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DISCUSSION

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DISCUSSION PAPER

// DANIEL ERDSIEK

Working From Home During COVID-19 and Beyond: Survey Evidence From Employers

Working From Home During COVID-19 and Beyond: Survey Evidence From Employers

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Abstract

Based on survey responses from more than 1,700 managers in Germany, this study elicits employers' perceptions of working from home during COVID-19 and their long-term expectations for the time after the pandemic. Based on employers' forecasts of the share of employees working from home post-COVID, the within-firm intensity of the expected shift is quantified. Many firms expect a persistent shift towards working from home induced by the COVID-19 pandemic. Larger firms and firms with pre-COVID use of working from home are most likely to expect a persistent and intensive shift. As the empirical results indicate, underlying mechanisms for the expected shift might include learning effects facilitating an improved perception of working from home, investments in physical and human capital, a general push in firms' digital progress, and the fact that most firms do not observe a reduction in productivity due to working from home during COVID-19.

Keywords: COVID-19, working from home, digitalisation, firm-level, managers, survey
JEL Class: D22, D23, L22, O33, M54

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1 Introduction

The COVID-19 pandemic triggered a massive shift towards working from home (WFH). In order to contain the spread of the virus, employers and workers around the world had to experiment with WFH. In Germany, roughly three quarters of firms had increased their use of WFH by July 2020 (Demmelhuber et al., 2021) and roughly 40 percent of workers had switched to WFH by April 2020 (Eurofound, 2020). At the same time, U.S. workers supplied around half of paid labour services from home (Barrero et al., 2020; Bick et al., 2020; Brynjolfsson et al., 2020). This unprecedented shift towards WFH is likely to induce persistent changes in the organisation of work (OECD, 2020). Focusing on this subject, the present study contributes to two strands of literature that provide evidence on how the pandemic might shape the future of work. First, several studies have analysed the underlying potential for WFH. In particular, these studies analyse which job tasks are suited for WFH and how the estimated feasibility of WFH differs across occupations, industries, and countries (Alipour et al., 2020; Dingel and Neimann, 2020; ILO, 2020). Second, several studies provide survey evidence on individuals' experiences with WFH during the pandemic and their expectations for the time after the pandemic (Bonin et al., 2020; Eurofound, 2020; Teodorovicz et al., 2021). Based on surveys among U.S. workers, Barrero et al. (2021) identify several mechanisms that might facilitate a long-lasting increase in WFH, such as positive experiences, investments in physical and human capital, reduced stigma, or innovation. In particular for the U.S., further studies provide evidence on firms' views on WFH during the pandemic (Altig et al., 2020, 2021; Steemers, 2020; Ozimek, 2020).

The present study focuses on employers in Germany and elicits their perception of WFH during COVID-19 and their long-term expectations for the time after the pandemic. Two sectors that are highly distinct in terms of feasibility of WFH are covered. First, the information and knowledge-intensive sector¹ where the majority of jobs entail activities that are suited to be performed at home (Alipour et al., 2020; Dingel and Neiman, 2020). Second, the manufacturing industry where operating machinery and other manual tasks are much more common, leading to a lower potential for WFH. Our data stem from three waves of the quarterly ZEW Business Survey in the Information Economy conducted in June, September, and December 2020. In total, our analysis is based on survey responses from more than 1,700 managers, e.g., the firm's CEO, CIO, or head of HR, and provide representative results for the German information economy and manufacturing industry.²

Our results indicate that many firms in Germany expect a persistent shift towards WFH due to COVID-19. In June 2020, a sizeable share of firms in the information economy (46%) and the manufacturing industry (30%) have stated that the pandemic will cause a long-term increase in their use of WFH. In general, large firms are more likely to expect a shift. Moreover, firms that used WFH before the pandemic are twice as likely as firms without a prior use of WFH to expect a shift. Based on the employers' forecasts of the share of employees working from home at least once a week post-COVID, we quantify the intensity of the expected shift. In particular, we compute the within-firm difference between the firms' share of employees who have worked from home before the pandemic and the firms' expected share of employees working from home after the pandemic.³ In June 2020, 16 percent of firms in the information economy expected that their post-COVID share of employees working from home will be more than 20

¹ We subsume the sectors ICT services, media services, knowledge-intensive providers of professional, scientific & technical services, and ICT hardware manufacturers under the term "information economy". See Table A1 in the Appendix for more details.

