantly, firms were confident in terms of their future prospects: the vast majority considered it to be very likely (92%) or somewhat likely (6%) that they would be in business in January 2022. However, when asked how much longer they expected their operations to be impacted by the pandemic, there was an even split between those answering less than a year (42%) and over a year (40%).[11]

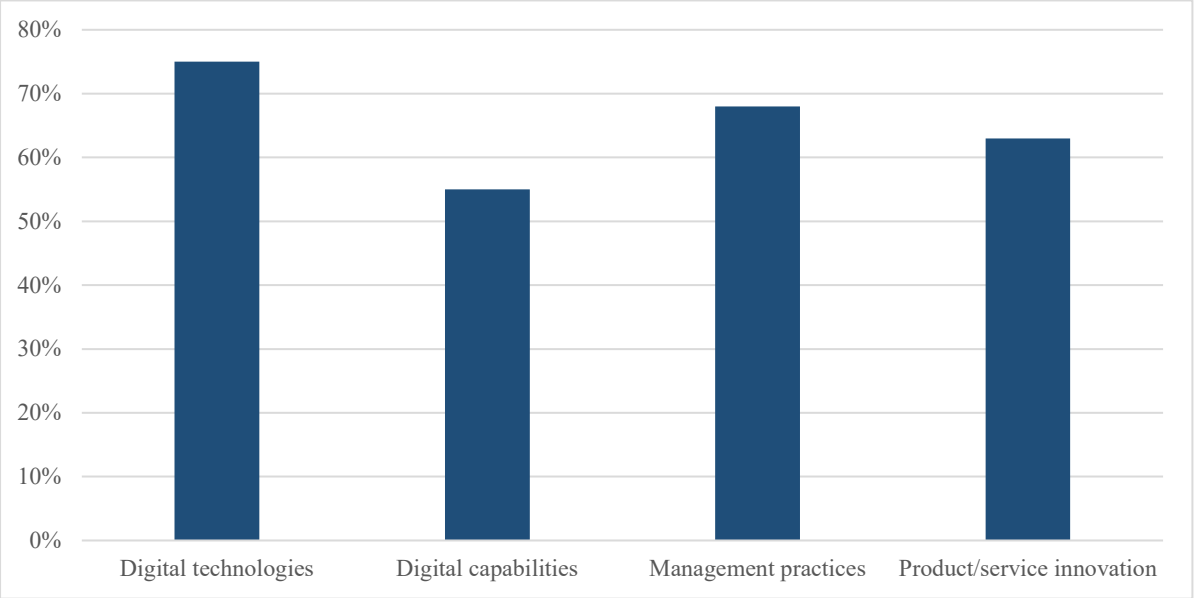
3. The overall innovation response to the pandemic

A majority of firms have adopted productivity-enhancing technologies and practices or introduced new products/services in response to the pandemic, and have continued to innovate through the crisis

As in our first survey, we asked firms whether they had engaged in four different types of innovation since the onset of the pandemic: adoption of new digital technologies, digital capabilities or management practices, or the introduction of new products or services. In the Appendix (Table A2), we detail the relevant innovations underlying each category, which we provided as examples in both waves to ensure consistency.

Firms report a strong overall business innovation response to the Covid-19 crisis across these categories since March 2020 (Figure 5). 75% of firms have adopted digital technologies, 55% new digital capabilities and nearly 70% new management practices. Over 60% engaged in product innovation.

Figure 5: Overall innovation response to Covid-19



Notes: N=425, N=393, N=388, N=376 responded to each question, respectively.

Our sample of firms is likely to be more innovative, and respondents more able to answer innovation questions, that the average firm in the UK

[11] The rest either answered "do not know" or "business operations are not affected).

Weighting these results to better represent the population of UK firms[12] leads to lower adoption rates across digital technologies, capabilities and management practices (Figure A6). This is because smaller firms are underrepresented in our sample and were less likely to innovate in all these categories (Figure A7). This approach gives very large weight to the 65 "micro" businesses (0-9 employee) in our sample, which had lower innovation rates, particularly in the case of management practices. Product/service innovation rates are unchanged by weighting.[13]

The ONS BICS wave 38 (23 August to 5 September 2021) asked some questions on innovation that were consistent with our core innovation questions. In particular, it asked firms if they had engaged in the following types of innovation since the start of the pandemic: adoption of digital technologies, changes in management practices, improvement of existing products or services and introduction of new products or services. The weighted responses, based on a sample of nearly 40,000 firms are shown in Appendix B for all businesses, and excluding micro businesses (0-9 size band). The shares innovating across all dimensions are lower than those implied by our survey, even when compared to our results based on the weighted sample (Figure A6). However, a very high share of businesses (46% across the entire sample) answered "not sure" in BICS.[14] Therefore, the differences between our findings and the BICS results are likely due to selection issues in terms of the types of firms that responded to our survey (the latter was comprised of larger firms on average, relative to BICS), and the fact that respondents themselves were perhaps more aware of technology issues in the business.

Given our relatively low sample size and resulting issues in claiming that respondents are representative of other firms in their strata (we still see differences between our weighted results and those in BICS), we focus on reporting unweighted results for our respondents in the aggregated analysis that follows, and provide a deeper analysis of heterogeneity in innovation rates and impacts across size bands and other key firm characteristics, controlling for sector, in Section 7.

Businesses continued to innovate beyond the initial lockdowns in March to June 2020, and for process innovations the vast majority stated that the pandemic either prompted or accelerated innovation

We asked firms about timing of adoption (Figure 6). Across types of innovation, a high share innovated in the year following July 2020. The pattern over the period of March to July 2020 is consistent with Wave 1, with the highest shares relating to digital technologies and management practices. In these two categories, activity was highest in the first period, but many firms made further investments beyond that. The introduction of new products or services grew in the second period, where 60% of firms innovated, compared with 50% in the first lockdown.

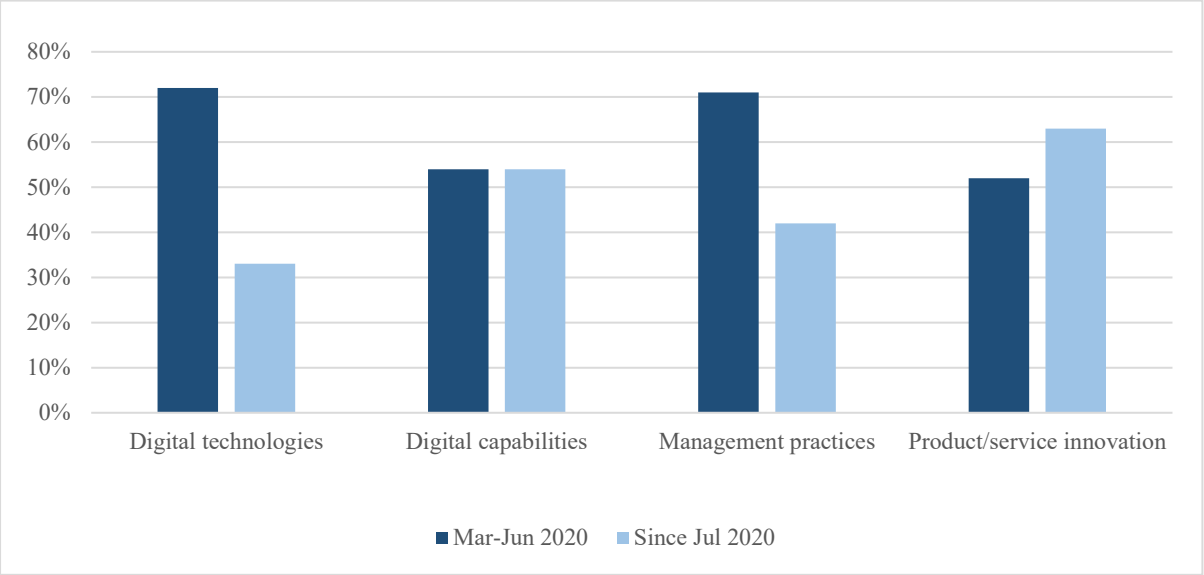
[12] We followed the ONS BICS business count weighting approach, where the weight for a particular stratum (h) is given by $w_h = N_h/n_h$, where N_h is the population of firms within a stratum, and n_h is our sample size in that stratum. Population figures are based on IDBR enterprise counts (accessed from NOMIS for 2020). Two approaches are taken – in the first, sector-size band strata are defined, and in the second, just size band.

[13] We also compare innovation rates between Wave 1 and Wave 2 using the two weighting approaches (Figure A8), the qualitative pattern is similar across types of innovation between survey waves. Over time we see that overall innovation rates rose in the second wave. This is to be expected as the firms had an additional year to make organisational changes – and, as we see in the next section - businesses continued to innovate beyond the initial lockdowns in 2020. As in wave 2, weighting wave 1 results reduces the share of businesses that introduced new management practices as this was more likely in larger firms).

[14] Compared between 0 and 3% across our process innovation questions, for those that answered, see Appendix Table B2.

Across types of innovation, 12-17% of firms say that they innovated in both periods, suggesting an ongoing process.

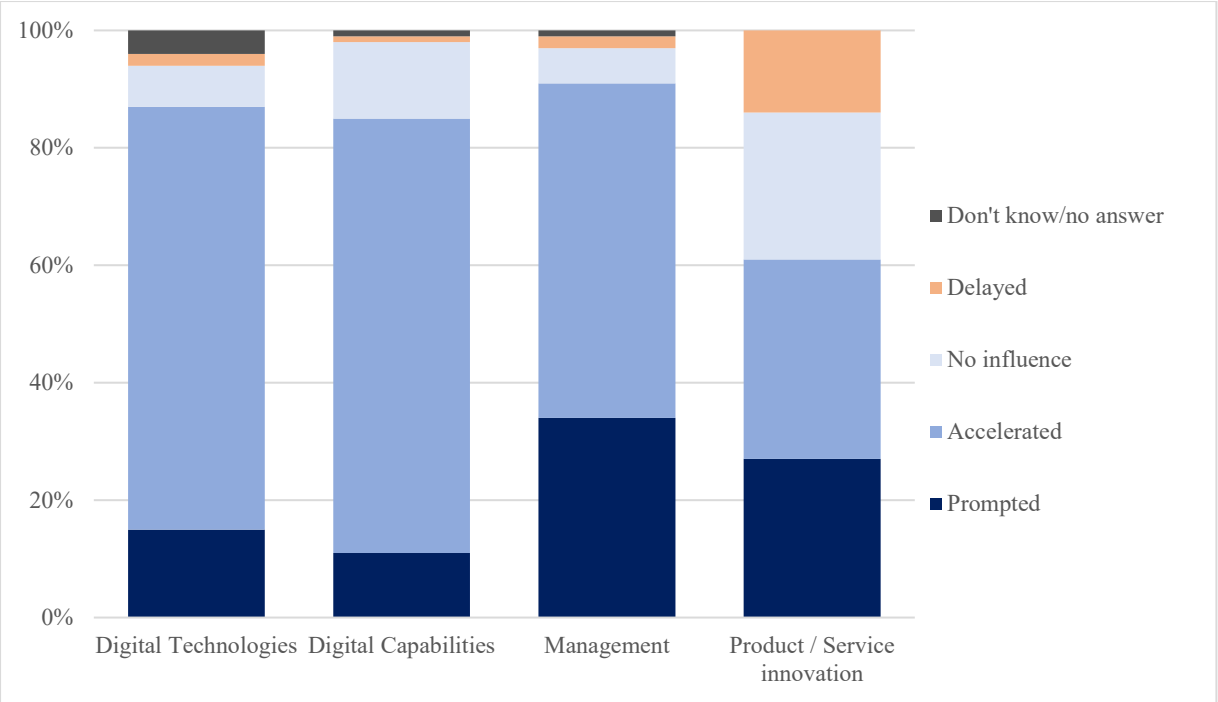
Figure 6: Timing of innovative response to Covid-19



Notes: N=319, N=216, N=267, N=238 (firms that innovated) – Columns not mutually exclusive.

When asked about the role of the pandemic in the business innovation response (Figure 7), firms say that Covid primarily accelerated (and to a lesser extent, prompted), all types of process innovation. In the case of management practices, more firms were prompted into making changes where plans were not already in place, as compared with digital technologies and capabilities. For product/service innovation, around a quarter of firms were prompted into innovating, but around 15% also faced delayed innovation.

Figure 7: Role of the pandemic in the business innovation response



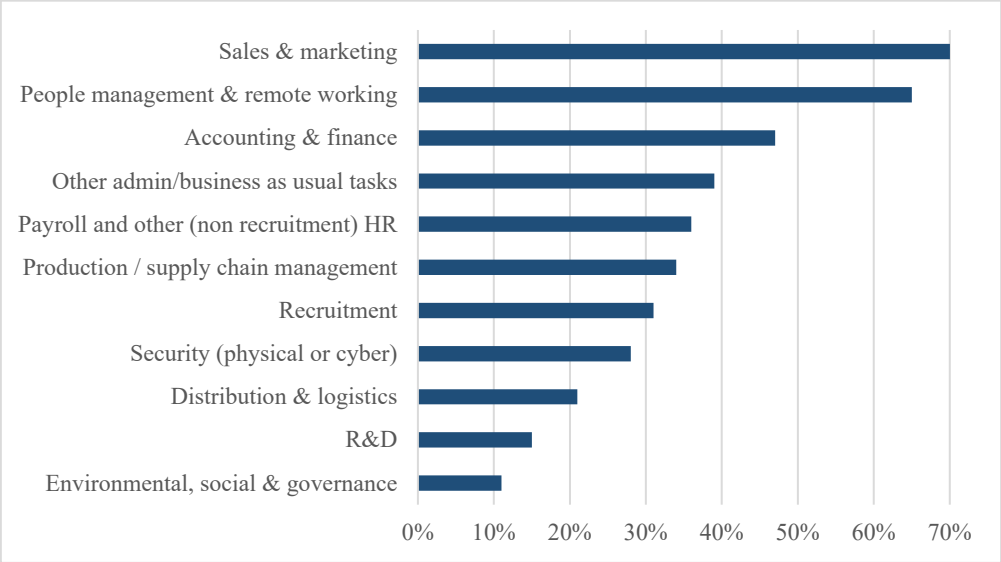
Notes: N=319, N=216, N=267, N=238 (Firms that innovated).

4. Digital technologies

Newly-adopted technologies relate to a range of business functions – not just remote working

New digital technologies touched on all business functions, from logistics to security, but sales and marketing, as well as people management and remote working came out top (with around 70% and 65% of adopters respectively selecting these functions).

Figure 8: Business functions that digital technologies related to



Notes: N=307 (Adopters that answered this question).

