

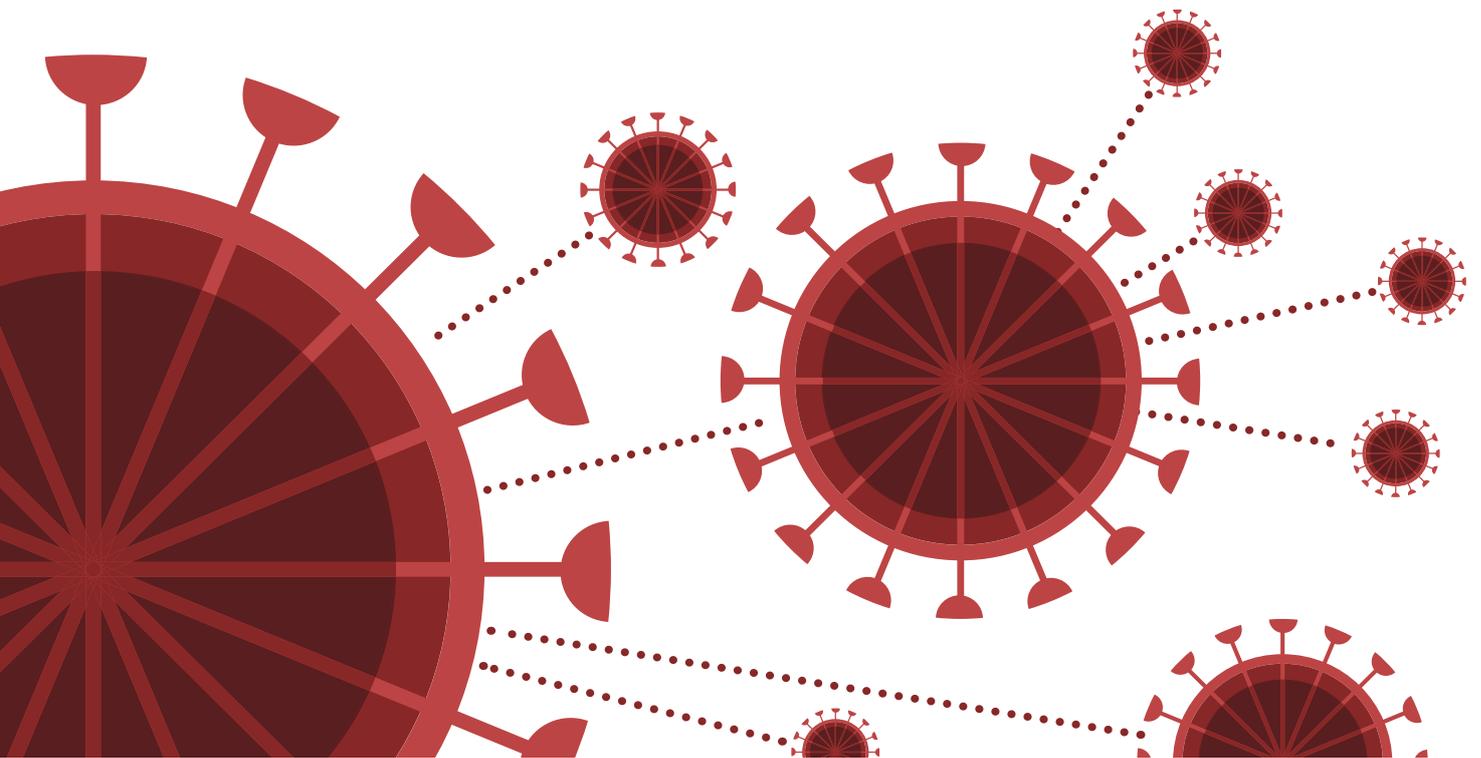
A series of background briefings on the policy issues arising from the Covid-19 pandemic

The business response to Covid-19: The CEP-CBI survey on technology adoption

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A CEP Covid-19 analysis

Paper No.009



The Business Response to Covid-19: the CEP-CBI survey on technology adoption

CEP COVID-19 ANALYSIS

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Summary

- We report results from the CEP-CBI survey of technology adoption in response to the Covid-19 crisis, conducted in July 2020.
- We find that Covid-19 has had a dramatic effect on business operations and performance: 75% of respondents had moved to remote working and, on average, they experienced a 25% loss of revenue compared to “business as usual”.
- In the period from late March to late July 2020, over 60% of firms adopted new digital technologies and management practices; and around a third invested in new digital capabilities. Nearly half of the respondents have introduced new products or services. The vast majority of respondents stated that Covid-19 prompted or accelerated these activities.
- These process and product innovations are generally considered to have had a positive impact on performance, and businesses expect to maintain them post-crisis.
- When asked about the impacts of these changes on their workforce, most firms consider that their adoption of new technologies, capabilities or practices will increase employee productivity, or allow employees to be reallocated to different tasks, rather than reduce the need for employees over time.
- Firms that had previously adopted digital technologies were significantly more likely to adopt new technologies, capabilities and practices, and introduce new products, even after controlling for other key business characteristics. London-based businesses were more likely to have adopted digital technologies, but there is no clear regional pattern to innovation in other measures.
- We asked businesses what they perceive to be major barriers to adopting new technologies and practices. Macroeconomic uncertainty was the most cited barrier, while financing constraints were second. This latter barrier was felt especially by smaller firms, who were also more likely to report information and IT infrastructure constraints as major barriers.
- New tax incentives and grants for innovation are considered the most useful policy levers for both technology adoption and product/process innovation, with smaller firms in particular valuing grants or vouchers.
- We will conduct a follow-on survey in 2021 to assess whether these innovations are persistent, and to understand their impacts on firm performance and employment.

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Introduction

Given the unprecedented economic shock brought about by Covid-19, timely research on businesses is required to inform policy as it evolves, hopefully, from the rescue phase into the recovery phase. While there is much discussion of the technological and organisational response to the crisis amongst firms, there is little systematic data describing the new technologies, or processes introduced, their drivers and impacts on firms and their employees.

In this policy brief, we present new data from a survey of 375 UK businesses conducted in July 2020 in partnership with the Confederation of British Industry (CBI), which seeks to understand the way in which firms have innovated in response to the crisis. Our focus here is on process innovations that might have been induced by the crisis in the first few months after national lockdowns were imposed (end of March to end of July), as opposed to the impacts on the longer term innovative activities, often measured using Research and Development (R&D) or Intellectual Property (IP) indicators. Our main questions relate to the diffusion of digital technologies, digital capabilities or management practices typically considered productivity-enhancing in “normal” times, and to analyse whether diffusion has accelerated as companies adapt to new ways of working. We also ask whether firms have introduced new products or services in response to the crisis.

We find that the pandemic has caused enormous business disruption, which has prompted many firms to focus on innovation. Over 60% of firms report that they have adopted new technologies or management practices since the onset of the pandemic, while a third have invested in new digital capabilities. Of these, the vast majority state that Covid-19 accelerated or prompted this adoption. We find similar patterns in terms of the introduction of new products or services. These shares appear to be higher than those reported by firms in the UK Innovation Survey before the pandemic, and in comparable survey data following the financial crisis. Nearly all firms report that they expect the adoption of new technologies or practices to be permanent and to have a positive impact on firm performance. A majority consider that these changes will increase the productivity of employees, or allow them to be reallocated to different tasks, as opposed to reducing headcount. We will carry out a similar survey and match to secondary data sources on firm performance in 12 months to assess whether such expectations are accurate. We also describe how innovation responses differ across types of businesses and find that previous technology adoption is a strong predictor of a rapid innovation response to the crisis, even after controlling for other factors.

Our analysis should help inform business policies for recovery from Covid-19, which occurs against a background of persistently poor UK productivity performance since the financial crisis (Valero and Van Reenen, 2019). One factor explaining this is the limited adoption of productivity-enhancing digital technologies and capabilities, and modern management practices (Bloom and Van Reenen, 2007), in particular amongst small and medium-sized enterprises (SMEs). The impacts of accelerated automation, or “automation forcing” (Autor and Reynolds, 2020), on labour markets, which is unique to this crisis, also needs to be understood. Where firms have discovered new ways to harness technologies to accomplish their core tasks with less labour, this is likely to create permanent displacements of workers and an urgent need for targeted programmes of training and up-skilling (Elliot Major and

Machin, 2020). Beyond the immediate crisis, policy will be needed to support any positive technological adoption response, address key barriers on the business demand and technology supply side (Be the Business, 2020), and manage workforce displacement and transition for an inclusive recovery (Stern et al., 2020).