² Survey responses are weighted based on 39 cells, made up of 13 sectors and 3 firm size classes. The 13 sectors and the number of observations per sector are presented in Table A2 in the Appendix. Firm size classes are 5-19, 20-100, and > = 100 employees. See www.zew.de/WS380-1 for more details on the ZEW Business Survey in the Information Economy.

³ Therefore, we focus on a firm's share of employees working from home at least once a week to measure the intensity of WFH. See, e.g., Altig et al. (2020, 2021) for U.S. evidence on the share of working days spent at home as another measure for intensity.

percentage points higher than their pre-COVID share. By December 2020, the share of firms expecting such an intensive shift has increased from 16 to 29 percent. Relative to the information economy, the intensity of the expected shift is much smaller in the manufacturing industry.

Focusing on the employers' perspective, our survey evidence points to a range of mechanisms that might contribute to the longevity and intensity of the shift towards WFH. These mechanisms include an improved perception of WFH, investments in technologies and human capital enabling a more efficient use of WFH, a general push in firms' digital progress, and the fact that most firms do not observe a reduction in productivity due to WFH during COVID-19. OLS results indicate that investments enabling WFH and updated beliefs about the feasibility of WFH are positively related to the extensive and intensive margin of an expected shift. A negative relation is observed for potential concerns, such as increased coordination costs and reduced monitoring opportunities due to WFH. Moreover, the firms' pre-COVID use of WFH is an important predictor of the extensive and intensive margin of an expected shift to WFH.

The remainder of this paper is organised as follows. Section 2 provides evidence on the firms' perception of WFH during COVID-19, their long-term expectations, and OLS results on the mechanisms underlying the within-firm intensity of the expected shift towards WFH. Section 3 provides evidence on the firms' assessment of the productivity effects of WFH during COVID-19. Section 4 provides evidence on the firms' self-assessed potential for WFH and its degree of utilisation. Section 5 provides evidence on the surge in digitalisation during COVID-19 and firms' plans for future investments in digital technologies and infrastructure enabling WFH. Finally, Section 6 concludes.

2 Working from home post-COVID: Employers' long-run expectations

2.1 Expectations about a persistent shift towards WFH

Many firms in Germany expect to use WFH more intensively after the pandemic than before its outbreak. In June 2020, 46 percent of firms in the information economy and 30 percent of manufacturing firms agreed with the statement that the pandemic will cause a long-term increase in WFH that will last beyond the end of the pandemic (Figure 1). Especially in larger firms, the pandemic will lead to a long-term expansion of WFH. Among firms with at least 100 employees, 75 percent in the information economy and 56 percent in the manufacturing industry expected a permanent expansion. Moreover, firms that already used WFH before the pandemic are twice as likely to expect a persistent shift, relative to firms without a prior use of WFH. Among firms that used WFH pre-COVID, 62 percent in the information and 52 percent in the manufacturing industry expected a long-term increase in WFH.

Before the outbreak of the pandemic, only 24 percent of firms in the German manufacturing industry had employees working from home at least once a week (Figure 2). By June 2020, this share had increased to around 50 percent. In the same survey, 37 percent of firms indicated that they plan to use WFH after the end of the pandemic. In addition to the extensive margin, the pandemic is likely to have a long-term effect on the intensity of WFH in the manufacturing industry: Before the pandemic, only 4 percent of the firms had more than one in ten employees working from home. After the pandemic, this share is expected to increase to 14 percent of firms. The expected long-lasting shift is even stronger for the information economy, where the share of work activities that are suited for WFH is considerably higher. Before the pandemic, 48 percent of firms in the information economy used WFH. In June 2020, this share amounted to 74 percent. At the same time, 64 percent of the firms expected to use WFH after the pandemic. In terms of the intensive margin, the firms assume that an increasing share of employees will work from home in the long run. Before the pandemic, only about one in ten firms had more than 20 percent of their

employees working from home. For the post-COVID period, almost every third firm expects such an intensive use of WFH. In addition, Table 1 provides the current and post-COVID use of WFH by firm size.