Overall impacts on business performance are broadly positive, particularly with respect to resilience

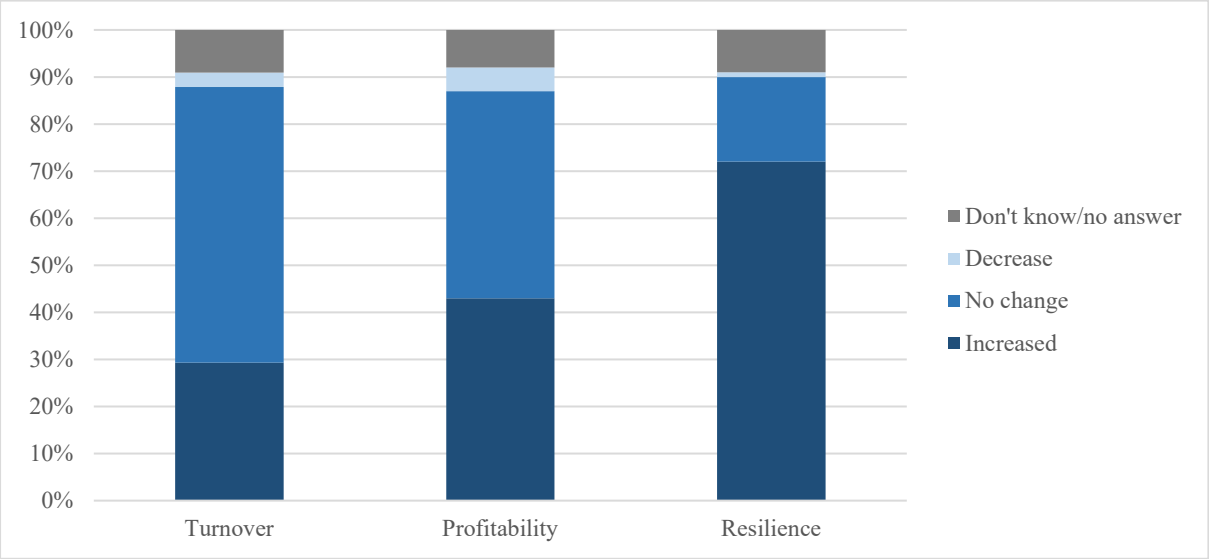
Most adopting firms say that, so far, these technologies have had no impact on turnover (Figure 9), but around a quarter report a positive impact, and a small minority a negative impact. Interestingly, a larger share report positive impacts on profits, which suggests that for some firms, benefits might relate more to efficiency (cost-saving) measures. The view on profits is less positive than the expectation among firms in Wave 1, when more than 70% thought that technology adoption would positively impact profits. This is consistent with a large behavioural science literature on optimism bias - measured empirically by recording an individual's expectations before an event unfolds and contrasting those with the outcomes that transpire (Sharot, 2011; Behavioral Insights Team, 2018). Over 70% of firms also say that new technologies have improved business resilience.

There are well-known caveats in the analysis of self-reported performance measures and resulting biases.[15] We might expect biases that result in firms over-reporting socially desirable behaviours (e.g., positive impacts of adoption) and under-reporting socially undesirable behaviours (e.g., reduction in workforce size) though we informed participants that their responses would be anonymised which should mitigate these effects. Beyond this immediate

[15] Self-report biases are ubiquitous in survey data (Bound et al., 2001) and can arise in the form of social desirability bias (tendency to respond in a manner that is perceived to be desirable), or acquiescent responding (tendency to prefer the positive side of the rating scale).

analysis, merging our sample with secondary data will allow us to cross-check self-reported performance with actual performance.

Figure 9: Impacts of digital technology on business performance



Notes: N=319 (Adopters).

The self-reported impacts of technology adoption on worker outcomes paint a contrasting picture

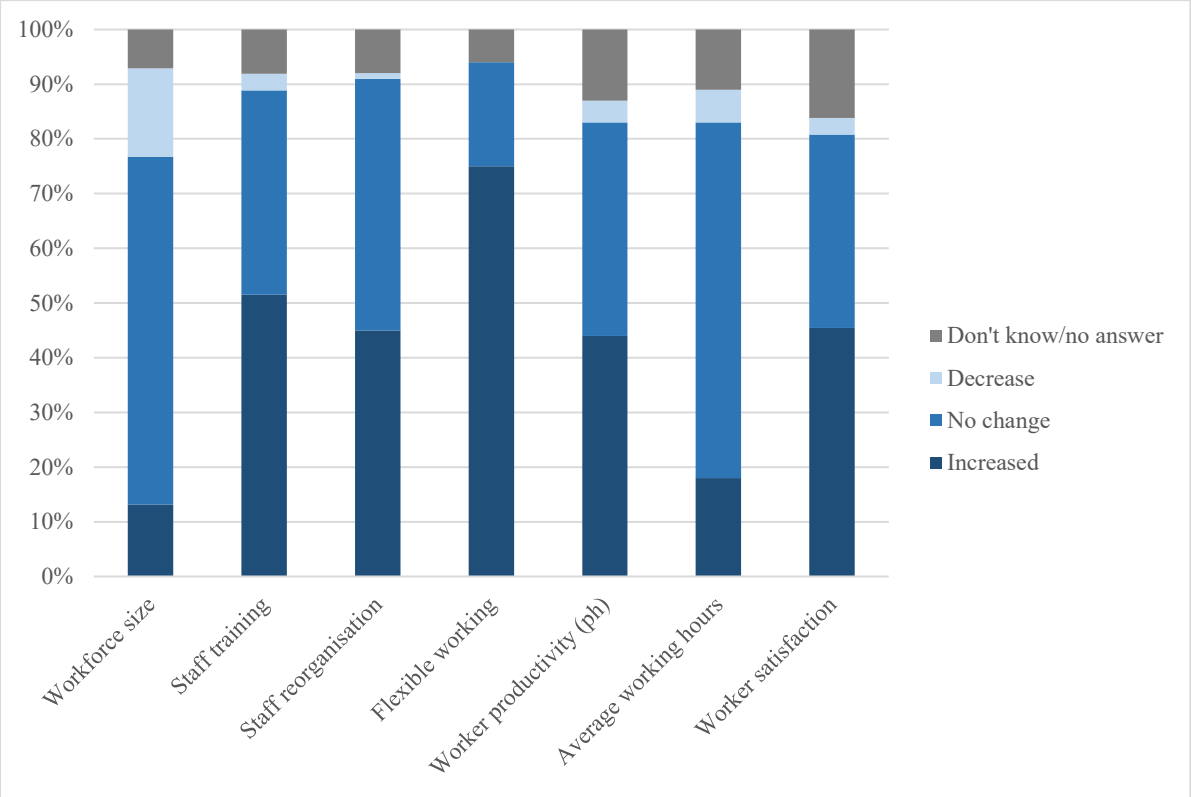
We asked questions to understand the impacts of newly adopted technologies on the workforce, and to shed light on whether adopted technologies might complement or replace workers.

Generally, firms report an increase or no change in what might be considered "positive" outcomes for workers, in particular flexible working (where 75% report an increase), but also training, productivity and worker satisfaction.

63% of adopters reported that these technologies had no impact on workforce size. Technologies reduced the need for workers in 16% of firms: and increased it in 13%.

New technologies also led to a reorganisation of the workforce in many firms, with 45% reporting that they had reorganised staff or reallocated employees to new tasks as a result of adoption. Whilst most firms report no change to working hours, 18% report a rise due to the adoption of new technologies. A further question asked how new technologies had impacted recruitment and training activities. Over a quarter report an increase in hiring in specialist skills, and a similar share reported hiring from a broader geography.

Figure 10: Impacts of technology adoption on workforce



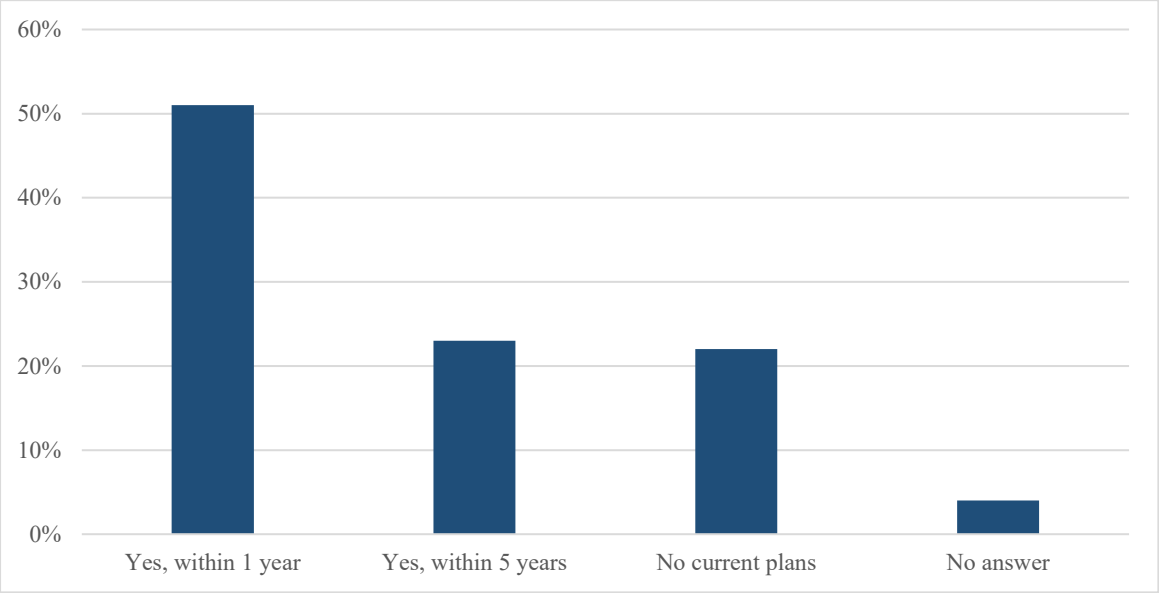
Notes: N=319 (Adopters).

Firms expect new technologies to remain in place, and future adoption plans accelerated for most

94% of firms expect to continue employing their newly adopted technologies into the future. In addition, 57% say that technology adoption during the pandemic has accelerated future technology adoption plans.[16] Across all firms (adopters and non-adopters), 50% are planning to adopt new technologies within the next year.

[16] In further analysis, not reported here, we find that adopting firms that consider adoption to have had positive impacts on turnover, profits and resilience, were more likely to report that plans for future technology adoption have been accelerated.

Figure 11: Plans for future technology adoption



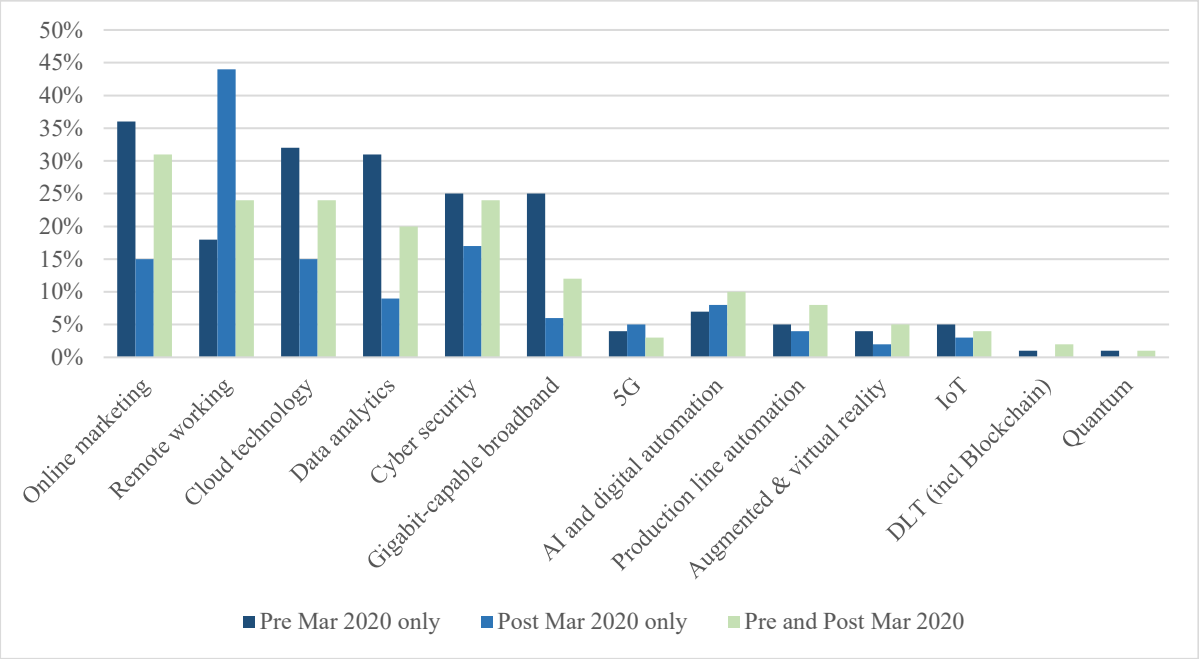
Notes: N=425.

Looking at specific technology types and adoption patterns pre and post pandemic, video conferencing and collaboration technologies were most common since March 2020

We developed a set of technology categories in collaboration with the CBI, which was informed by their previous Tech Tracker survey (CBI, 2020). The full categories, with examples given in the question, are set out in Appendix Table A3. For each technology, we asked all firms (not just adopters) to specify if they had invested pre-pandemic only (before March 2020), since March 2020 only, or in both periods (Figure 12), as well as their future plans.

This reveals a picture consistent with our business function analysis – remote working technologies (more specifically video conferencing and collaboration technologies, such as Microsoft Teams, Zoom or Slack) is the category that saw the largest investment since March 2020 only. But nearly a quarter of firms invested in these both pre and post pandemic. A larger share of businesses invested in online marketing tools (such as a new website, new social media platforms or e-commerce) pre-pandemic, and consistently in both periods (over 30%). Investments in cloud technologies, data analytics and cyber security were also common in firms since March 2020. There is some evidence for increased adoption of AI and digital automation, as well as production line automation since the onset of the pandemic, though the overall shares are lower in these more advanced technologies.

Figure 12: Specific digital technologies adopted



Notes: N=425 (Bars are mutually exclusive). Excluded category is "have not invested" and "do not know/no answer".