This work links to a broader literature on the innovation response of firms to crises. A number of studies have focused on a standard measure of innovative input – R&D activity – showing that this tends to suffer in downturns.² Due to immediate disruptions since Covid-19, Roper and Vorley (2020) find that nearly 80% of Innovate UK grant holders have either stopped or reduced R&D activity; and McKinsey (2020) finds that commitment to innovation-led initiatives has decreased as companies focus on short-term issues. The previous literature suggests that, going forwards, financially constrained firms will find it harder to resume R&D activities. Less is known about the impact of crises on process innovation and the introduction of new products specifically, partly due to the absence of timely, detailed datasets. Some analyses have linked previous downturns to accelerated adoption of new technologies (see, for example, Kopytov et al., 2018). We seek to contribute to this literature, noting that the nature of this crisis is fundamentally different from other recent economic shocks, with lockdowns and restrictions prompting rapid changes in organisational processes or product offerings, which may or may not persist into the future.

Covid-19 has influenced business operations and performance, across the economy

A number of business surveys have been carried out since the Covid-19 crisis began to unfold in the UK and internationally.³ Our bespoke survey, in the field over the last two weeks of July 2020, was designed and conducted in collaboration with the CBI. The CBI is the UK's leading business organisation, which represents 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 distributed via a combination of direct e-mailing to the panel, and promotion on social media by both the CBI and the London School of Economics.

² For example, Aghion et al. (2012) finds that this is particularly the case for credit constrained firms following the financial crisis. See OECD (2012) for a summary of evidence.

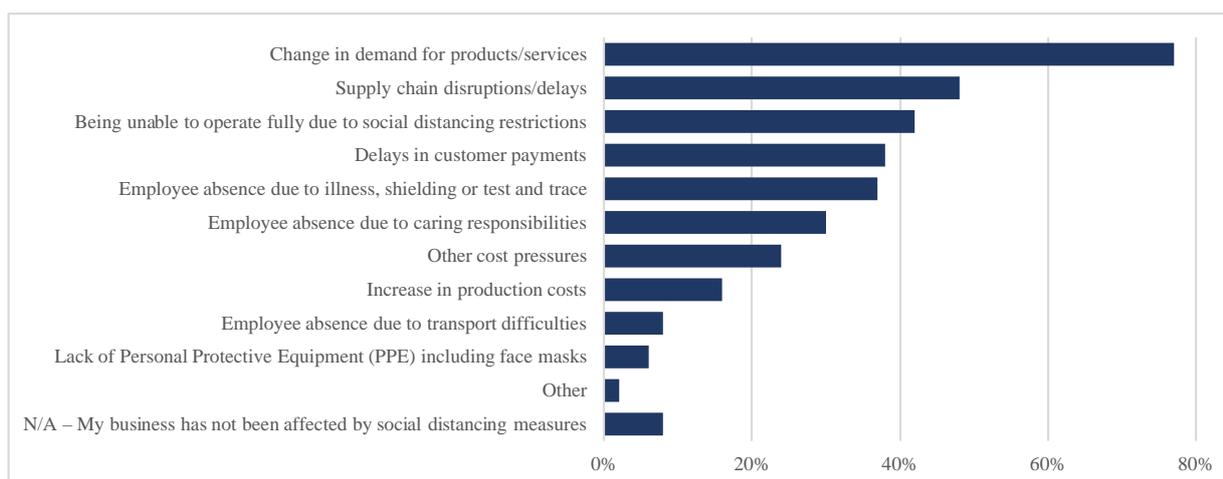
³ To date, surveys have focused on the impacts on businesses in terms of layoffs, closures, financial fragility, uptake of government policies and business expectations (e.g. those conducted by the CBI, British Chamber of Commerce and ONS in the UK; Bartik et al., (2020) on the US and Bennedsen et al., (2020) on Denmark). McKinsey (2020) surveyed over 200 organisations on business expectations and innovation; and Roper and Vorley (2020) surveyed Innovate UK grant holders on their R&D activity. Be the Business and McKinsey have conducted an in-depth survey on the UK SME technology market, examining the barriers and opportunities on the demand and supply side (Be the Business, 2020).

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.

Some basic descriptives of the responding firms⁵ are reported in the Appendix. 15% of firms have their registered address in London and the rest are spread across regions of the UK.⁶ Firms are spread across sectors of the economy, with 29% of respondents in manufacturing and the majority in services. Half of the firms are classified as small in employment terms (fewer than 50 employees) and 60% are classified as small in revenue terms (under £10 million of turnover a year). Respondents tend to be, on average, larger in employment terms than in the population of UK firms⁷ and are considerably older, with nearly 90% having been incorporated over 10 years ago.⁸ We note that the response to the crisis of larger, more established firms might differ from that of the average UK firm and, where relevant, we consider heterogeneity in our results by different size bands or other business characteristics.⁹

We find that, across all respondents, only 20% reported that they were completely operational, with all sites open as at the end of July. The majority (nearly 80%) have had to close business or production sites and transition to remote working in response to the Covid-19 crisis. When asked about the types of business disruptions faced, only 8% responded that their business has not been affected by social distancing measures (Figure 1).

Figure 1: Business disruptions due to Covid-19



Notes: N=374 (firms that responded to this question). Firms could select more than one option, so the bars do not sum to 100%.

⁵ We manually verified responding firms to Companies House entries and/or company websites, and dropped some instances of duplicates or firms that did not answer any of the core questions. The resulting core sample is 375 firms.

⁶ See Appendix Figure A1, which shows the distribution of respondents across NUTS2 and NUTS1 regions respectively. This is broadly in line with the distribution of GDP across the UK, as shown in Appendix Figure A2 – in fact, a smaller share of our sample is in London as compared to its share in UK GDP.

⁷ Using the BEIS Business Population Estimates (BPE) for 2019, total registered businesses by size band. See Appendix Figure A3.

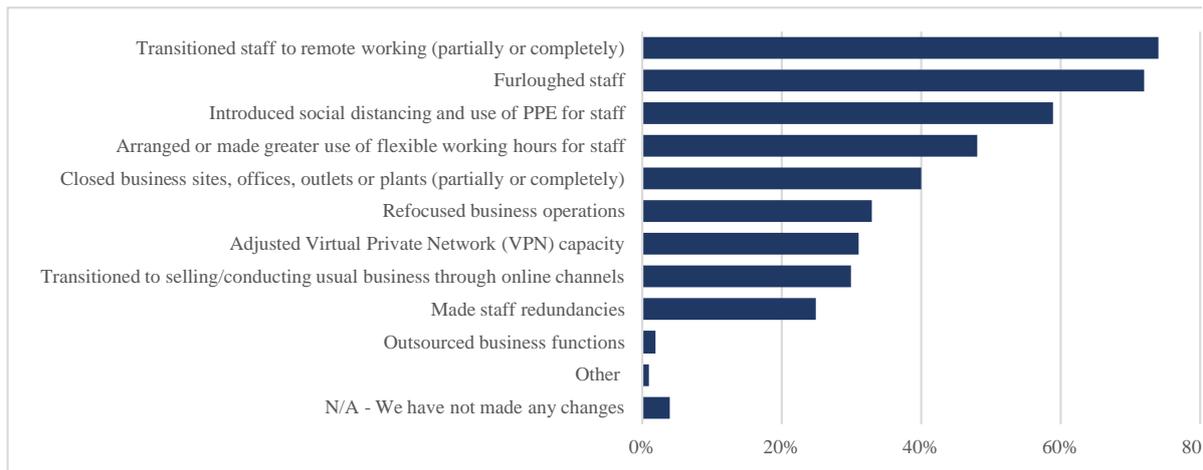
⁸ The average age of respondents based on incorporation date in Companies House was 29 years. As of March 2020, the average age of a company on the full Companies House register was 8.7 years (ONS, 2020).