In December 2020, firms in the information economy were asked about their current and expected use of WFH again. 19 percent of firms did not use WFH in December 2020, while in June 2020 this share was 26 percent (Table 2). Over the course of the pandemic, long-term expectations have changed, too: In December 2020, 21 percent of firms expected more than half of their employees to work from home at least once a week after the pandemic. In comparison, this share amounted to 10 percent in June 2020. The sharp increase in the share of firms expecting an intensive use of WFH post-COVID might be related to the second wave of COVID-infections in Germany that started in late October 2020.

2.2 Within-firm intensity of the expected shift

In addition to industry-level results, the following analyses provide evidence on the within-firm intensity of the expected long-lasting shift towards WFH. In particular, we study the within-firm difference in the share of employees who have worked from home pre-COVID and the share of employees expected to work from home after the pandemic ends (as indicated by employers in June 2020). For 53 percent of firms in the information economy, the forecast of their share of employees working from home post-COVID is exactly equal to their share of employees who have worked from home pre-COVID (Figure 3). However, 46 percent of firms expect their post-COVID share to be higher than their pre-COVID share.⁴ In terms of the intensity of the expected long-term shift, 30 percent of firms expect the increase in their share of employees working from home at least once a week to range from 1 to 20 percentage points. Furthermore, 16 percent of firms expect an increase between 21 and 10 percentage points.

The within-firm differences in the pre-COVID and post-COVID share also point to an ongoing improvement of the perception of WFH over the course of the pandemic. In the information economy, the share of firms expecting that the long-term intensity of WFH will be exactly the same as the pre-COVID intensity decreased from 53 percent in June 2020 to 41 percent in December 2020. By this time, 57 percent of firms expected their post-COVID intensity of WFH to be higher than their pre-COVID intensity. For instance, 29 percent of firms expected that their share of employees working from home post-COVID will be 21 to 100 percentage points higher than their pre-COVID share. Moreover, the intensity of the shift increases in firm size, with half of the large firms expecting an increase of more than 20 percentage points.

In the manufacturing industry, roughly 26 percent of firms expect that their post-COVID share of WFH will be higher than their pre-COVID share. However, relative to the information economy the intensity of the shift is much smaller in the manufacturing industry. Most firms expecting a lasting shift in the intensity of WFH forecast an increase in the range between 1 and 10 percentage points. Differences in the task content of jobs might be the main reason for the lower intensity of the expected shift in the manufacturing industry as compared to the information economy.

Figure 4 and Figure 5 show that pre-COVID experience in WFH matters for persistent shifts towards WFH in the aftermath of the pandemic. In particular, Figure 4 plots the average share of firms by industry that expect a persistent shift in relation to the average share of firms by industry that used WFH before the outbreak of the pandemic. The relationship of these industry-means is significantly positive, with sub-sectors of the manufacturing industry appearing in the lower left quadrant and sub-sectors of the information economy appearing in the upper right quadrant. Thus, even within the two broad sectors of the information economy and the manufacturing industry, sub-sectors with a higher share of pre-COVID

⁴ In only 1 percent of firms in the information economy or manufacturing industry the post-COVID share is expected to be lower than the pre-COVID share.

use of WFH have a higher share of firms that expect a long-term shift to WFH induced by the pandemic. In addition, Figure 5 plots the average of the intensity of the expected shift by industry in relation to the average pre-COVID share of employees WFH by industry. The intensity of the shift is measured as the within-firm difference in the expected post-COVID share of employees WFH and the pre-COVID share of employees WFH. Again, the averages for the sub-sectors are aligned in a strongly positive relationship, with manufacturing firms appearing in the lower left quadrant and firms from the information economy in the upper right quadrant. Thus, sub-sectors with a higher pre-COVID share of employees WFH expect a more intensive long-term shift to WFH.