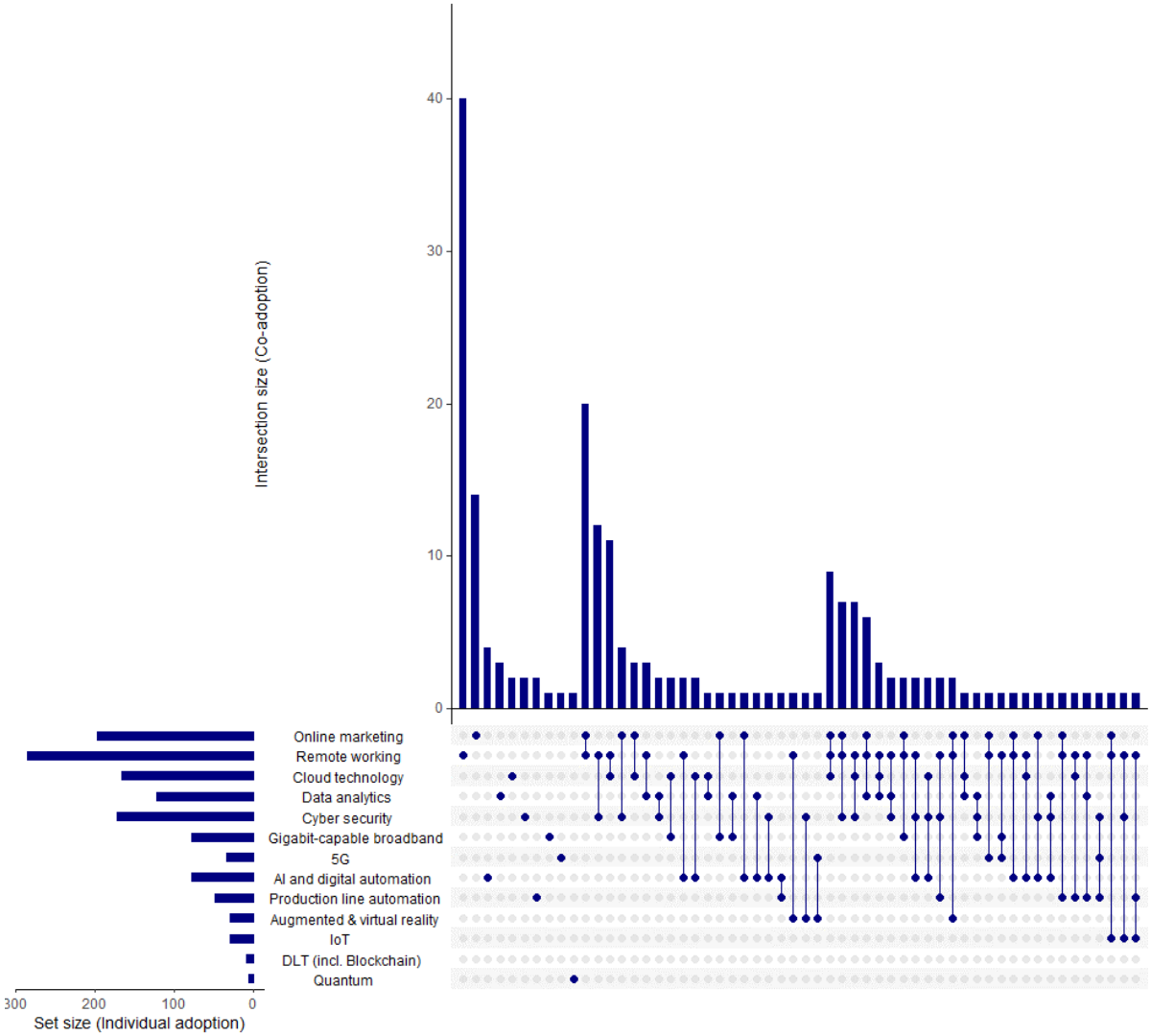
We also analyse the patterns of co-adoption of these different technologies – in other words, whether technologies tended to be adopted individually or in a bundle. In fact, of firms that adopted any of these technologies since March 2020, 80% adopted more than one. Many firms adopted bundles of different technologies and a small minority adopted across most of them (Figure A9).

Figure 13 shows adoption in each individual technology type, and in different combinations of technologies – up to and including bundles of three different technologies which covers over 50% of adopting firms (larger bundles are shown in Appendix Figure A10).[17] This analysis shows that while a large share of firms that invested in remote working technologies made no other technology investments, the most common bundles tended to feature remote working technologies too – particularly in combination with online marketing, cyber security and cloud technologies.

Future plans for the adoption of these specific technologies follow broadly similar patterns (Appendix Figure A11), with the technologies most adopted to-date also being the technologies that larger shares of firms are more likely to plan to adopt in the short term. Compared to other emerging technologies, relatively higher shares of businesses report 1-year or 5-year plans for adoption of AI and digital automation in particular, suggesting that this is an area set to grow over the short to medium term.

[17] This is for each technology, the horizontal bar on the left is the sum of firms that adopted post March 2020, and pre and post March 2020 (as per the share columns in Figure 12).

Figure 13: Patterns of co-adoption of digital technologies (bundles of up to 3 technologies)

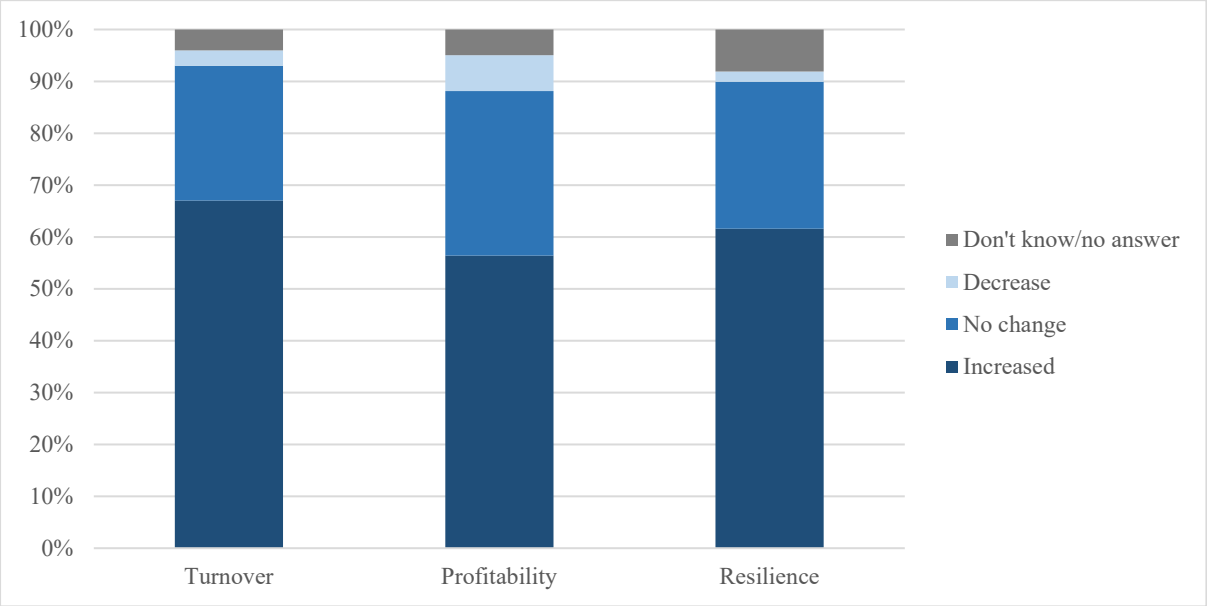


Notes: N=425. The smaller chart on the left plots the total responses for each individual technology, in terms of the number of firms that adopted it since March 2020. In the main chart, instances of adoption of each technology individually are sorted first, followed by sorted instances of adoption of combinations of two and then three technologies respectively (larger bundles are included in Appendix Figure A10). We drop "empty intersections", or the combinations that were never selected.

5. Impacts of product/service innovation and future plans

Of the firms that introduced new products since March 2020, 41% introduced entirely new products, 23% improved existing products, and 36% did both. Only a minority of firms report negative impacts on turnover, profitability and resilience – a much larger share say new products increased these performance measures relative to if they had not been introduced, which is similar to the picture with technology adoption (Figure 9).

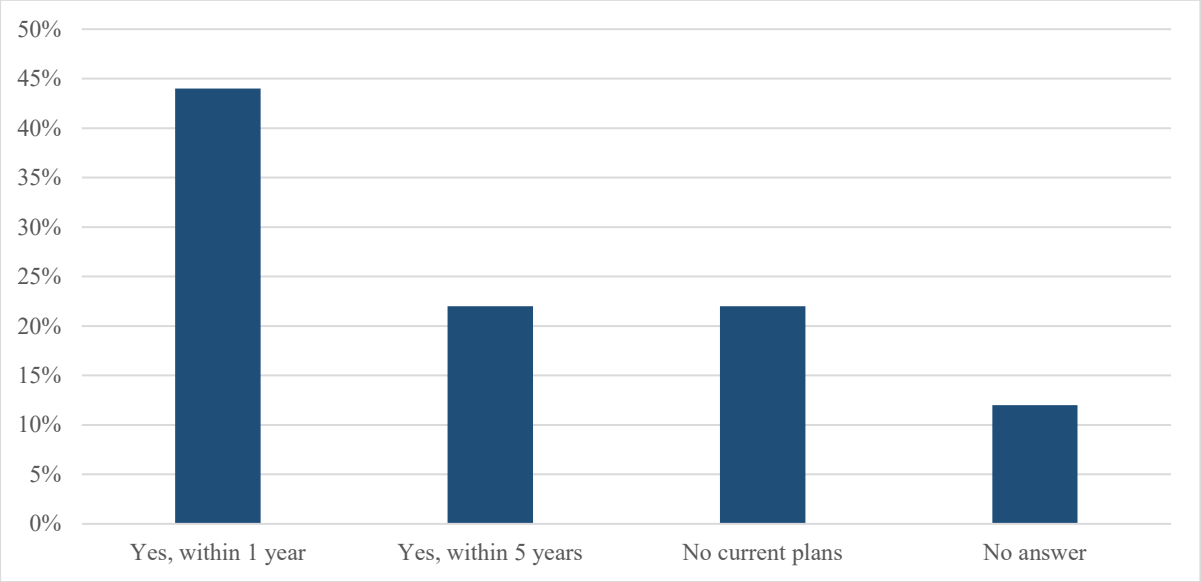
Figure 14: Product/service innovation



Notes: N=238 (Firms that introduced new products/services).

As with digital technologies, nearly all (95%) firms expect to continue offering the new products/services beyond the pandemic. And over half (52%) say that their product/service innovation during the pandemic accelerated future plans for product/service innovation. Amongst all firms, nearly 45% say that they planned to introduce new products or services within the next year (Figure 15).

Figure 15: Future plans for product/service innovation



Notes: N=425.

6. How do innovation patterns and impacts vary across firms?

Larger and more technologically advanced businesses were more likely to innovate

Our first wave survey found that smaller firms were less likely to innovate across the board. We find the same pattern in this wave, but a more detailed split of innovation across firm size bands reveals that this is not necessarily a linear relationship. This is particularly true in the case of product/service innovation, where rates are highest for the businesses with 100 employees or more, and for micro businesses (between 1 and 9 employees).

Broad sectoral patterns are similar. Adoption of digital technologies and capabilities appear to have been less common in manufacturing firms and most common in "contact services" (Appendix Figure A12).[18] Regional adoption rates are summarised in Appendix Figure A13. The highest rates of adoption of digital technologies was in the East of England, Yorkshire and the Humber and London, where over 80% of businesses adopted. The lowest rates were in Northern Ireland and Wales, suggesting that more productive regions have seen faster digitisation. Yorkshire and the Humber had the highest share of firms adopting new management practices; Scotland for digital capabilities; and the North West had highest rate of product/service innovation.

We consider heterogeneity in adoption by different firm characteristics separately (in Appendix Table A4) and all together in a regression (Table 2). We include basic firm characteristics: firm size, age, and an indicator for being in the manufacturing sector or headquartered in London. We also include a set of firm characteristics which, based on the wider literature and our first-wave survey, we would expect to have a positive influence on innovative activity. These are: pre-Covid innovation (digital adoption, product innovation or R&D), human capital intensity, the nature of competition faced by the business, the extent to which technology adoption decisions are decentralised, and the share of the workforce that would have been expected to be able to work from home pre-pandemic (this latter aspect being particularly relevant for remote working technologies).

This analysis shows that, all else equal, smaller firms are significantly less likely to have engaged in process innovation, but that there is no difference for product innovation. Manufacturing firms are significantly less likely to adopt new digital technologies or capabilities.

As for Wave 1, pre-covid digital adoption is the most significant predictor of digital technology adoption since the pandemic, and it also predicts the adoption of new digital capabilities. This result is in line with recent studies that find evidence of a trend toward digital polarisation (see, for example, Rückert et al., 2020). Companies that introduced new products or services in the three years pre-Covid are also more likely to have adopted new digital capabilities, management practices, and to have introduced new products or services since the onset of the pandemic. Firms with a more highly educated workforce are more likely to have introduced new products or services.[19] These results suggest that there is some level of path dependence in both process and product innovation.[20]

[18] This is an indicative grouping of service sectors that require high levels of physical contact: arts & entertainment, accommodation & food, and wholesale & retail trade.

[19] These results are broadly unchanged when a full set of region or industry dummies is included, when regressions are weighted or estimated using a non-linear (logit) model, or when the sample is allowed to vary across columns according to outcome availability.

[20] We note that, with a relatively small sample, we are underpowered in detecting significant relationships.

Table 2: Relationships between innovation responses and key business characteristics

	Adoption of			
	Digital technologies	Digital capabilities	Management practices	Product/service innovation
Small (<50 employees)	-0.106**	-0.145***	-0.175***	0.008
	(0.049)	(0.054)	(0.051)	(0.049)
Firm > 10 years old	-0.051	0.166**	0.034	0.046
	(0.066)	(0.075)	(0.073)	(0.068)
London HQ	-0.026	-0.029	-0.055	0.013
	(0.056)	(0.068)	(0.064)	(0.059)
Manufacturing	-0.097	-0.168***	-0.006	0.083
	(0.060)	(0.065)	(0.061)	(0.058)
Share degree >50%	0.072	0.083	0.072	0.126**
	(0.048)	(0.059)	(0.057)	(0.058)
Competition intense	0.001	0.026	-0.043	0.061
	(0.048)	(0.053)	(0.049)	(0.049)
Pre-Covid digital adoption	0.139**	0.146**	0.038	-0.111*
	(0.064)	(0.062)	(0.060)	(0.058)
Pre-Covid product innovation	0.070	0.149***	0.109**	0.433***
	(0.052)	(0.055)	(0.054)	(0.051)
Pre-Covid R&D	0.002	-0.001	0.065	-0.007
	(0.049)	(0.053)	(0.052)	(0.050)
Pre-Covid: Tech decentralised	0.063	0.048	0.072	0.010
	(0.046)	(0.052)	(0.050)	(0.049)
Pre-Covid: ln(1+share wfh)	0.028	-0.000	0.045**	0.024
	(0.020)	(0.021)	(0.020)	(0.019)
Observations	366	366	366	366

Notes: OLS regressions with robust standard errors in parentheses, *** denotes significance at the 1% level, ** 5% level and * 10% level. Sample restricted to observations where all innovation questions were answered, and business characteristics available.