⁹ Weighting key results to be more representative of the UK's firm size and sectoral GVA distributions did not have much impact on our main results. We report the unweighted data for transparency.

The most prevalent disruption (for 77% of firms) was a change in demand for their products and services. Supply chain disruptions and restrictions on operations were also common, being reported by over 40% of respondents.

Firms have had to adjust business operations in several ways (Figure 2). 75% had transitioned to remote working, partially or in full. While over 70% had furloughed staff, a quarter of surveyed firms had already made staff redundancies in response to Covid-19.

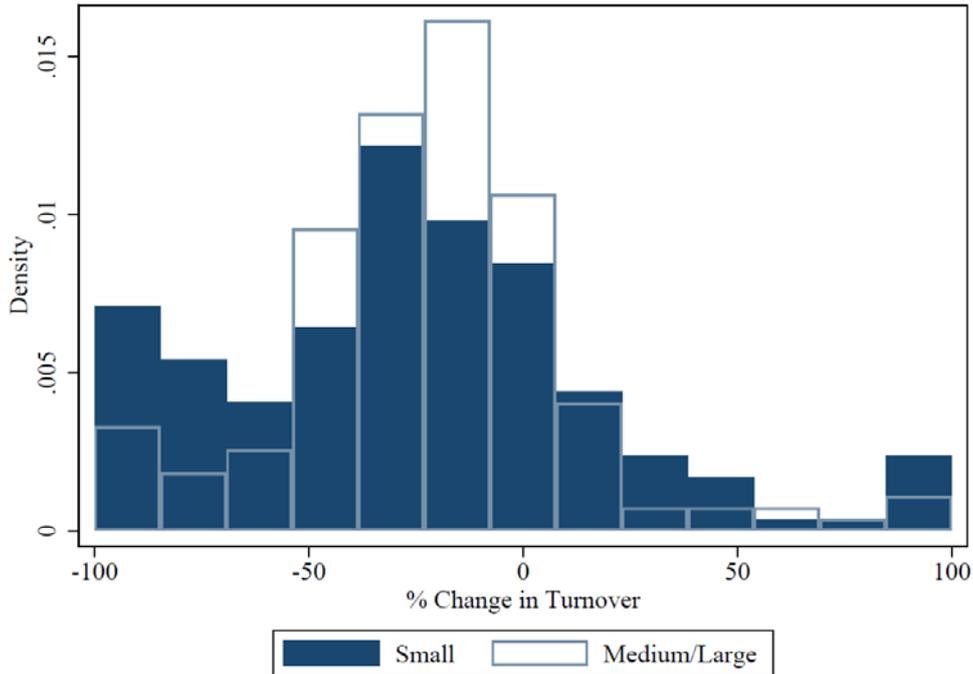
Figure 2: Business operation adjustments in response to Covid-19



Notes: N=374 (firms that responded to this question). Firms could select more than one option, so the bars do not sum to 100%.

Given these disruptions and adjustments, the majority of respondents (over 80%) experienced a reduction in turnover relative to “business as usual” since the government’s social distancing measures came into force on 23rd March (Figure 3). On average, there was a loss in turnover of 24%. The average loss and the variance of the change in turnover was slightly higher amongst smaller firms, compared to their larger counterparts.

Figure 3: Change in turnover versus “business as usual”



Notes: N=369 (firms that responded to this question).

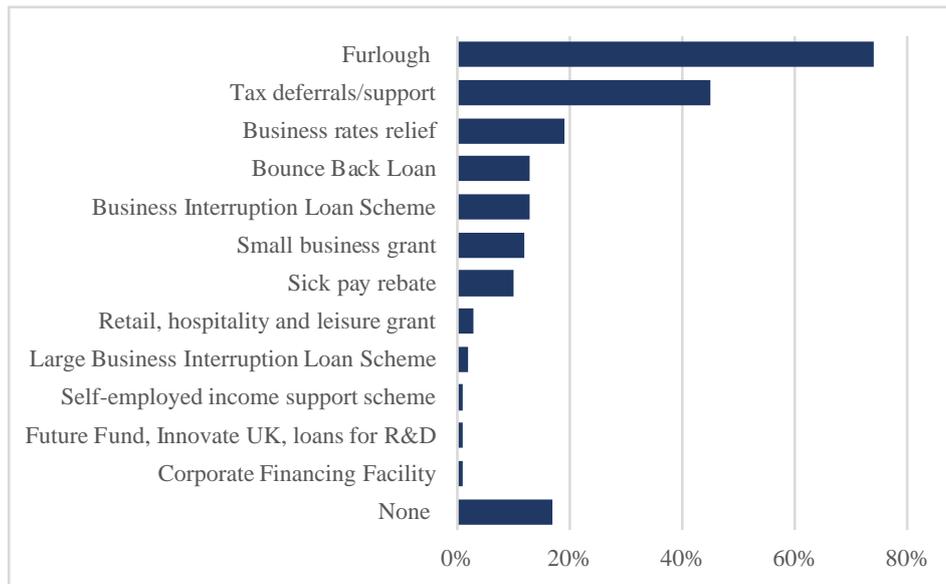
In contrast, in the period to July, respondents saw a fall in employment of 5%, on average. While employment is known to be ‘stickier’ than turnover, we also document below the widespread take-up of the furlough scheme, which arguably helped firms avoid making redundancies in the short-term.

A large share of respondents is financially fragile, with nearly a third reporting under three months’ worth of cash reserves to meet expected outgoings. Despite this, firms are confident of their survival, with only 1% of respondents considering it unlikely that they will be open on 31 January 2021.

Given these impacts, a large majority of firms have taken up government support schemes to date. Amongst these, the Coronavirus Job Retention (furlough) scheme has been by far the most popular, with around 75% reporting take-up (Figure 4). This is consistent with other business surveys conducted during similar periods to this one. For example, the CBI’s business surveys in July reported that 76% of businesses had made use of the furlough scheme.¹⁰ Around 60% of respondents have taken up more than one government scheme.

¹⁰ The CBI’s July business surveys were conducted between 25 June and 15 July, including firms in manufacturing, distribution, consumer services and business & professional services.

Figure 4: Take-up of government Covid-19 support schemes



Notes: N=373 (firms that responded to this question). Firms could select more than one option, so the bars do not sum to 100%.

A majority of respondents have adopted productivity-enhancing technologies and practices, or introduced new products/services in response to the pandemic

We investigate the extent to which firms have rapidly adopted new technologies, capabilities and practices, or introduced new products and services in response to the Covid-19 crisis. We asked firms whether they had engaged in four different types of innovation in the period from the end of March to end of July 2020. The first three relate to “process innovation”, i.e. the adoption of new digital technologies, digital capabilities or management practices within the organisation. To be more specific about the types of innovation across these categories, we gave a series of examples in the survey questions, as set out in Table 1.

Table 1: Examples of relevant process innovation

Digital Technologies	Digital Capabilities	Management Practices
<ul style="list-style-type: none"> Enterprise Resource Planning Customer Relationship Management systems Remote working technologies Cloud computing Mobile technology Automated machinery AI applications (e.g. chatbots) 	<ul style="list-style-type: none"> E-commerce Advanced analytics Cyber security 	<ul style="list-style-type: none"> New processes around business operations New HR and people management practices

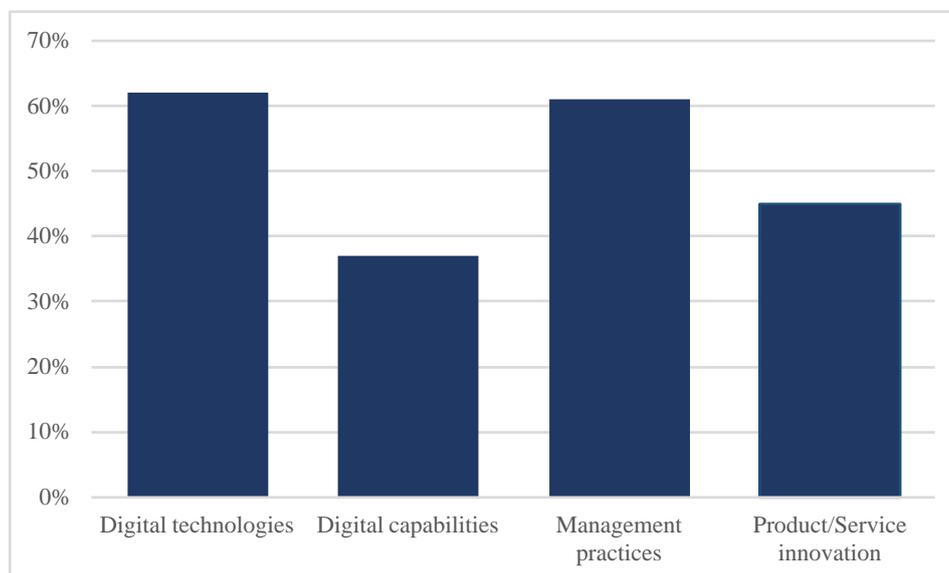
Notes: Examples given in survey questions and developed in collaboration with the CBI.