2.3 Mechanisms facilitating a persistent shift

There are different mechanisms that might facilitate a permanent increase in WFH after the pandemic ends (see, e.g., Barrero et al., 2021). One important mechanism, which has so far been largely discussed from the workers' perspective, revolves around new experiences with WFH during the pandemic. Since the majority of employers and employees have been forced to experiment with WFH, they have learned about its potential advantages and disadvantages. Taken together, previous survey results indicate that these forced experiences with WFH have been rather positive for the majority of workers and employers (Barrero et al., 2021; Bonin et al., 2020; Ozimek, 2020). Contributing to the previous literature, our survey elicits whether firms have updated their beliefs about the feasibility of WFH. In June 2020, firms have been asked whether they agree with the following statement: "The current situation makes it evident that more job tasks can be performed from home than we have previously expected". This learning effect might favour a persistent shift if COVID-19 made employers realise that a larger-than-expected share of their employees performs job tasks suited for WFH. In the manufacturing industry, a share of 42 percent of firms have learned that more job tasks are suited for WFH than previously expected (Figure 6). Given that only 24 percent of manufacturing firms used WFH before the pandemic, COVID-19 seems to have had a sizeable effect on the firms' perception of WFH. In particular large firms (70%) have learned that more job tasks are eligible for WFH (Table 3). But also medium-sized firms (43%) and small firms (36%) have updated their beliefs on the feasibility of WFH in light of the pandemic. In the information economy, a share of 53 percent of firms have experienced that more job tasks than previously expected can be performed from home. This result indicates that also firms with mostly knowledge-intensive job tasks have recognised untapped potential for WFH through the pandemic. Furthermore, firms that used WFH pre-COVID are more likely to update their beliefs about the feasibility of WFH than firms without such prior experience (Table 4).

The successful implementation of WFH arrangements is based on various requirements. Even if job tasks are – in theory – well suited for WFH, a productive collaboration with colleagues usually also requires a suitable technological infrastructure and fundamental skills to use those technologies.⁵ Therefore, many firms and workers had to invest in technical equipment and human capital in order to suddenly shift to WFH. These investments in physical and human capital are deemed to reduce the marginal costs of WFH in the long-run.⁶ In this way, investments enabling WFH are a further mechanism that might contribute to a persistent shift towards WFH (Barrero et al., 2021). In June 2020, roughly one third of firms in the information economy and the manufacturing industry indicated that they had to make short-term investments in new technologies in order to offer WFH (Figure 6). Considering large firms, nearly half of

⁵ See, e.g., DeFilippis et al. (2020) for an analysis on how digital communication patterns have changed in light of COVID-19.

⁶ Bloom et al. (2021) also document a sharp increase in the number of innovations enabling WFH during the pandemic that are likely to further reduce the marginal costs of WFH.

the firms had to suddenly invest in new technologies (Table 3). Concerning investments in human capital, firms in the information economy have been asked whether they had invested in IT training in the year 2020. In December 2020, roughly 60 percent of firms indicated that they had made such investments. While large firms (80%) and medium-sized firms (74%) had invested in IT training most often, the majority of small firms (53%) also invested in human capital enabling WFH.

One potential concern speaking against wide-spread WFH arrangements is that they might make teamwork more difficult. This is another example where the forced experimentation induced by the pandemic might have changed pessimistic beliefs. In the information economy, a share of 63 percent of firms agreed with the statement that “virtual solutions enable good teamwork for employees working from home”. Especially large firms (83%) and firms that used WFH pre-COVID (75%) believe that good teamwork is feasible by using virtual solutions. A further potential concern with WFH might stem from a perceived reduction in monitoring opportunities. In total, 44 percent of firms in the information economy and 54 percent of manufacturing firms indicated that it is not sufficiently possible to monitor the job performance of employees working from home. Another reason for potential efficiency losses may stem from an increase in coordination costs due to WFH. In June 2020, more than 60 percent of firms believed that WFH makes the coordination of work processes more difficult. The potential concerns of increased coordination costs and reduced monitoring opportunities are more prominent for firms that did not use WFH before the pandemic than for firms that used WFH pre-COVID.