In contrast to our Wave 1 results, we observe that in firms where working from home was feasible for a higher share of the workforce, there is a higher likelihood of introducing new management practices, but this does not predict digital adoption, controlling for other factors.[21]

There are differences in impacts of innovation on firm performance and the workforce, depending on firm type and technology applications

There is some evidence of differential impacts of technology adoption on firms and their workers, as reported in Tables A5-A8 in the Appendix. These show how the likelihood of a business reporting an increase in business or worker outcomes varies according to key business

[21] As shown in Appendix Table A4, a number of correlations exist which do not survive once we control for other factors. For example, working from home feasibility is positively correlated with digital technology adoption, and technology decision decentralisation is positively correlated with all types of innovation.

characteristics or the business functions that new technologies relate to, controlling for sector of activity.[22]

Firms that were more decentralised in technology decision-making processes are significantly more likely to report increased turnover because of technology adoption (Table A5), as well as increased working hours (Table A6). This finding is consistent with research following the financial crisis, which found that firms that were more decentralised performed better due to their ability to take urgent action (Aghion et al., 2021). Older firms are less likely to report increased turnover or profits, and smaller firms less likely to report improved resilience or increased flexible working.

Firms that had adopted new digital technologies prior to the pandemic were more likely to report improved resilience and worker productivity because of new technology adoption, but less likely to report an increase flexible working, controlling for other factors. Perhaps such firms already had such practices in place before the pandemic. As might be expected, a higher share of work from home feasibility was associated with a higher likelihood of reporting increased flexible working because of new technology adoption. Firms with a higher degree share were more likely to report an increase in overall workforce size, which is consistent with new technologies and skills being complementary.[23]

Turning now to differential impacts according to business functions. Where businesses adopted technologies relevant for sales and marketing functions, they were more likely to report an increase in turnover and profits (Table A7). In terms of impacts on workers, firms that adopted new technologies relevant for R&D functions were more likely to report an increase in the workforce size (Table A8). Where firms adopted technologies relevant for people management and remote work or other business as usual tasks, they were more likely to report increased flexible working because of technology adoption. Firms that adopted remote working technologies also reported a rise in average working hours, and this was also the case for technologies relating to production or supply chain management. This finding is consistent with other studies that have shown that home workers have put in more hours since Covid (e.g., Barrero et al., 2021).

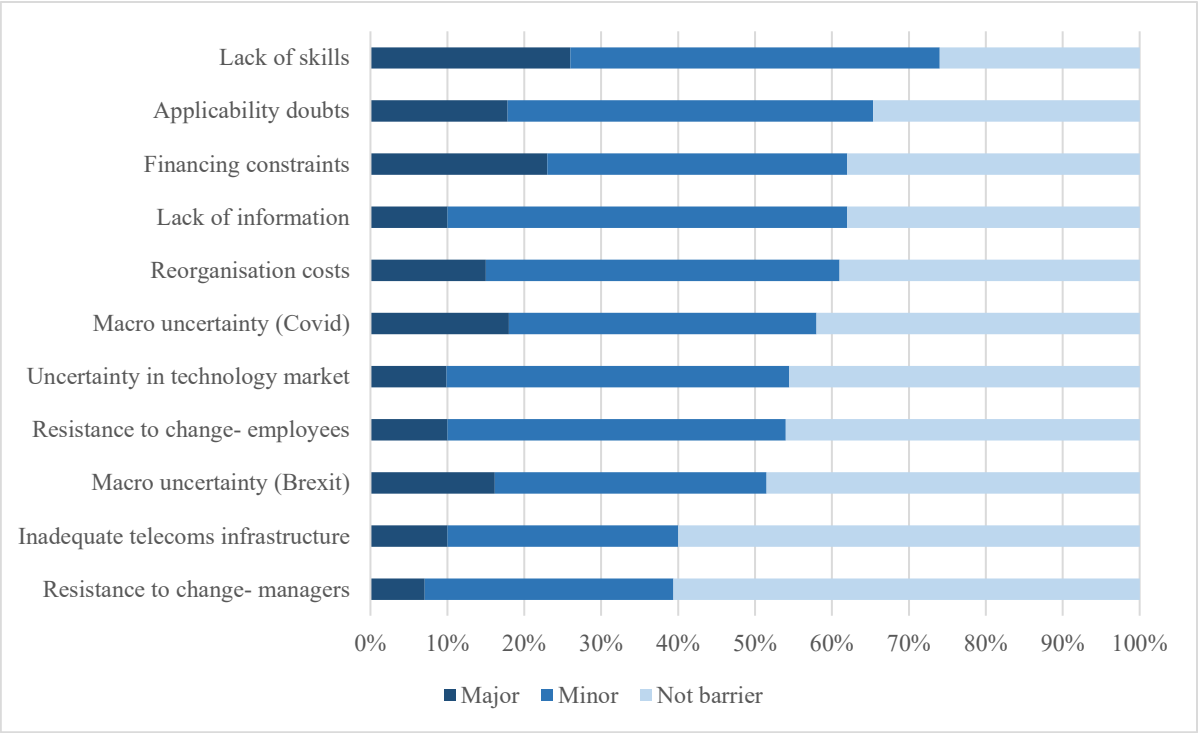
7. Barriers, policy preferences and opportunities

Lack of skills and applicability doubts have risen in prominence as barriers to digital adoption, and new financial incentives are the most popular policy to address these

Overall, the most cited barriers to technology adoption - skills, financing constraints and reorganisation costs - are consistent with the Wave 1 survey and the wider literature. However, the lack of skills tops the list in Wave 2, which is likely to reflect the heightened skills shortages during this time period. In addition, applicability doubts appear to have risen in importance. Macro uncertainty (related to both Covid-19 and Brexit) was the most highly cited barrier in our first survey, and this has fallen in relative importance. This is expected given the fact that the UK left the EU on 31 December 2020 (notwithstanding continued uncertainty with regards to the UK's future trading relationship with Europe), and the fact that vaccines had already been widely rolled out by July 2021 and the economy was reopening.

[22] Again, these results are robust to non-linear estimation, including an ordered logit model where the dependent variable reflects three possibilities for each outcome (0=decreased, 1=unchanged, 3=increased).
[23] See Valero (2021), section 7.1 for a summary of relevant literature on human capital, investment and technology.

Figure 16: Barriers to process innovation

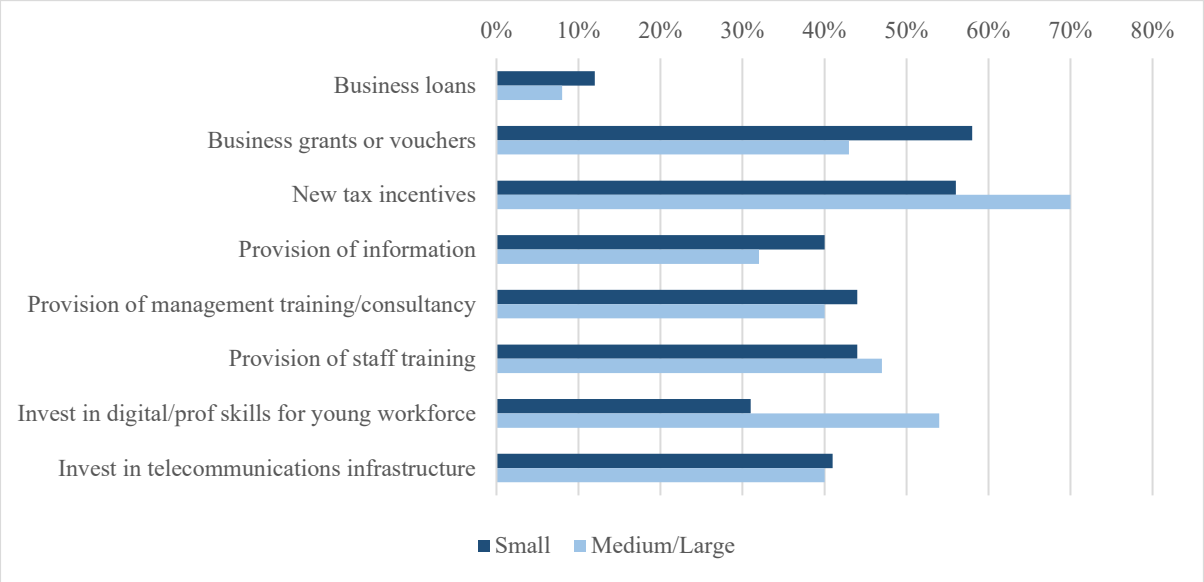


Notes: N=375 (Firms that answered this question).

We asked businesses about the technology support typically accessed (Appendix Figure A14). While online research is the most commonly cited option, learning from peer companies and business networks are also cited by over half of firms. In fact, government schemes are the least cited form of support accessed.

As in Wave 1, the top two ranked policies to address barriers to process innovation were new tax incentives and business grants or vouchers, with smaller firms in particular wanting the latter. They also rank improvements in telecommunication infrastructure highly. Larger firms highlight the importance of investments in the digital and professional skills of younger people entering the workforce. The policy option selected by the lowest share of respondents relates to improving access to business loans.

Figure 17: Policy preferences for process innovation

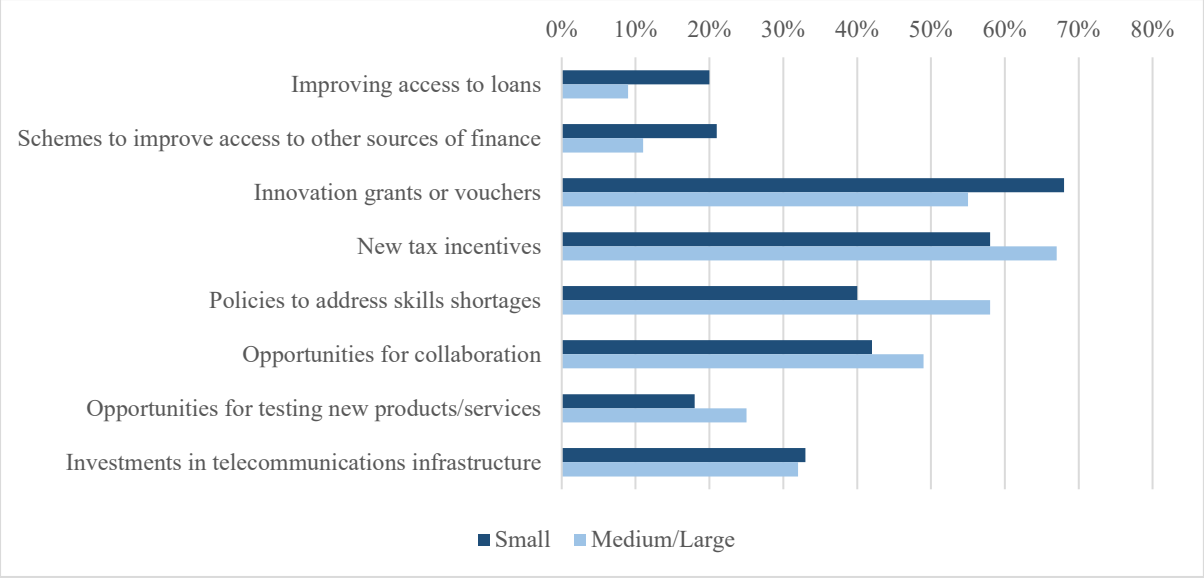


Notes: N=352 (Firms that answered this question).

Policy priorities are similar with respect to product innovation, where tax incentives and innovation grants or vouchers were the most popular

Consistent with Wave 1, the types of policy support most favoured by firms for product innovation are similar to those relevant for process innovation: financial assistance via the tax system or via grants or vouchers. Policies to address skills shortages are also a priority for larger businesses in particular. As before, nearly half of larger firms also want policies to improve collaboration with universities or other industrial partners.

Figure 18: Policies for product/service innovation



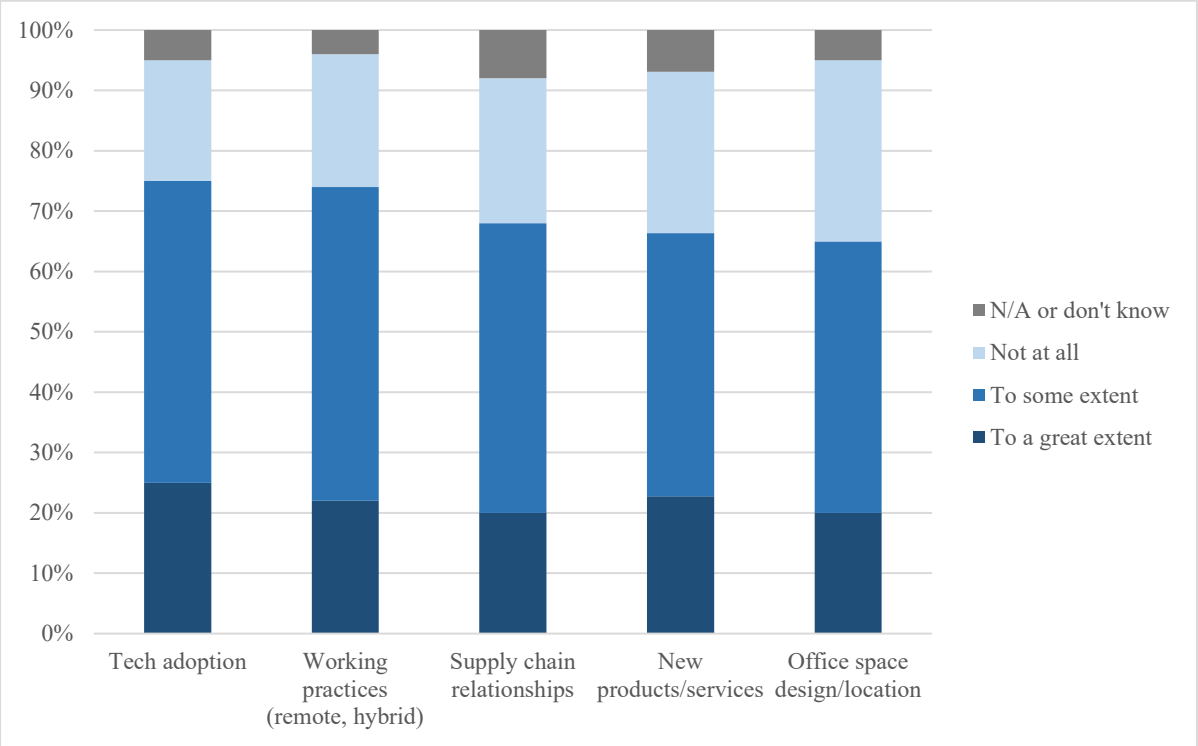
Notes: N=334 (Firms that answered this question).