We also asked firms if they had introduced any new product or services in the period since the end of March 2020, which we refer to as “product/service innovation”.

We find a strong business innovation response to the Covid-19 crisis across these categories (Figure 5). Over 60% of respondents have adopted digital technologies and new management

practices during the crisis and 38% adopted new digital capabilities. Of those who have not adopted, a third plan to adopt new digital technologies or capabilities in the near future, and 20% plan to adopt new management practices.¹¹

Figure 5: Innovation response (March – July 2020)



Notes: N=375, N=374, N=371 and N=365 responded to each question, respectively.

With respect to product innovation, 45% have introduced a new product or service, with 75% of these stating that they had introduced entirely new products or services, and nearly 60% improving existing products or services.

These innovation rates appear to be greater than what we might have expected in the absence of the Covid-19 crisis - with the most recent UK Innovation Survey finding that around 13% of businesses were process innovators and 18% were product innovators over the 3 year period from January 2016 to December 2018.¹² Moreover, the technological response to Covid-19 so far appears to be larger than that following the financial crisis. Data from the Workplace Employment Relations Study (WERS, 2011) showed that 48% of employers had introduced or upgraded technologies, 38% had introduced changes in workplace organisation and a third had introduced new products and services over the two years prior to the survey.

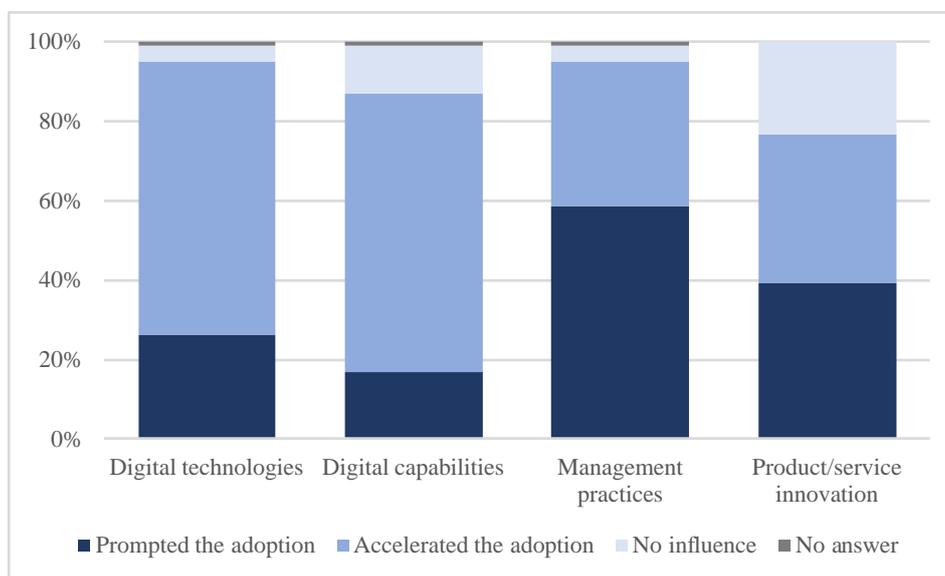
Figure 6 shows that firms overwhelmingly reported that Covid-19 prompted or accelerated their innovative activities. This was the case for 95% of firms with respect to the adoption of

¹¹ These results appear consistent with the Be the Business-McKinsey survey of SMEs (Be the Business, 2020). They find that 2 in 3 businesses believe that technology can improve their business, and 45% of businesses expressing a willingness to invest in technology post-Covid.

¹² See the UK Innovation Survey (2019) Figure 2.1. Taking a broader view of innovative activity, the share in 2016-18 was 39% (this includes firms that have introduced new or improved services; those that have engaged in innovation projects not yet complete, scaled back or abandoned; those that have introduced process innovations; and those that have invested in R&D or other activities associated with innovation). In 2016-18, innovation rates were similar to 2008-10 levels, having risen over the years since the financial crisis and then fallen in more recent years.

new digital technologies or new management practices, nearly 90% for digital capabilities, and 75% for new products or services.

Figure 6: Influence of Covid-19 on innovation



Notes: N=231, N=139, N=225, N=163 (those who adopted) in each column, respectively.

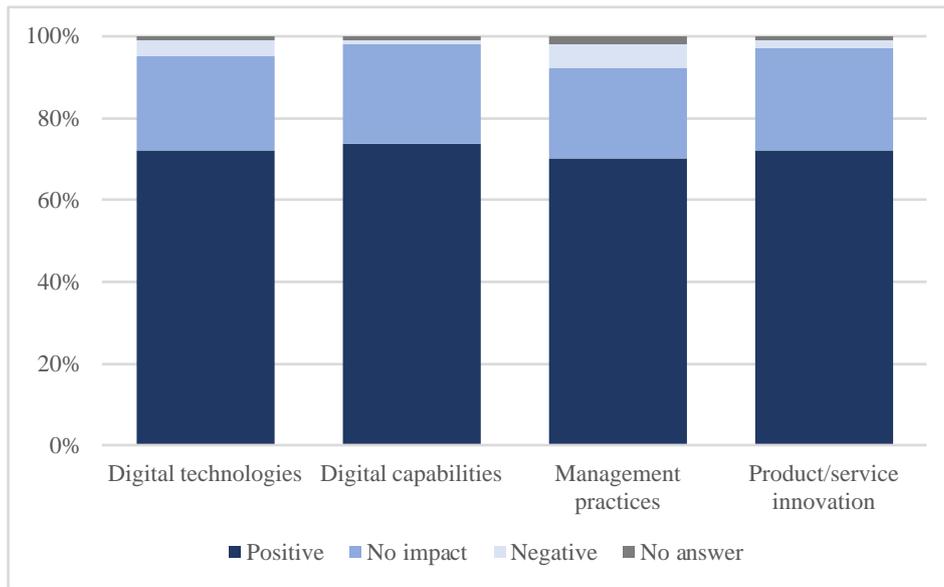
Firms anticipate that innovations introduced during the pandemic will outlive the crisis

The widespread innovative response to the crisis raises many questions. One could argue that firms were effectively forced to innovate, for example, by ensuring management practices would adapt to remote work or by transforming interrupted supply chains. The question is whether such changes are considered temporary or whether they represent more permanent changes that could improve performance beyond the immediate crisis. We find that over 90% of adopting firms, across the four types of innovation, reported that they intend to continue with these innovations. This suggests that the changes introduced are not considered momentary fixes. We will test this hypothesis and the effect of these innovations on firm performance in our follow-on survey.

Across types of innovation, firms report that these have generally had a positive impact on performance. They expect that adoption will raise the productivity of workers or allow a reallocation of tasks, rather than substitute workers

Across the four types of innovation, around three quarters of innovating firms considered that innovation had a positive impact on profitability (Figure 7). Only a small minority (between 1-10%) reported a negative impact.