2.4 Regression results

So far, descriptive statistics on the intensity of the expected shift to WFH and potential underlying mechanisms have been presented. The following paragraphs additionally provide OLS results for the potential mechanisms facilitating a wide-spread shift to WFH induced by the pandemic. To measure the extensive and the intensive margin of the shift towards WFH, we make use of the firms’ share of employees WFH at least once a week before the pandemic and the firms’ expected share of employees WFH at least once a week after the pandemic. Thus, the extensive margin is measured by the variable “*Expecting a shift to WFH*” taking a value of one if a firm’s expected post-COVID share is higher than its pre-COVID share, and zero otherwise. Similarly, the intensive margin is indicated by the variable “*Intensity of expected shift to WFH*” and measures the within-firm difference between the post-COVID share of employees WFH and the pre-COVID share of employees WFH.⁷

Table 5 provides the OLS results for the entire sample of firms from the information economy and the manufacturing industry. Columns 1-3 present the results on the extensive margin and columns 4-6 present the results on the intensive margin of the within-firm shift towards WFH. As depicted in column 1, the updating of firms’ beliefs about the feasibility of WFH is positively and significantly related to expecting a shift to WFH. In particular, firms indicating that the pandemic made them realise that more job tasks are suited for WFH than previously expected are 36 percentage points more likely to expect a long-lasting shift in their use of WFH. Firms that indicated (in June 2020) that they had to suddenly invest in new technologies enabling WFH are also significantly more likely to expect a persistent shift (11 percentage points). In contrast, firms that indicate that WFH makes the coordination of working processes more difficult or undermines the capabilities to monitor job performance are significantly less likely to expect a shift in their use of WFH (4 and 8 percentage points, respectively).

⁷ To create a binary variable, 13 observations of firms with a higher pre-COVID share than expected post-COVID share are excluded from the analyses. However, the results presented in this study do not qualitatively differ if those cases are included.

As depicted in column 2 and 3, the firms' pre-COVID use of WFH is an important determinant of expecting a long-lasting shift. In particular, firms that had any employees working from home at least once a week before the pandemic are 19 percentage points more likely to expect that an increasing share of employees will work from home in the long run (column 2). Focusing on the intensity of the pre-COVID use of WFH, the specification in column 3 includes the pre-COVID share of employees WFH in its normal and squared form. While both coefficients are significant, the positive coefficient for the normal term dominates the significantly lower negative coefficient of the squared term. In general, the coefficients of the already described mechanisms are highly robust to the inclusion of the pre-COVID use of WFH into the regression model.

The regression results with respect to the intensive margin of the expected shift to WFH are presented in columns 4-6. As column 5 shows, the firm-level intensity of the expected shift is 7 percentage points higher for firms that have learned that more job tasks are suited for WFH than previously expected and 2 percentage points higher for firms that had to suddenly invest in new technologies. In contrast, firms concerned with difficulties in terms of coordination and monitoring expect a 2 and 3 percentage points lower shift to WFH, respectively. A further significant determinant of the intensity of the expected shift is the previous use of WFH. Firms that used WFH before the pandemic expect the shift towards WFH to be 3 percentage points higher relative to firms without a prior experience with WFH. In column 6, firms' pre-COVID share of employees working from home is introduced in its normal and squared form. The significant coefficients indicate that the intensity of the expected shift increases with the pre-COVID share of employees working from home with a decreasing marginal effect. The decreasing marginal effect might result from the fact that firms with an already high pre-COVID share only have a limited potential left to further increase the share of WFH. In all specifications, the results indicate that medium-sized and large firms are more likely to expect a (more intensive) shift to WFH than small firms. Moreover, the coefficients of the industry dummies indicate that, relative to ICT services, all manufacturing sectors are less likely to expect a shift to WFH.

Table 6 and Table 7 provide the OLS results for the separate samples of firms from the information economy and the manufacturing industry. Across both sectors, the results for the beliefs concerning the feasibility of WFH and the monitoring costs are qualitatively similar. Moreover, firms' pre-COVID use of WFH seems to be an important determinant for expectations on the future use of WFH in both sectors. In Table 8, OLS results are presented conditional on the firms' pre-COVID use of WFH. The results indicate that updated beliefs about the feasibility of WFH are positively correlated to expecting a (more intensive) shift for firms with and without pre-COVID use of WFH. Investments in new technologies, however, are only significantly correlated with a shift to WFH for firms that did not use WFH pre-COVID. Within this group, firms that have invested in new technologies are 20 percentage points (information economy) and 14 percentage points (manufacturing industry) more likely to expect a shift. Results on the potential concerns of increased coordination costs and reduced monitoring opportunities are more mixed across sectors and firms with a different pre-COVID use of WFH.