Joined-up thinking in businesses present opportunities for a "green" productive recovery

As at July 2021, businesses were facing the dual challenges of surviving or adapting in light of Covid, and adjusting strategies in light of increasing net-zero commitments in the UK and internationally. Two thirds of firms in our sample report having a sustainability or decarbonisation strategy in place, and nearly half consider themselves more likely to take action on Net Zero since the onset of the pandemic (with a further 50% reporting no change in likelihood).

While our survey was focused on technology adoption, we were keen to understand how organisational decision-making in technology and other related areas take environmental considerations into account. This occurs to a great extent or some extent for around two thirds of firms across a number of areas, including decisions on technology adoption, working practices, supply chain relationships, new products or services, and office design and location.

Figure 19: Environmental sustainability considerations in decision-making



Notes: N=367, N=367, N=365, N=365, N=367 (Number of firms that answered each question, respectively).

8. Conclusions

Our survey results show that firms continued to adopt new technologies and practices, and to introduce new products and services during the pandemic. While remote working technologies were a prominent feature (particularly during the early days of the pandemic), there was also widespread adoption of online marketing technologies, cloud, data analytics and cyber security technologies, often in combination.

These activities were generally prompted or accelerated by the pandemic, but firms expect their innovations to persist beyond it, and plans for future innovation have also been accelerated. This suggests that Covid-19 might be making businesses more innovative.

However, our findings suggest that gaps between more and less digitised firms might widen in the future. In line with our first wave survey, we find that smaller firms and those that were less digitised pre-pandemic tend to have adopted less and, along some dimensions, report differential impacts of technology adoption on firms and their workers. For example, firms that had adopted new digital technologies prior to the pandemic were more likely to report increased resilience and worker productivity as a result of new technologies, and smaller firms were less likely to report an increase in resilience.

In terms of policy preferences, businesses continue to signal that grants and tax incentives, in particular, are welcome support for both process and product innovation, with smaller firms tending to favour grants and larger firms preferring tax incentives. There is little evidence that firms that accessed different Covid financial support schemes have seen differential innovation outcomes over the period covered.

Looking ahead, firms report taking environmental sustainability into account in technology adoption and broader organisational decision-making. This presents an opportunity for a joined-up approach to business support policies in the context of a sustainable recovery from Covid-19.

About the Authors

Anna Valero is Senior Policy Fellow at the Centre for Economic Performance, and Deputy Director of the Programme on Innovation and Diffusion

Capucine Riom is a PhD candidate in Economic Geography at the LSE

Juliana Oliveira-Cunha is a Research Assistant in the Growth Programme at CEP

For further information contact:

Anna Valero, a.a.Sivropoulos-Valero@lse.ac.uk

Capucine Riom, c.a.riom@lse.ac.uk

Helen Ward, communications manager, CEP: 07970 254872, h.ward1@lse.ac.uk

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APPENDIX A: Extra results

Appendix Tables

Table A1: Key characteristics and pre-Covid baseline

	Wave 2		Wave 1	
	Mean	N	Mean	N
Registered address in London	0.18	425	0.15	375
Multisite business	0.57	424	0.50	371
Manufacturing	0.25	425	0.29	375
Small (<50 employees)	0.44	425	0.52	375
Small (<£10m revenues)	0.53	416	0.61	373
Firm > 10 years old	0.86	425	0.87	375
Exporter (customers overseas)	0.54	425		
Competition intense	0.67	424		
Share degree >50%	0.3	419		
Pre-Covid: wfh feasibility share of workforce (%)	46.35	423	35.55	361
Pre-Covid: Decisions always decentralised- hiring	0.52	425		
Pre-Covid: Decisions always decentralised- capex	0.24	425		
Pre-Covid: Decisions always decentralised- technology	0.42	424		
Pre-Covid: Digital technologies (last 3 years)	0.75	423	0.76	371
Pre-Covid: New products (last 3 years)	0.61	423		
Pre-Covid: R&D (last 3 years)	0.54	423		
Pre-Covid: Digital technologies embedded in business	0.44	425		

Table A2: Examples of relevant process innovation

Digital Technologies	Digital Capabilities	Management Practices
• Enterprise Resource Planning • Customer Relationship • Management systems • Remote working technologies • Cloud computing • Mobile technology • Automated machinery • AI applications (e.g. chatbots)	• E-commerce • Advanced analytics • Cyber security	• New processes around business operations • New HR and people management practices

Notes: Examples given in survey questions and developed in collaboration with the CBI.

Table A3: Specific technologies – Full options with examples

Online marketing tools (e.g., new website, new social media platforms)
Video conferencing/collaboration technology (e.g., Microsoft Teams, Zoom)
Cloud technology (e.g., Internet as a Service, Software as a Service)
Data analytics (e.g., Customer Relationship Management - CRM)
Cyber security technology (e.g., two factor authentication)
Gigabit-capable broadband (e.g., full fibre)
5G
Artificial Intelligence and digital automation (e.g., analysing documents using machine learning, chatbots, automating data migration)
Production line automation
Augmented and Virtual Reality
Internet of Things (e.g., smart factory equipment)
Distributed Ledger Technology (DLT) – including blockchain
Quantum computing

Table A4: Basic correlations between firm characteristics and innovation outcomes

		Adoption of			
		Digital technologies	Digital capabilities	Management practices	Product/service innovation
(1)	Small business (<50 employees)	-0.111**	-0.196***	-0.192***	-0.034
		(0.046)	(0.051)	(0.048)	(0.051)
(2)	Firm > 10 years old	-0.039	0.201***	0.071	0.079
		(0.063)	(0.072)	(0.072)	(0.073)
(3)	Pre-Covid digital adoption	0.220***	0.269***	0.157***	0.048
		(0.057)	(0.058)	(0.058)	(0.059)
(4)	Pre-Covid product innovation	0.122**	0.213***	0.182***	0.414***
		(0.047)	(0.052)	(0.050)	(0.048)
(5)	Pre-Covid R&D	0.075	0.094*	0.163***	0.135***
		(0.046)	(0.052)	(0.048)	(0.050)
(6)	Share degree >50%	0.134***	0.093*	0.086*	0.077
		(0.046)	(0.056)	(0.051)	(0.054)
(7)	Competition intense	0.034	0.087	-0.004	0.081
		(0.049)	(0.055)	(0.051)	(0.054)
(8)	Pre-Covid: Tech decisions decentralised	0.120***	0.120**	0.153***	0.117**
		(0.045)	(0.052)	(0.048)	(0.050)
(9)	Pre-Covid: ln(1+share work from home)	0.049***	0.019	0.046**	0.034*
		(0.019)	(0.020)	(0.019)	(0.019)
(10)	London HQ	0.080	0.059	0.004	0.028
		(0.055)	(0.067)	(0.063)	(0.065)
(11)	Manufacturing	-0.132**	-0.147**	0.003	0.068
		(0.057)	(0.061)	(0.057)	(0.057)

Notes: N=366. This is the regression sample where innovation outcome questions were answered and all covariates are non-missing. Each cell represents a separate regression of the innovation outcome named in the column on the variable named in the row. OLS regressions with robust standard errors in parentheses, *** denotes significance at the 1% level, ** 5% level and * 10% level.

Table A5: Firm characteristics and firm impacts of technology adoption

	Adoption of digital technologies has increased:		
	Turnover	Profits	Resilience
Small business (<50 employees)	0.015	-0.043	-0.152***
	(0.066)	(0.069)	(0.054)
Firm > 10 years old	-0.154*	-0.164*	-0.007
	(0.090)	(0.091)	(0.069)
Pre-Covid digital adoption	0.061	0.041	0.145*
	(0.071)	(0.080)	(0.074)
Share degree >50%	0.083	0.110	0.014
	(0.071)	(0.075)	(0.061)
Pre-Covid: Decisions always decentralised- technology	0.171***	0.029	-0.010
	(0.061)	(0.064)	(0.050)
Pre-Covid: ln(wfh feasibility share of workforce)	-0.020	-0.028	0.034
	(0.032)	(0.033)	(0.027)
London HQ	-0.019	-0.027	-0.059
	(0.080)	(0.084)	(0.064)
Observations	284	286	285

Notes: No answer and do not know are not included in these samples. The dependent variable=1 if the manager considers that adoption increased turnover, profits, resilience respectively in each column, and 0 if decreased or unchanged. Sector dummies are included in all columns. OLS regressions with robust standard errors in parentheses, *** denotes significance at the 1% level, ** 5% level and * 10% level.

Table A6: Firm characteristics and worker impacts of technology adoption

	Adoption of digital technologies has increased:						
	Workforce size	Staff training	Staff reorganisation	Flexible working	Worker productivity	Average working hours	Worker satisfaction
Small business (<50 employees)	0.049	-0.090	-0.041	-0.134**	0.009	-0.078	-0.070
	(0.047)	(0.068)	(0.067)	(0.054)	(0.071)	(0.055)	(0.072)
Firm > 10 years old	-0.036	0.028	0.018	0.038	-0.111	-0.004	0.030
	(0.071)	(0.091)	(0.088)	(0.065)	(0.095)	(0.080)	(0.098)
Pre-Covid digital adoption	-0.055	0.035	-0.018	-0.130**	0.147*	-0.054	-0.071
	(0.061)	(0.077)	(0.078)	(0.058)	(0.083)	(0.064)	(0.083)
Share degree >50%	0.239***	0.057	-0.037	-0.009	0.061	0.089	-0.050
	(0.057)	(0.072)	(0.074)	(0.059)	(0.075)	(0.061)	(0.077)
Pre-Covid: Decisions always decentralised- technology	0.015	0.077	-0.014	0.061	0.103	0.118**	0.013
	(0.046)	(0.064)	(0.064)	(0.048)	(0.065)	(0.054)	(0.066)
Pre-Covid: ln(wfh feasibility share of workforce)	0.003	0.006	-0.015	0.052**	-0.026	0.038	0.026
	(0.022)	(0.030)	(0.031)	(0.025)	(0.031)	(0.023)	(0.033)
London HQ	-0.060	-0.138	0.102	0.002	-0.034	-0.041	-0.005
	(0.057)	(0.085)	(0.083)	(0.061)	(0.083)	(0.066)	(0.083)
Observations	291	288	290	294	271	277	262

Notes: No answer and do not know are not included in these samples. The dependent variable=1 if the manager considers that adoption increased each worker outcome respectively in each column, and 0 if decreased or unchanged. Sector dummies are included in all columns. OLS regressions with robust standard errors in parentheses, *** denotes significance at the 1% level, ** 5% level and * 10% level.

Table A7: Business functions that technology relates to and firm impacts of technology adoption

	Adoption of digital technologies has increased:		
	Turnover	Profits	Resilience
Sales & marketing	0.155**	0.155**	-0.006
	(0.065)	(0.070)	(0.061)
Production / supply chain management	0.069	-0.003	0.015
	(0.067)	(0.072)	(0.060)
Distribution & logistics	0.140	0.061	0.077
	(0.085)	(0.083)	(0.064)
Payroll and other (non recruitment) HR	0.104	0.005	-0.047
	(0.071)	(0.074)	(0.058)
Recruitment	-0.007	0.078	0.077
	(0.073)	(0.076)	(0.059)
People management & remote working	-0.002	0.064	0.085
	(0.061)	(0.066)	(0.058)
Other admin/business as usual tasks	-0.015	0.029	0.083
	(0.062)	(0.068)	(0.054)
Accounting & finance	-0.131*	-0.127*	-0.002
	(0.068)	(0.071)	(0.053)
R&D	0.147	0.089	-0.031
	(0.099)	(0.094)	(0.082)
Environmental, social & governance	-0.009	0.066	-0.148
	(0.101)	(0.100)	(0.095)
Security (physical or cyber)	-0.030	-0.027	0.029
	(0.067)	(0.074)	(0.055)
Observations	289	292	290

Notes: No answer and do not know are not included in these samples. The dependent variable=1 if the manager considers that adoption increased turnover, profits, resilience respectively in each column, and 0 if decreased or unchanged. Sector dummies are included in all columns. OLS regressions with robust standard errors in parentheses, *** denotes significance at the 1% level, ** 5% level and * 10% level.

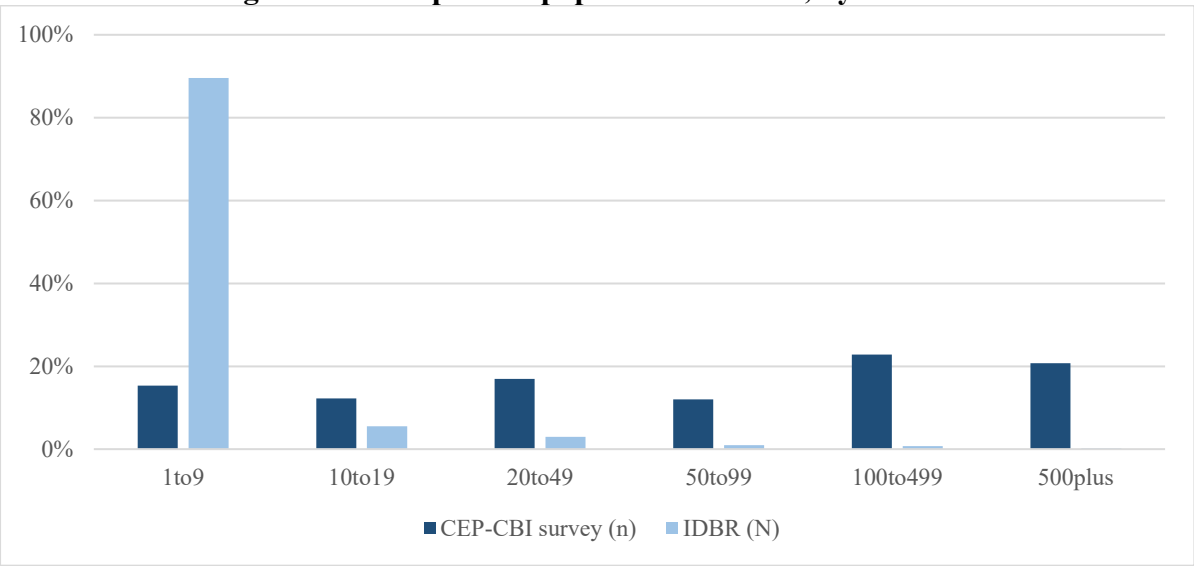
Table A8: Business functions that technology relates to and worker impacts of technology