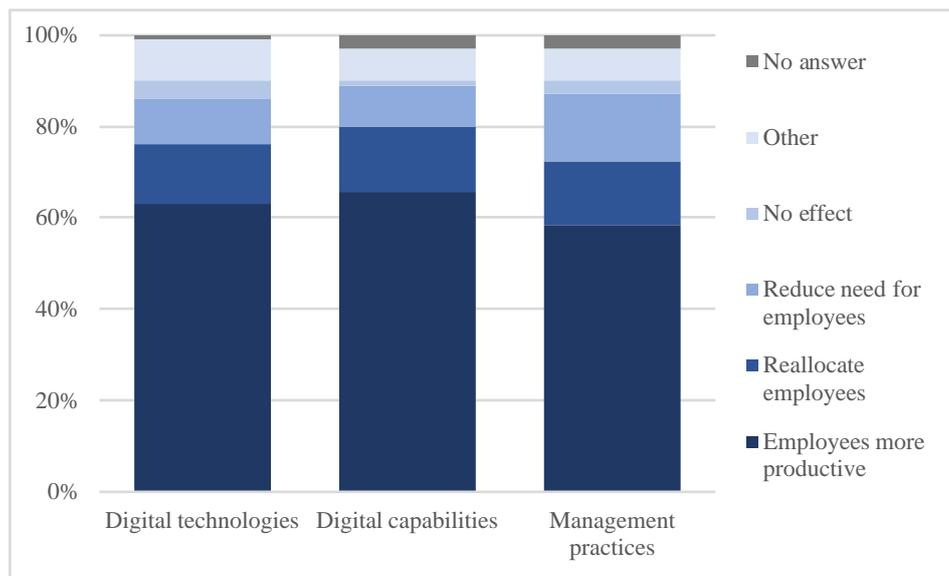
Figure 7: Impact of innovation on profitability



Notes: N=231, N=139, N=225, N=163 (those who adopted) in each column, respectively.

In the case of the adoption of new technologies, capabilities or management practices, we also asked about business expectations on the impact of continued adoption on their existing workforce. Most firms expect that continuing to employ such process innovations will increase the productivity of employees in their current tasks or allow employees to be allocated to more productive tasks (Figure 8). Only a minority (10-15%) consider that such process innovation will imply a reduced need for employees over time. This suggests that the types of technologies or practices in question are not, for the most part, considered by firms to be labour replacing. Amongst those that answered “other”, many highlighted benefits for employees due to the increased workforce flexibility resulting from technology adoption.

Figure 8: Expected workforce impacts of continuing process innovation

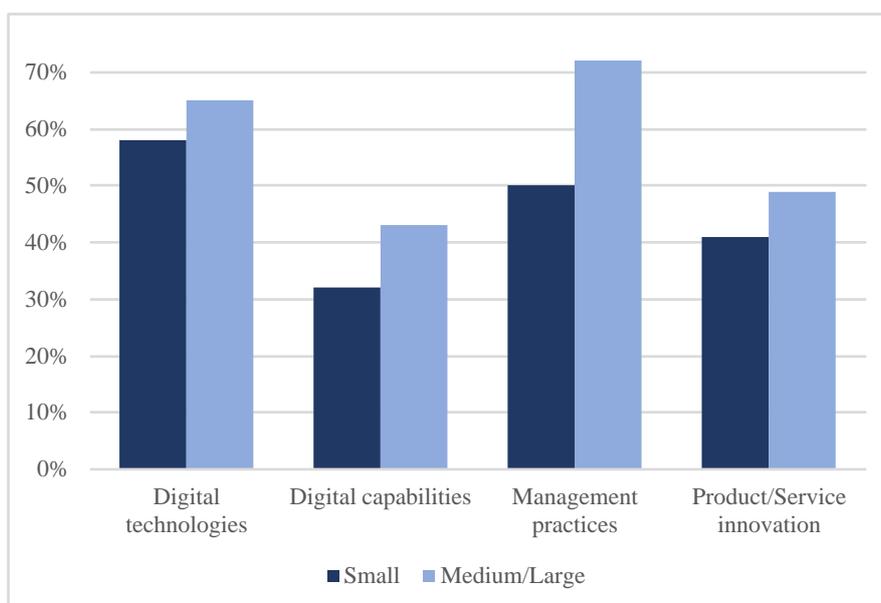


Notes: N=231, N=139, N=225, N=163 (those who adopted) in each column, respectively.

There are differences in innovative activity across firm types – in particular, prior adoption of digital technologies and capabilities is a strong predictor of an innovative response to the Covid-19 crisis

Consistent with the literature and other business surveys, we find that all four different types of innovative response were more prevalent amongst larger firms (Figure 9).

Figure 9: Innovation rates by firm size band



Notes: N=375, N=374, N=371 and N=365 responded to each question, split between small and medium/large firms, respectively.

However, regression results suggest this difference by firm size is not always significant once we control for other key business characteristics (Table 2), such as firm age, sector and being registered in London.¹³ We include two other variables that we expect to matter: an indicator for whether firms state that they had adopted new digital technologies or capabilities in the 3 years prior to the Covid-19 crisis; and the share of the workforce that respondents consider were able to work from home in “normal” circumstances, i.e. before the Covid-19 crisis hit.¹⁴

Table 2: Relationships between innovation responses and key business characteristics

	Adoption of			
	Digital technology	Digital Capabilities	Management practices	Product/service innovation
Small business (<50 employees)	-0.026 (0.050)	-0.088* (0.051)	-0.169*** (0.051)	-0.053 (0.053)
Firm > 10 years old	0.128 (0.078)	0.040 (0.078)	0.169** (0.078)	0.066 (0.082)
Manufacturing	-0.102 (0.063)	-0.144** (0.061)	-0.114* (0.060)	-0.059 (0.063)
London	0.185*** (0.062)	0.051 (0.069)	-0.069 (0.074)	0.073 (0.073)
Pre-Covid adoption	0.256*** (0.060)	0.295*** (0.050)	0.271*** (0.061)	0.241*** (0.059)
ln(1+share work from home)	0.039* (0.020)	0.013 (0.019)	-0.004 (0.020)	0.029 (0.020)
Observations	359	358	356	351
Mean of dep var on this sample	0.62	0.38	0.62	0.46

Notes: Analysis in each column based on observations where all variables are non-missing. OLS regressions with robust standard errors in parentheses, *** denotes significance at the 1% level, ** 5% level and * 10% level. The mean of the dependent variable is reported in the bottom row and gives the share innovating under each category on the analysis sample (this differs slightly from the main results in Figure 5, as it depends on the number firms for which the full set of variables are available for regressions).

Prior adoption is the variable that matters most. All else equal, firms that state that they had previously adopted were nearly 30 percentage points more likely to have adopted new technologies and practices, or to have introduced new products and services since the crisis hit, suggesting that there might be a path dependence in this type of activity.¹⁵

While small firms appear less likely to innovate, even after controlling for these other features, the effect is only significant in the case of digital capabilities and, in particular, management practices. Smaller firms were 17 percentage points less likely to adopt new management practices, while more established firms (over 10 years old) had a greater

¹³ The patterns are very similar in regressions including a full set of sector and region dummies, or if probit specifications are estimated instead of OLS.

¹⁴ We take the natural log of this value, plus 1 to account for the zeroes.

¹⁵ We note that the mean of this variable is quite high – with 76% of respondents stating that they had previously adopted new digital technologies or capabilities in the three years before the crisis. Indeed, the question is rather broad compared to our main technology questions, and the relationship we document here could simply reflect the fact that more productive businesses were more likely to innovate in response to Covid-19. We will investigate these issues further in our final report, which will include analyses based on matching the data from this and our follow-on survey to secondary data sources.

likelihood of doing so. The types of innovation we measure appear to be less common in manufacturing firms, but this effect is only significant in the case of digital capabilities and management practices. This basic pattern is also shown in Appendix Figure A4, which summarises adoption rates across high-level sector groupings, including parts of the service sector where contact tends to be important (for example, retail and hospitality).¹⁶

The geographic pattern is less clear. While firms in London were 18 percentage points more likely to adopt new digital technologies, location does not matter for the other types of innovation we measure. This is also illustrated in Figure A5, which shows the innovation rates across UK regions. Other than London, where 80% of firms adopted digital technologies, the East Midlands, Scotland, the South East, and Yorkshire and the Humber also saw more than 60% of surveyed firms adopting new digital technologies. The South West had the highest share of firms adopting new management practices; Scotland for digital capabilities; and the East Midlands saw the highest rate of product/service innovation.

Finally, there is a positive relationship between the share of the workforce that could work from home before the crisis hit and the adoption of digital technologies, but there was no relationship for the other categories. This suggests that firms already in the practice of remote working were faster to adopt relevant digital technologies.