So far, only investments in new technologies have been introduced as a proxy for investments enabling WFH induced by the pandemic. In December 2020, firms in the information economy have also been asked about investments in human capital, i.e. whether they invested in IT training in the year 2020. Table 9 provides evidence on the interplay of investments in physical and human capital by including the main terms as well as the interaction term in the regression model. The coefficient for the main term of investments in new technologies becomes insignificant in all specifications. In contrast, the interaction term indicates that firms that have invested in new technologies and in IT training simultaneously have a significantly higher propensity to shift towards more WFH in all specifications (except specification 6). The

coefficients for firms that only have invested in IT training, however, are only significant for the dependent variable of expecting a shift at all. Finally, firms that believe that virtual solutions enable good teamwork for employees working from home are more likely to expect a (more intensive) shift to WFH.

3 Employers' assessment of the productivity effects of WFH during COVID-19

Some recent studies provide evidence on workers' self-assessment of the productivity effects resulting from the sudden shift to WFH during COVID-19 (Barrero et al., 2021; Etheridge et al., 2020; Teodorovicz et al., 2021).⁸ In contrast, evidence on the employers' perspective is still scarce (Bartik et al., 2020). Employers' beliefs about the productivity effects of WFH, however, are likely to be an important determinant of the longevity and the intensity of the shift towards WFH induced by the pandemic. Only if firms are willing to continue to offer WFH after the pandemic ends, the sudden and widespread change in working practices is likely to persist. The following paragraphs provide evidence on the employers' perception of the productivity effects of WFH during COVID-19. In December 2020, firms in the information economy have been asked to indicate the change in productivity among employees who started WFH during the pandemic on a scale ranging from 1 "strongly decreased" to 5 "strongly increased". For our analysis, the answers are aggregated into three categories "productivity decreased" (options 1 and 2), "productivity did not change" (option 3), and "productivity increased" (options 4 and 5). In total, a share of 60 percent of firms in the information economy have noticed no change in the productivity level of employees who have started WFH during the pandemic (Figure 7). In addition, a share of 15 percent of firms have observed an increase in productivity among this group of employees. Therefore, most firms (75%) have not observed a reduction in productivity due to the expansion of WFH induced by the pandemic. However, the remaining quarter of firms indicated a decreasing productivity level for those employees who started WFH during the pandemic.⁹ Perceived negative productivity effects may be a result of unfavourable circumstances during the pandemic. In Germany, schools and day care centres were closed several months before the survey took place and had not been reopened by then. In comparison to normal times, this tough childcare situation is likely to have made it more difficult to concentrate while working from home and might have reduced satisfaction with work and family life for parents (Eurofound, 2020; Möhring et al., 2020). Moreover, the rapid change in work organisation often had to be managed without a prior planning phase creating difficulties for employers and employees alike. Such difficulties might include the provision of the relevant technical infrastructure or remote access.

An important determinant of the assessment of productivity effects is whether a firm can rely on previous experiences with WFH. Firms that already used WFH before the pandemic are significantly more likely to report an increase in productivity among employees who have started WFH (20%) than firms without prior use of WFH (6%).¹⁰ Similarly, a negative assessment of productivity effects is significantly less likely among firms with prior experience (18%) as compared to firms that have only offered WFH since the start of the pandemic (42%). A potential explanation may be that technical and organisational preconditions have been in place already in firms that used WFH before the pandemic. Scaling up the share of employees working from home may have created less frictions than adopting WFH. A potential

⁸ Studies analysing the productivity effects of WFH before the outbreak of the pandemic include Angelici and Profeta (2020), Bloom et al. (2015), and Choudhury et al. (2021).

⁹ Focusing on responses from roughly 1,200 managers in Germany, Demmelhuber et al. (2020) similarly find that 23 percent of firms indicated a decreasing quality of work for employees working from home in July 2020.