	Adoption of digital technologies has increased:						
	Workforce size	Staff training	Staff reorganisation	Flexible working	Worker productivity	Average working hours	Worker satisfaction
Sales & marketing	0.033	-0.029	0.038	0.045	0.115	0.013	0.065
	(0.045)	(0.072)	(0.068)	(0.053)	(0.073)	(0.059)	(0.075)
Production / supply chain management	0.031	0.061	0.044	0.031	0.050	0.143**	0.066
	(0.053)	(0.072)	(0.069)	(0.056)	(0.073)	(0.056)	(0.076)
Distribution & logistics	-0.057	0.110	0.127	0.015	0.050	-0.033	-0.031
	(0.062)	(0.086)	(0.085)	(0.067)	(0.088)	(0.069)	(0.093)
Payroll and other (non recruitment) HR	0.051	0.122*	-0.013	0.002	0.001	0.050	0.020
	(0.055)	(0.071)	(0.073)	(0.053)	(0.079)	(0.061)	(0.082)
Recruitment	-0.029	-0.005	0.034	-0.025	-0.142*	-0.004	0.070
	(0.061)	(0.070)	(0.073)	(0.054)	(0.079)	(0.064)	(0.080)
People management & remote working	0.030	-0.103	-0.082	0.209***	-0.024	0.122***	0.093
	(0.042)	(0.065)	(0.062)	(0.056)	(0.070)	(0.047)	(0.069)
Other admin/business as usual tasks	-0.019	-0.033	0.017	0.103**	0.104	0.039	0.051
	(0.045)	(0.067)	(0.065)	(0.049)	(0.069)	(0.058)	(0.069)
Accounting & finance	0.034	-0.010	0.029	0.001	0.046	0.036	0.098
	(0.041)	(0.069)	(0.067)	(0.054)	(0.072)	(0.054)	(0.076)
R&D	0.293***	-0.078	0.071	0.056	0.071	0.130	0.111
	(0.086)	(0.102)	(0.099)	(0.062)	(0.094)	(0.079)	(0.096)
Environmental, social & governance	-0.094	0.157*	0.049	-0.035	0.116	-0.154*	-0.112
	(0.088)	(0.095)	(0.106)	(0.070)	(0.107)	(0.089)	(0.108)
Security (physical or cyber)	-0.007	0.129*	0.134*	0.066	0.021	-0.023	-0.073
	(0.052)	(0.072)	(0.070)	(0.048)	(0.077)	(0.056)	(0.076)
Observations	296	293	295	299	276	283	267

Notes: No answer and do not know are not included in these samples. The dependent variable=1 if the manager considers that adoption increased each worker outcome respectively in each column, and 0 if decreased or unchanged. Sector dummies are included in all columns. OLS regressions with robust standard errors in parentheses, *** denotes significance at the 1% level, ** 5% level and * 10% level.

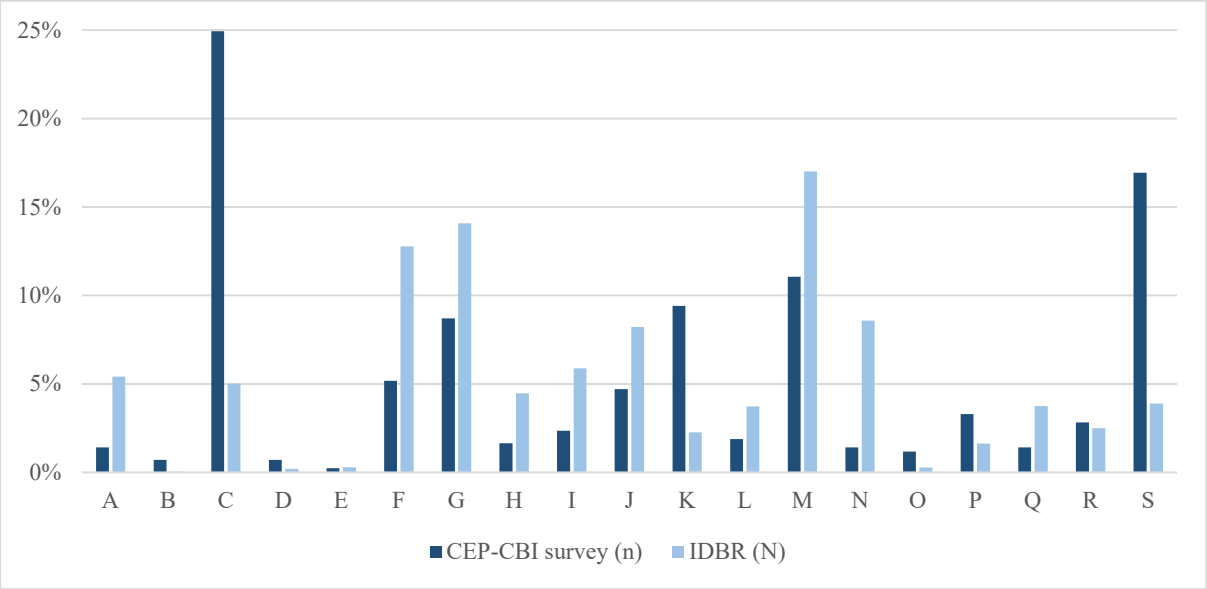
Appendix Figures

Figure A1: Sample and population of firms, by size band



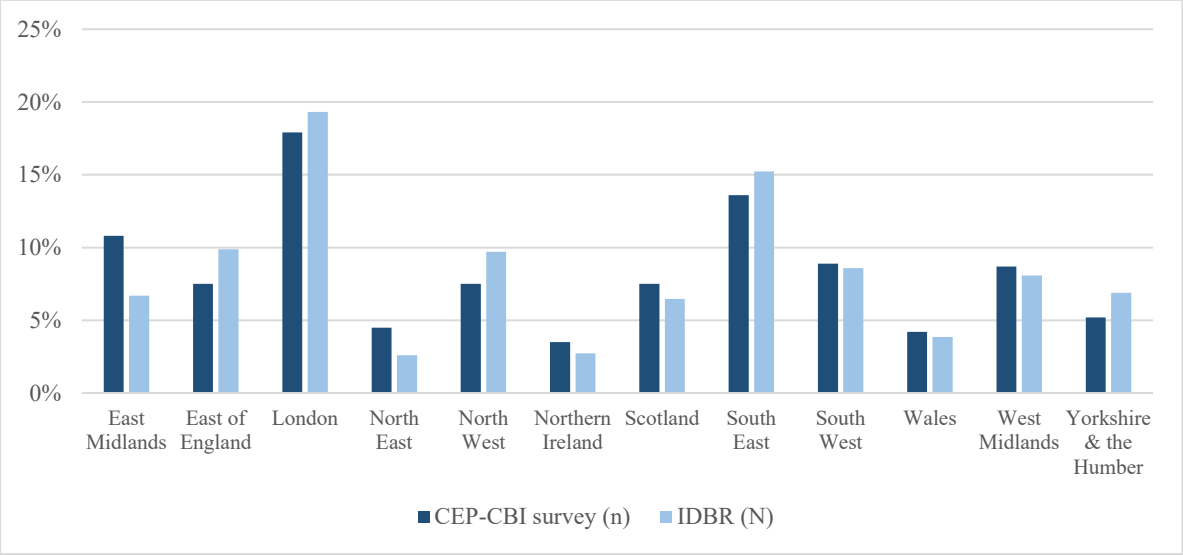
Notes: Sample observations: 425, population of firms in the IDBR (sourced from NOMIS, 2020): 2.7 million.

Figure A2: Sample and population of firms, by SIC section



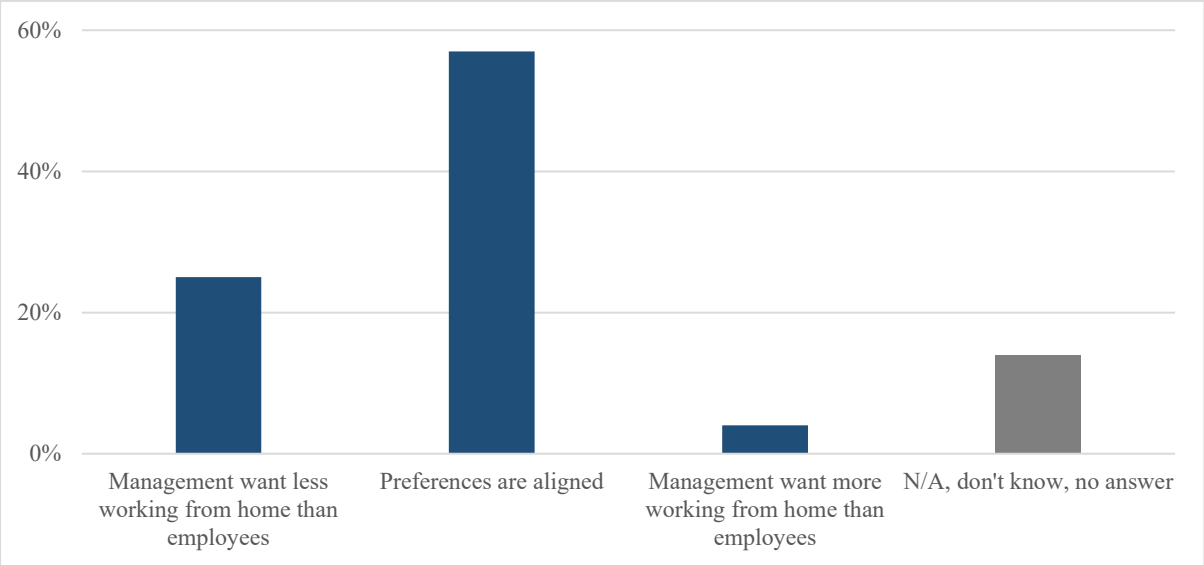
Notes: Sample observations: 425, population of enterprises in the IDBR (sourced from NOMIS, 2020): 2.7 million. Manufacturing firms (section C) in particular were overrepresented in our survey sample. A: Agriculture, Forestry and Fishing, B: Mining and Quarrying, C: Manufacturing, D: Electricity, Gas, Steam and Air Conditioning Supply, E: Water Supply; Sewerage, Waste Management and Remediation Activities, F: Construction. G: Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles. H: Transportation and Storage, I: Accommodation and Food Service Activities, J: Information and Communication, K: Financial and Insurance Activities, L: Real Estate Activities, M: Professional, Scientific and Technical Activities, N: Administrative and Support Service Activities, N: Administrative and Support Service Activities, O: Public Administration and Defense; Compulsory Social Security, P: Education, Q: Human Health and Social Work Activities, R: Arts, Entertainment and Recreation, S: Other Service Activities, T: Activities of Households as Employers; Undifferentiated Goods and Services, Producing Activities of Households for their own use, U: Activities of Extraterritorial Organisations and Bodies

Figure A3: Sample and population of firms, by region



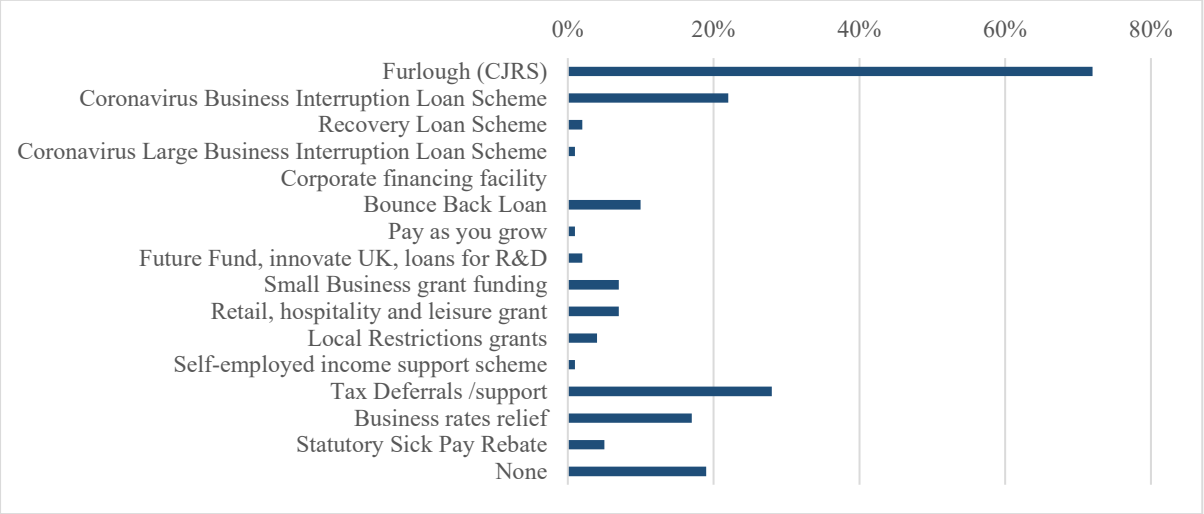
Notes: Sample observations: 425, population of enterprises in the IDBR (sourced from NOMIS, 2020): 2.7 million.

Figure A4: Preferences of managers and workers



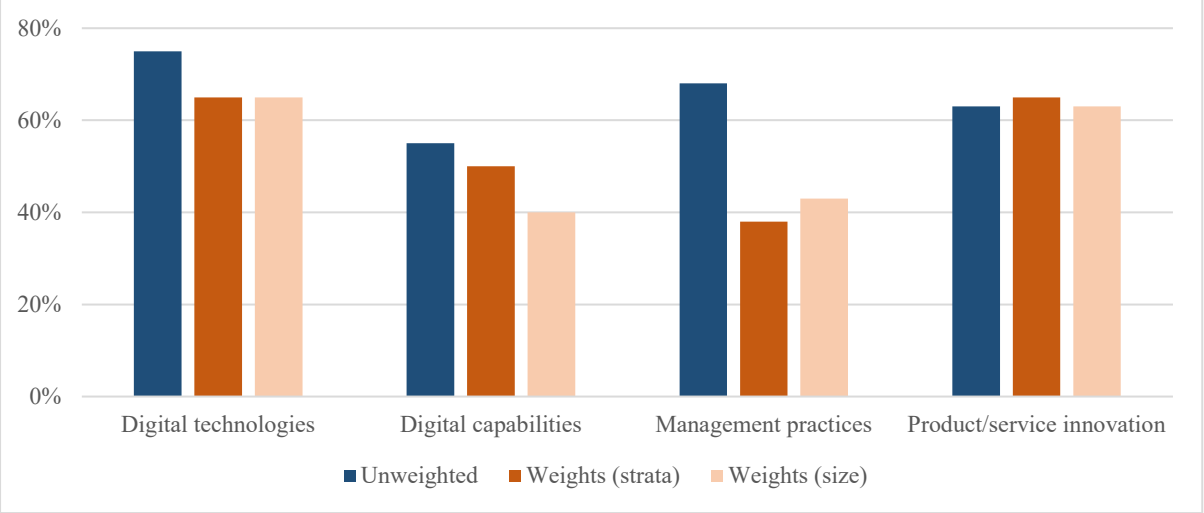
Notes: N=425.