To the extent that past adoption is a driver of future adoption or product innovation, then the innovative response to the pandemic could have nudged a large number of firms into a path of improved use of technology and innovation. We will be able to test this hypothesis in our follow-on survey next year.

Macroeconomic uncertainty and financing constraints are considered key barriers to investment in new technologies and practices and new financial incentives are the most popular policy to address these

We asked firms to score potential barriers to the adoption of new technologies, capabilities or management practices. Macroeconomic uncertainty (where we cited Covid-19 and Brexit as examples), was selected by most firms as a barrier (Figure 10).¹⁷ The second most cited barrier was financing constraints, especially for smaller firms, who were also more likely to report information and IT infrastructure constraints as major barriers.¹⁸ The finding that financing constraints are important is consistent with other innovation surveys – for example, in the UKIS, cost factors including finance availability, innovation costs and finance costs were the highest rated barrier to innovation in 2016-18 (each being reported as barriers of high importance for over 17% of firms).¹⁹

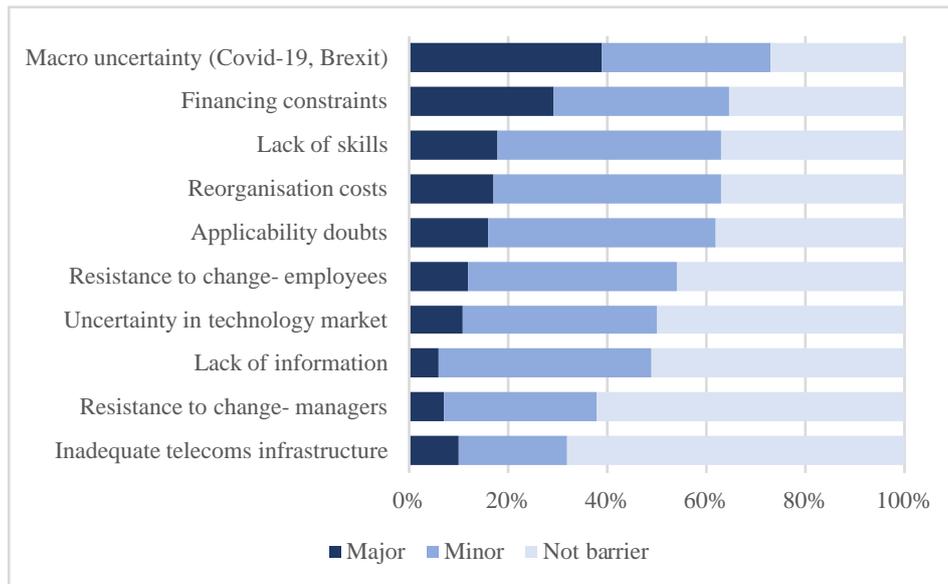
¹⁶ The split of respondents across SIC2007 sections is shown in Table A2. It shows that some sections had a very small number of firms in our sample (e.g. mining and quarrying). We, therefore, map to high-level sector groupings to meaningfully compare adoption rates across sectors.

¹⁷ See Bloom et al., 2018 for analysis of Brexit-related uncertainty and discussion on why uncertainty harms investment, and Altig et al., (2020) on Covid-19 induced uncertainty.

¹⁸ In regressions with a dummy = 1 if a firm reported each barrier to be major, it was found that smaller firms were 12 p.p. more likely to report financing constraints as a major barrier; and 6 p.p. more likely to report information or IT infrastructure constraints as major barriers. These relationships are unchanged when other controls are included in the regressions (firm age, pre-Covid adoption, sector and region dummies).

¹⁹ See Figure 7.1. in UK Innovation Survey (2019).

Figure 10: Barriers to process innovation



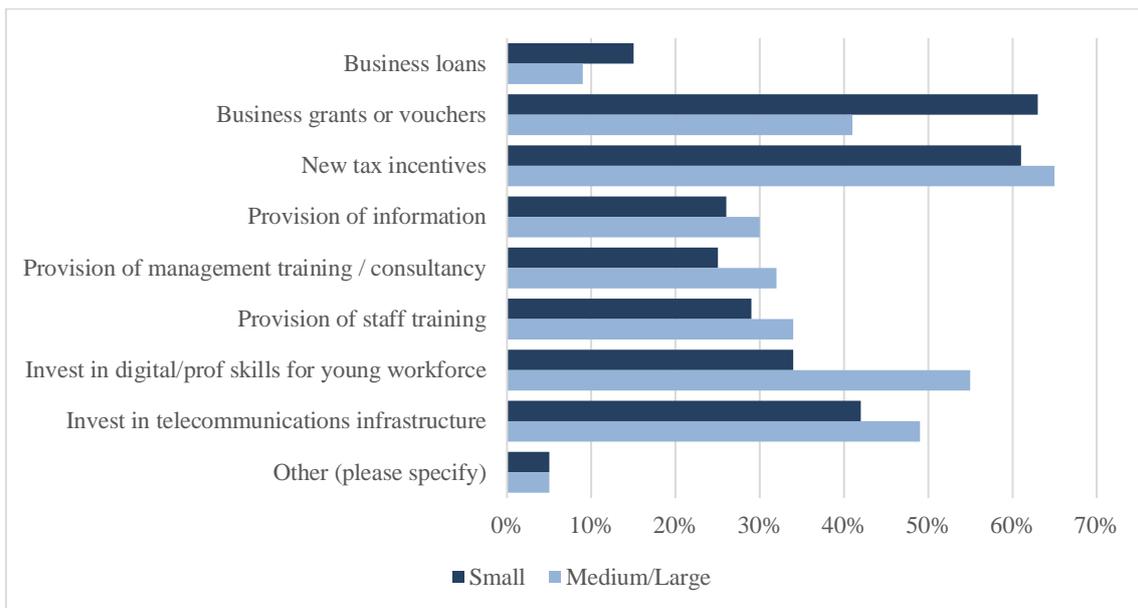
Notes: N=361 (firms that responded to this question).

The top two ranked policies to address these barriers were new tax incentives and business grants or vouchers (Figure 11), with smaller firms in particular welcoming 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 options selected by the lowest share of respondents were information campaigns and policies to improve access to business loans.

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

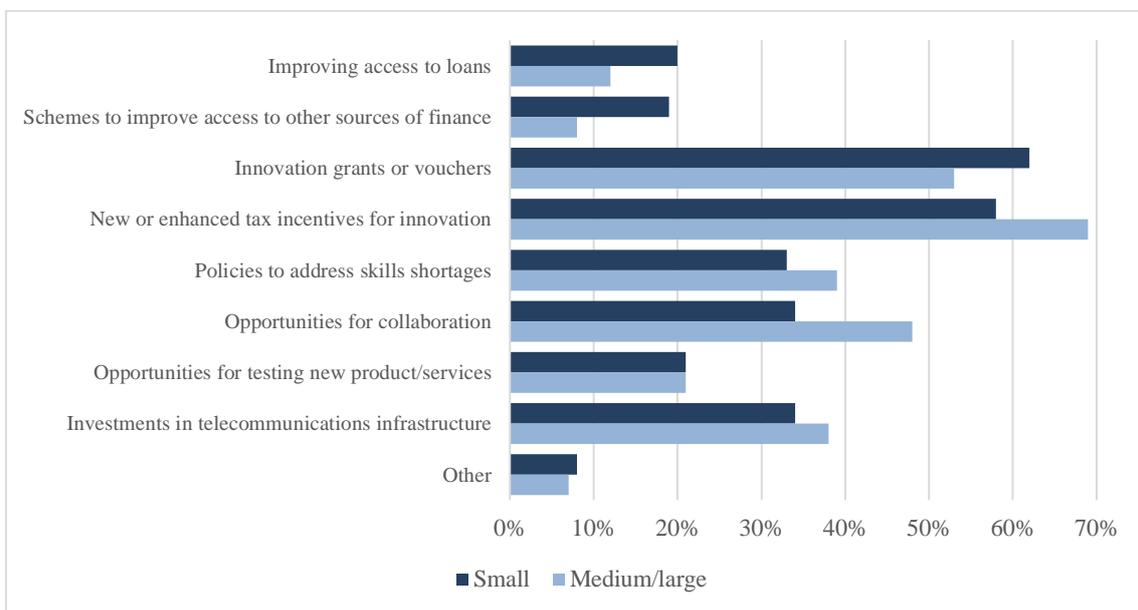
Interestingly, the type of support most favoured by firms for product innovation are similar to those relevant for process innovation: financial assistance via the tax system or via grants or vouchers (Figure 12). Nearly half of larger firms would also welcome policies to improve collaboration with universities or other industrial partners, while only a third of smaller firms chose this option.

Figure 11: Potential new government assistance schemes for process innovation



Notes: N=346 (firms that responded to this question) (182 small firms defined as having fewer than 50 employees; and 164 medium/large defined as having 50 or more employees). Firms could select more than one option, so the bars do not sum to 100%.

Figure 12: Potential new government assistance schemes for product innovation



Notes: N=318 (firms that responded to this question) (166 small firms defined as having fewer than 50 employees; and 152 medium/large defined as having 50 or more employees). Firms could select more than one option, so the bars do not sum to 100%.

Putting it all together

Covid-19 has had a dramatic influence on firm operations and performance. Our survey of 375 UK firms reveals that, in response to this, firms have engaged in process and product

innovations, which are generally considered by the respondents to have had a positive impact on performance. Firms expect to maintain these changes beyond the current crisis.

We also find that there appears to be a path dependence in technology adoption and, even after controlling for key firm characteristics, firms that had adopted digital technologies or capabilities in the 3 years prior to the survey were significantly more likely to innovate since the Covid-19 crisis hit.

While all firms consider macroeconomic uncertainty to be a key barrier to innovation, the second most cited barrier was financing constraints. This latter barrier was especially felt by smaller firms, which were also more likely to report information and IT infrastructure constraints. New tax incentives and grants for innovation are considered the most useful policy levers for both technology adoption and product/process innovation, with smaller firms in particular valuing grants or vouchers for these types of activity.

The nature of the Covid-19 crisis appears to have accelerated certain types of innovation in a way that previous crises might not have done. Our results highlight a number of important questions to be investigated in future research: will innovations introduced during the crisis persist and, if so, will they have a positive impact on firm performance and survival, as firms expect? Will they lead to higher productivity of existing workers or a reduction of employees over time – indeed, will the implementation of new technologies and practices actually lead to business growth and hence increased employment? How will these patterns vary by type of innovation introduced, and by firm size or sector? Will businesses continue to seek out and adopt new technologies and practices during the next phase of the Covid-19 crisis and beyond? Is there a path dependence with respect to previous adoption or is this merely a reflection of more productive firms being more likely to innovate in the past and in the future? We will investigate these questions further in our survey and analysis of secondary data one year on.

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APPENDIX

Table A1: Key firm characteristics

	Mean	N
Dummy for registered address in London	0.15	375
Dummy for multi-site business	0.5	371
Dummy for operates across multi-regions	0.53	375
Dummy for manufacturing	0.29	375
Dummy for small (<50 employees)	0.52	375
Dummy for small (<£10 million revenue)	0.61	373
Dummy for pre-Covid-19 technology adoption	0.76	371
Dummy for outsources business functions	0.96	375
Share of workforce that can work from home	35.55	361
Dummy for firm > 10 years old	0.87	375
Age based on incorporation date in Companies House	29.09	373

Notes: The sample size varies across variables because the majority of questions in the survey were not compulsory.

Table A2: Number of surveyed firms by sector

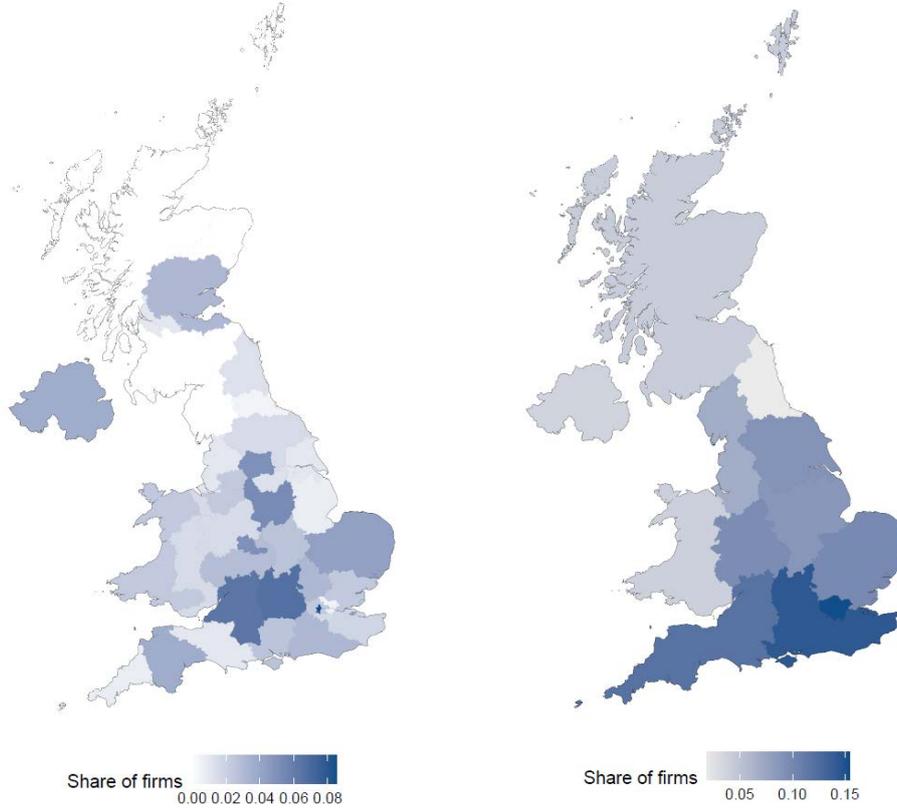
Sector	#	Share	Sector grouping
Agriculture, forestry and fishing	4	1%	Agric, Mining, Energy, Utilities, Cons
Mining and quarrying	3	1%	Agric, Mining, Energy, Utilities, Cons
Manufacturing	107	29%	Manufacturing
Electricity, gas, steam and air conditioning supply	2	1%	Agric, Mining, Energy, Utilities, Cons
Water supply; sewerage, waste management and remediation activities	3	1%	Agric, Mining, Energy, Utilities, Cons
Construction	15	4%	Agric, Mining, Energy, Utilities, Cons
Wholesale and retail trade, repair of motor vehicles and motorcycles	39	10%	Contact services
Transportation and storage	10	3%	Other services
Accommodation and food service activity	7	2%	Contact services
Information and communication	30	8%	Other services
Financial and insurance activities	24	6%	Other services
Real estate activities	6	2%	Other services
Professional, scientific and technical activities	39	10%	Other services
Administrative and support service activities	9	2%	Other services
Education	2	1%	Other services
Human health and social work activities	5	1%	Other services
Arts, entertainment and recreation	10	3%	Contact services
Other service activities	60	16%	Other services
Total sample	375		

Notes: Sector based on answer to the question “Please select the sector description that best fits your business”. “Contact services” are an indicative grouping of sectors in the market economy that generally require high levels of physical contact. De Lyon and Dhingra (2020) analyse CBI survey data in May and June 2020. to show that arts & entertainment, accommodation & food, and wholesale & retail (which they term “in-person services”) are the three sectors with the largest negative expected effects on business volumes over the following three months. Shares are rounded to the nearest integer. In the allocated sector groupings, “Construction” is abbreviated to “Cons”.