Figure A5: Take-up of government Covid-19 support schemes



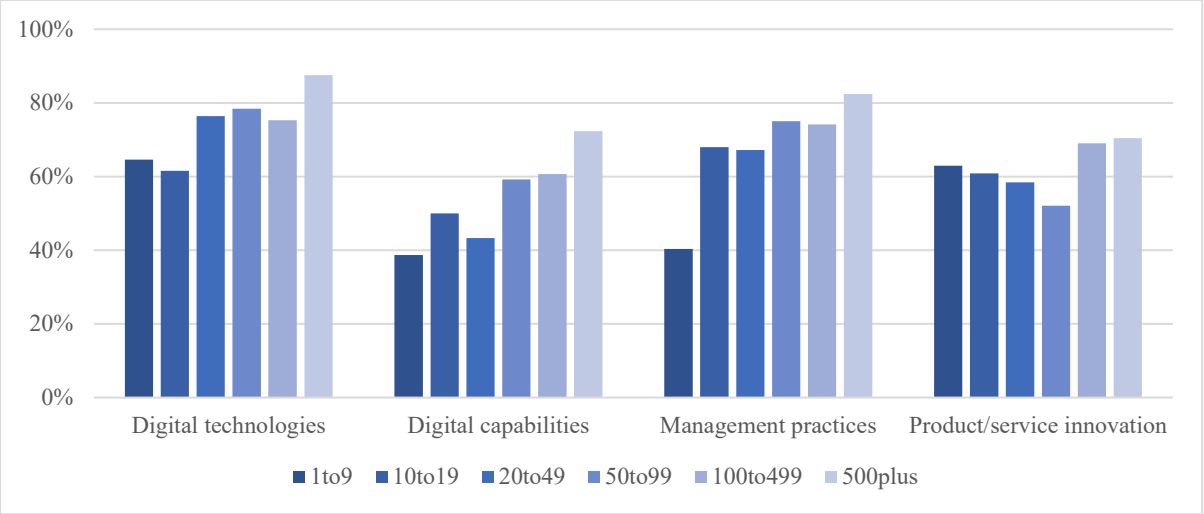
Notes: N=418 (firms that responded to this question). Firms could select more than one option, so the bars do not sum to 100%.

Figure A6: Weighted innovation response



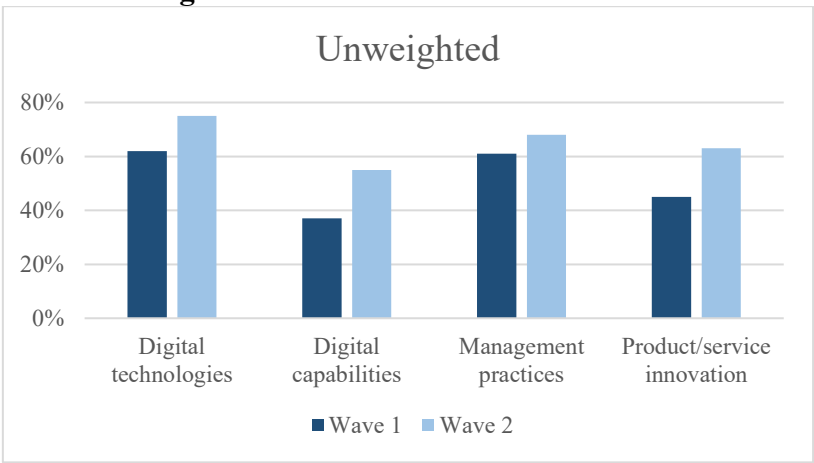
Notes: N=425, N=393, N=388, N=376 responded to each question, respectively.

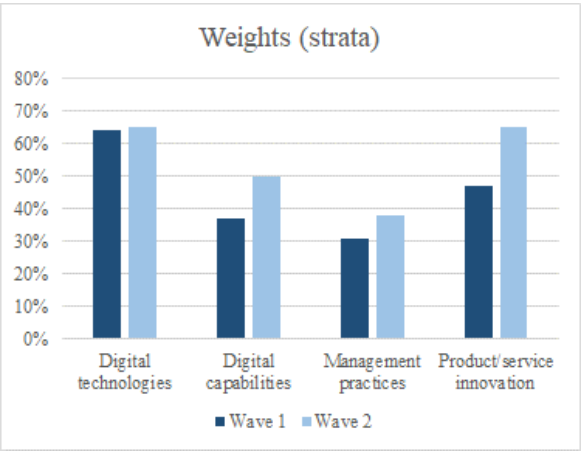
Figure A7: Innovation response by size band

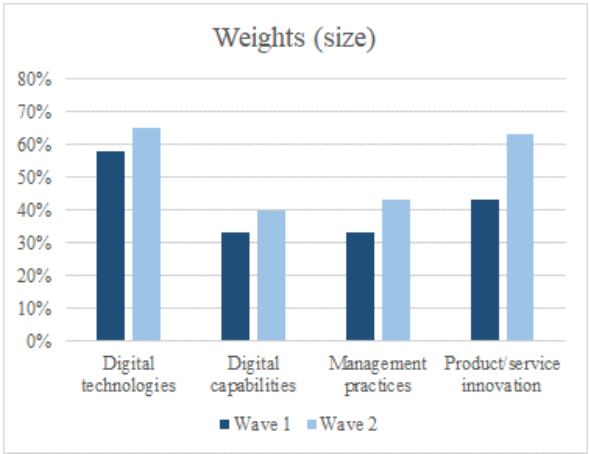


Notes: N=425, N=393, N=388, N=376 responded to each question, respectively.

Figure A8: Innovation between waves

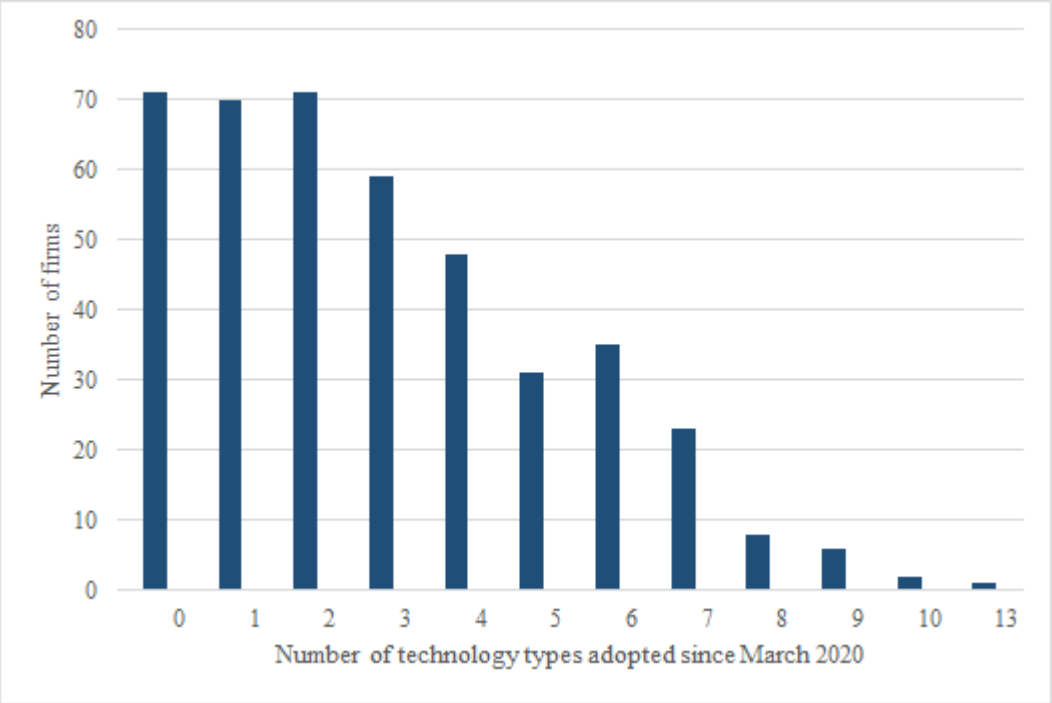






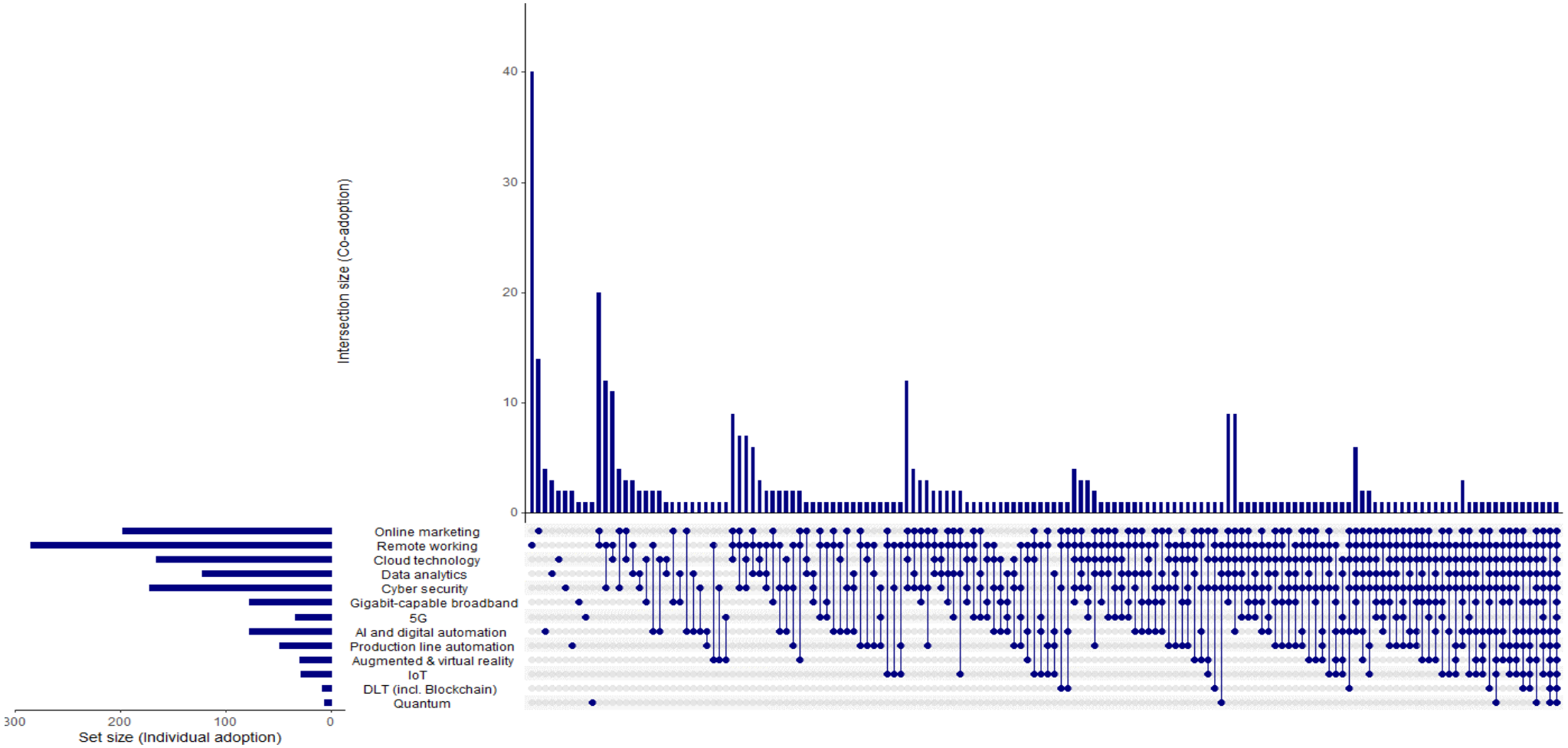
Notes: Wave 2: N=425, N=393, N=388, N=376 responded to each question, respectively. Wave 1: N=375, N=374, N=371 and N=365 responded to each question, respectively.

Figure A9: Number of firms that adopted bundles of technologies, by number of technologies



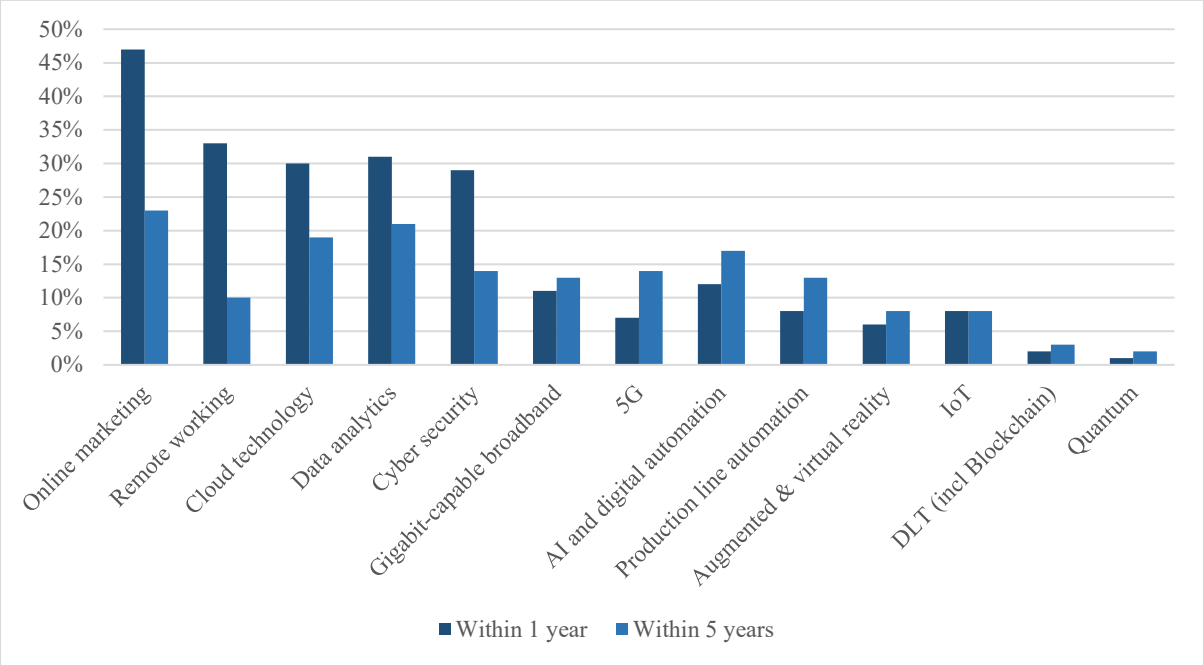
Notes: N=425. 71 firms are marked as having adopted zero technologies – these are firms that either answered "don't know" or no answer across technology types (31), those that answered that they did not invest in any of the technologies (2), or those that invested only pre-pandemic in some technologies and answered "don't know" or did not invest since March 2020 across the others.