Figure A1: Share of respondents by NUTS regions of the UK

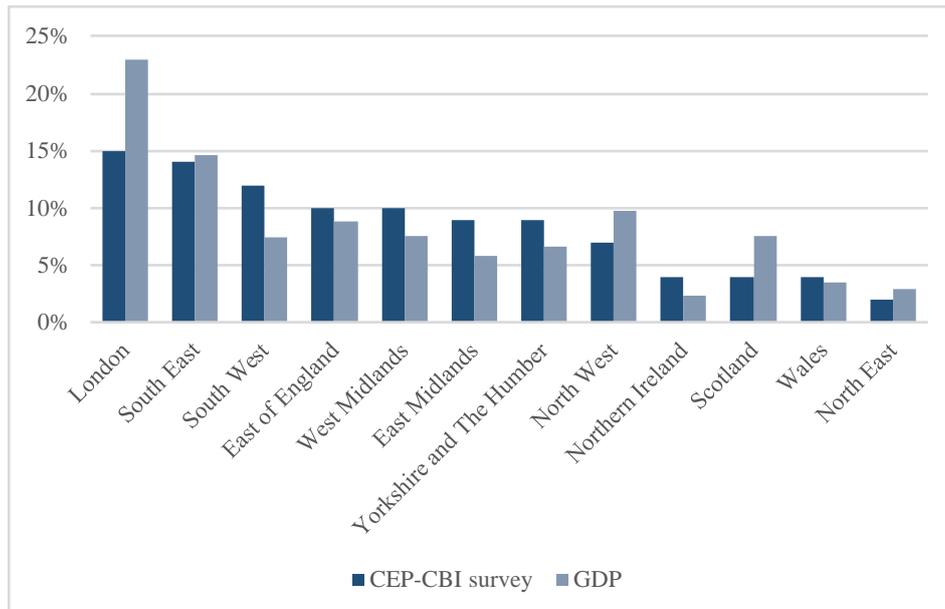
A. Share by NUTS2 Regions

B. Share by NUTS1 Regions



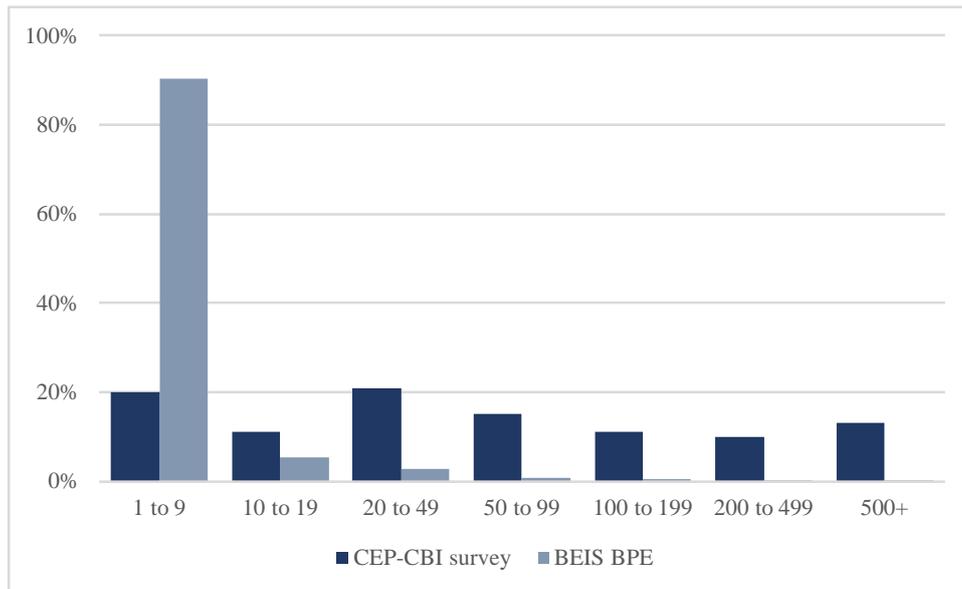
Notes: N=375. Maps show the share of respondents across NUTS2 and NUTS1 regions based on registered address in Companies House.

Figure A2: Share of respondents and share of UK GDP across NUTS1 regions



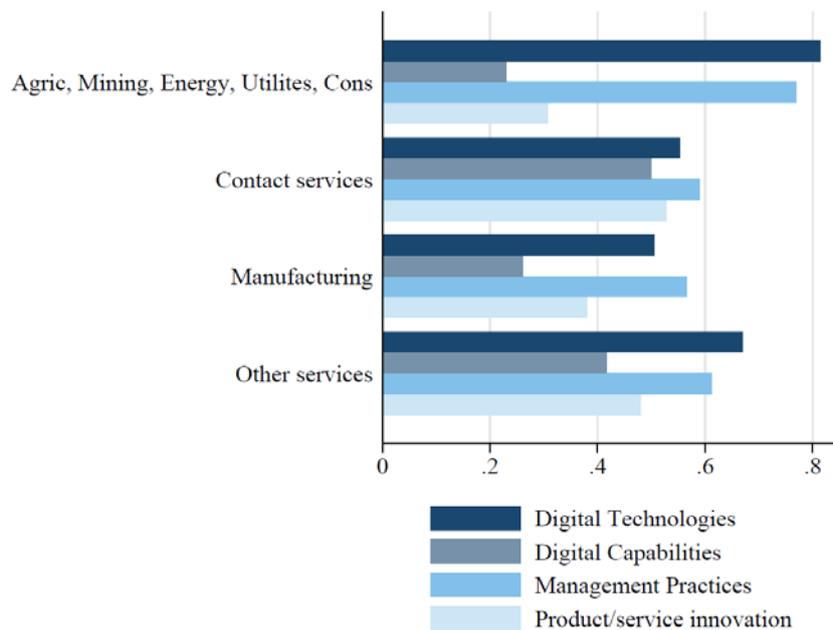
Notes: N=375. Source of GDP data: Office for National Statistics - Regional economic activity by gross domestic product, UK: 1998 to 2018. Shares are rounded to the nearest integer.

Figure A3: Size distribution of respondents compared to BEIS BPE



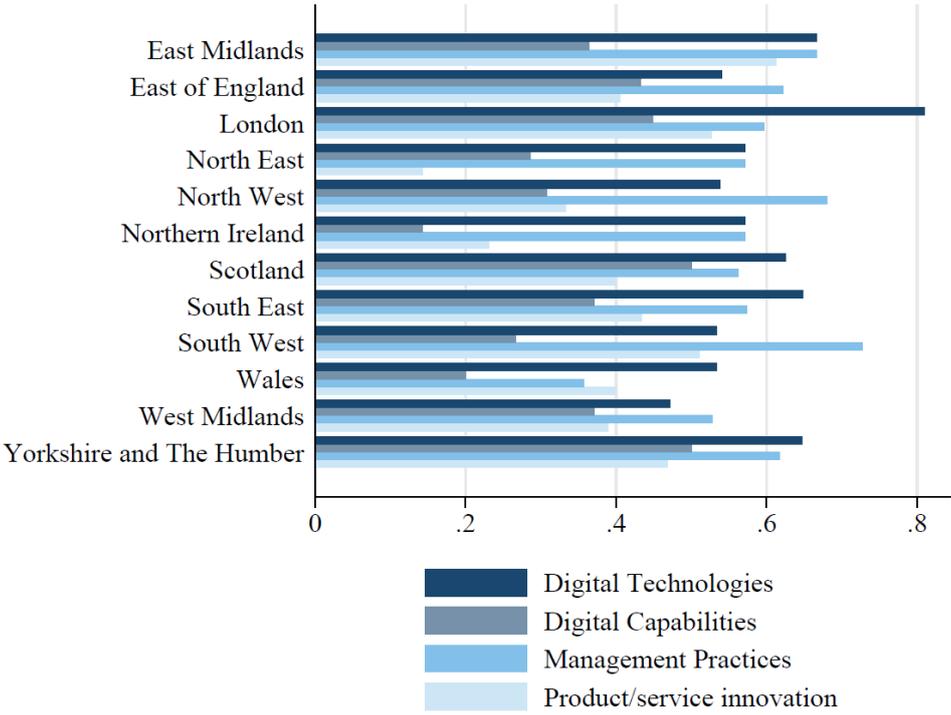
Notes: N=375. The size distribution of the population of 2.6 million registered firms from the BEIS Business Population Estimates (BPE) is used for comparison to our sample (1.2 million of which have no employees over and above the working proprietor). Shares are rounded to the nearest integer.

Figure A4: Innovation rates across sector groupings



Notes: Share of responding firms that reported innovation. Samples across sector groupings (see Table A2 for allocations of SIC sections to high-level groupings) for each type of innovation are N=375, N=374, N=371 and N=365, respectively. “Construction” is abbreviated to “Cons”.

Figure A5: Innovation rates across UK regions



Notes: Share of responding firms that reported innovation. Samples across regions for each type of innovation are N=375, N=374, N=371 and N=365, respectively.

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