Figure A10: Patterns of co-adoption of digital technologies – all bundles



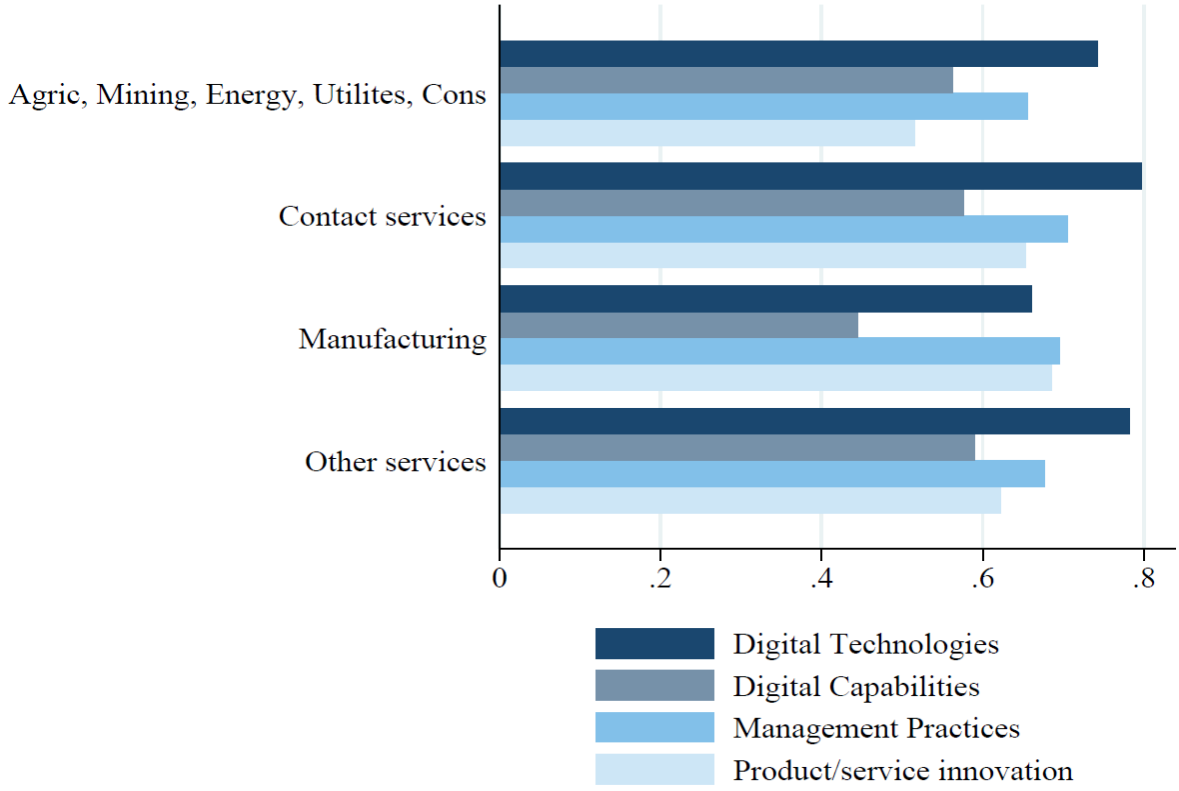
Notes: N=425. The smaller chart on the left plots the total responses for each individual technology, in terms of the number of firms that adopted it since March 2020. In the main chart, instances of adoption of each technology individually are sorted first, followed by sorted instances of adoption of larger bundles. We drop "empty intersections", or the combinations that were never selected.

Figure A11: Specific digital technologies: Future plans



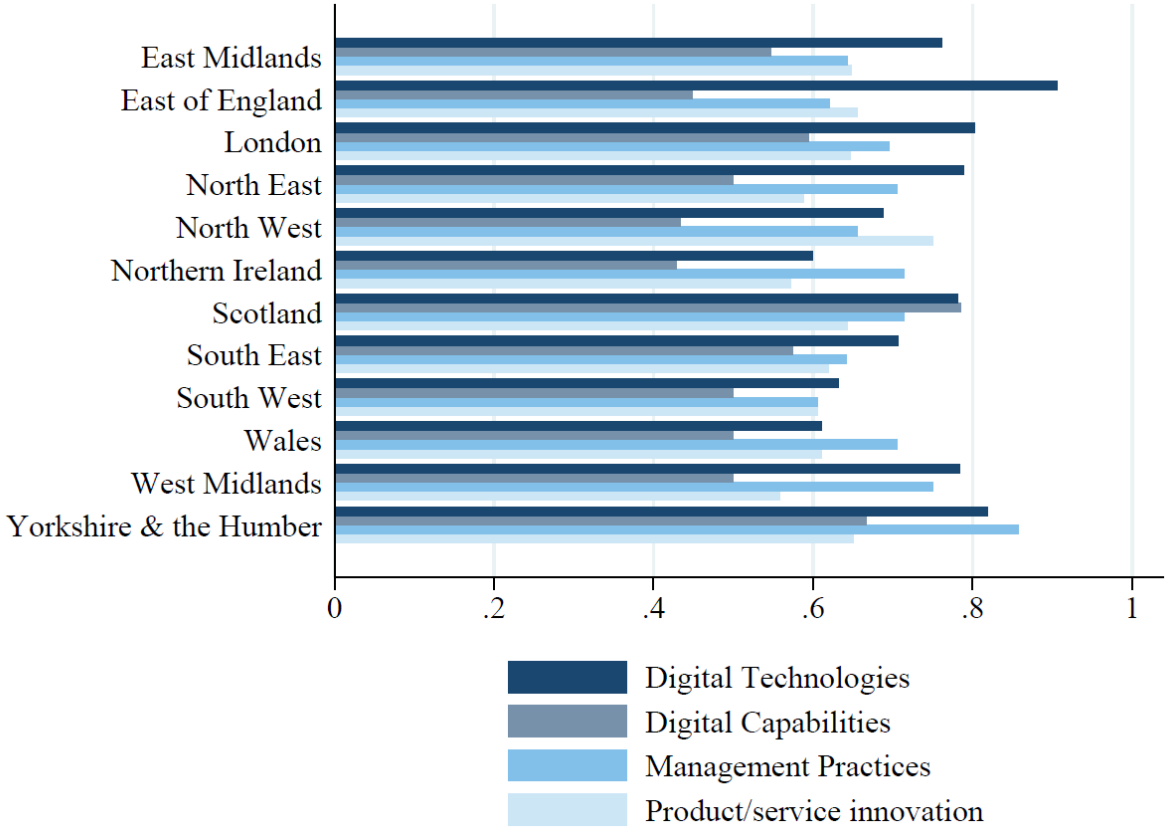
Notes: N=425 (Bars are mutually exclusive). Excluded category is "no plans to invest" and "do not know/no answer".

Figure A12: Innovation by sector groupings



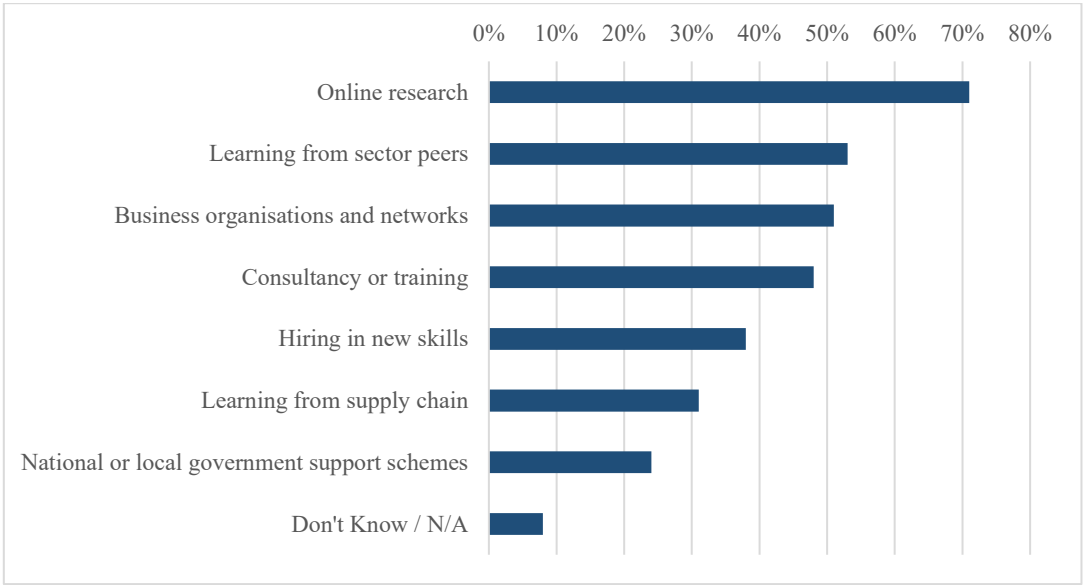
Notes: N=425, N=393, N=388, N=376 responded to each question, respectively.

Figure A13: Innovation by region



Notes: N=425, N=393, N=388, N=376 responded to each question, respectively.

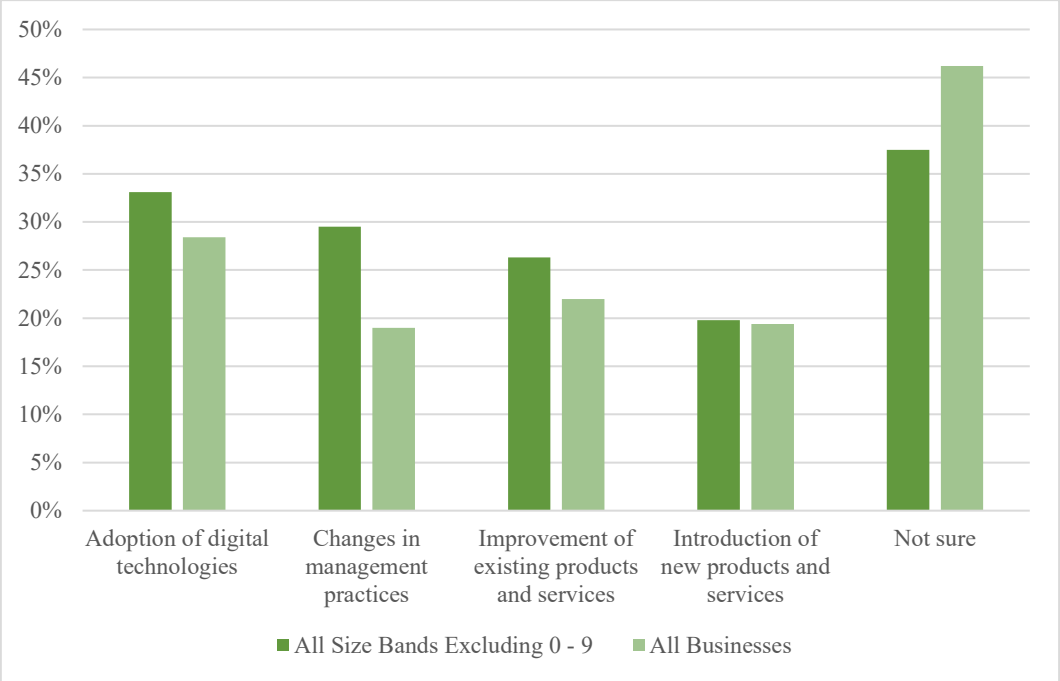
Figure A14: Technology support accessed



Notes: N=373

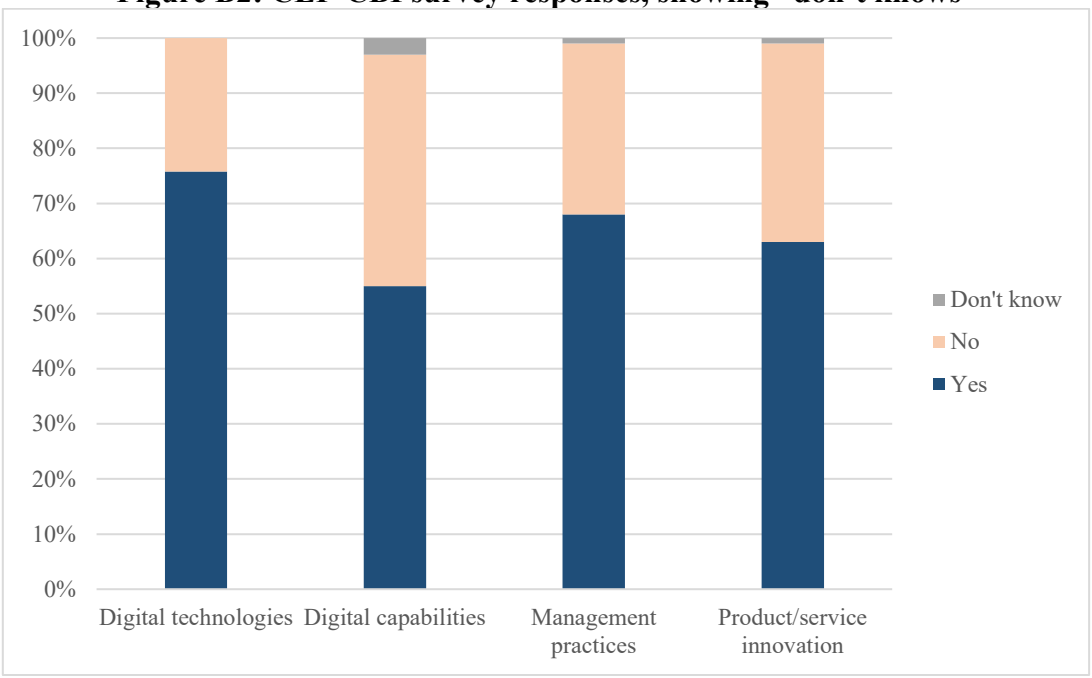
APPENDIX B: Comparison with BICS Survey Wave 38

Figure B1: BICS responses on innovation since the start of the pandemic



Notes: Source: BICS wave 38. Answer to the question "Question: Since the start of the coronavirus (COVID-19) pandemic, which of the following did your business innovate?". Data reported as a percentage of businesses not permanently stopped trading who indicated a change, no change or not sure if there was a change in innovation, broken down by industry and size band, weighted by count, UK, 23 August to 5 September 2021. Sample of 38,438 firms. Variables most comparable to our survey questions selected. Other innovations in question include: Improvements in methods of logistics, delivery or distribution; Improvements in methods of manufacturing products and services and Investment in innovation activities.

Figure B2: CEP-CBI survey responses, showing "don't knows"



Notes: N=425, N=393, N=388, N=376 responded to each question, respectively.

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We are grateful to Helen Ward and Arjun Shah for their helpful comments.
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cepinfo@lse.ac.uk | cep.lse.ac.uk/ | @CEP_LSE