¹⁰ In a similar vein, U.S. firm-level evidence by Bartik et al. (2020) suggests that productivity assessments for employees working from home are positively correlated with the share of employees who worked from home pre-COVID as well as with a measure for suitability of WFH (Dingel and Neimann, 2020).

reason for these differences may, however, also be that firms without previous experiences with WFH are more critical of this organisation of work and, thus, assess the impact on productivity more negatively.

Firms that used WFH pre-COVID were also asked how the productivity had changed for employees who had already worked from home before the outbreak of the pandemic. The majority of firms reported no change in terms of productivity for this group of employees (81%). Furthermore, about ten percent of firms experienced an increase or a decrease in work productivity, respectively.

In addition to their beliefs about the productivity effects of WFH, firms have also been asked the following question: “How difficult is it for you to assess the productivity of employees working from home?”. For their answer, firms could choose from a scale ranging from 1 “not difficult at all” to 5 “highly difficult”. Again, we aggregated the answers into three categories “not difficult” (options 1 and 2), “neutral” (option 3), and “difficult” (options 4 and 5). In total, 24 percent of firms in the information economy find it difficult to assess the productivity of employees working from home, while 46 percent see no difficulties (Table 10). In addition, firms had to indicate how difficult it is to assess the productivity of employees working on business premises. For this group of employees, only 3 percent of firms have difficulties, while the vast majority (75%) indicated that it is not difficult to assess their productivity.

4 Utilisation of firms’ potential for WFH

A number of studies analyse the suitability of jobs for WFH based on workers’ self-assessment or the task-approach (Alipour et al., 2020; Grunau et al., 2020; European Commission, 2020). However, despite its importance, there is little evidence on employers’ beliefs about the general suitability of jobs for WFH. Therefore, firms in the information economy have been asked to estimate the share of their employees whose job tasks are – in theory – suited for WFH. According to firms’ self-assessments, there is a high potential for WFH in the information economy. In December 2020, about 45 percent of firms have estimated that more than half of their employees have a job that is – in theory – suited for WFH (Table 11). The share of firms with such a potential is highest among ICT service providers (63%), knowledge-intensive service providers of professional, scientific, & technical activities (41%), and media service providers (35%). In contrast, ICT hardware manufacturers estimate their potential for WFH to be significantly lower. The self-assessed potential increases with firm size: The share of firms estimating that more than half of their employees could – in theory – work from home amounts to 42 percent for small firms, 52 percent for medium-sized firms, and 58 percent for large firms.

To analyse the firm-level difference in the potential for WFH and the actual use of WFH in December 2020, two survey questions are contrasted: 1) The potential for WFH as measured by the question: “How high do you estimate the share of your employees whose job tasks are – in theory – suited for working from home?”. 2) The current use of WFH as measured by the question: “How high do you estimate the share of your employees who currently work from home at least once a week?”. For 33 percent of firms, the answers to both questions are exactly the same (Table 12). Therefore, these firms have utilised their potential for WFH in terms of the number of eligible employees at the time of the survey in December 2020. In roughly 13 percent of the firms in the information economy, the current use of WFH even exceeded their self-assessed potential. On average, the share of employees currently working from home in these firms was roughly 25 percentage points higher than the share of employees whose jobs are – in theory – suited for WFH (median difference: 20 percentage points). Large firms are particularly prone to an excessive current use of working from home (28%). On the contrary, a sizeable share of firms in the information economy had not fully utilised their potential for WFH. In roughly 26 percent of firms, the potential exceeded the share of employees currently working from home by 21 to 100 percentage points.

5 Surge in digitalisation and future investments

As a result of investments and effort put into necessary adjustments during the pandemic, firms are deemed to have become more digitised (OECD, 2020). As our survey results from September 2020 indicate, many firms in Germany have observed a surge in digitalisation due to COVID-19. Over the course of the pandemic, these firms have made progress with regard to the digitalisation of their products and services, their business processes, or their way of working. In total, 42 percent of firms in the information economy and 26 percent of manufacturing firms have reported such a surge in digitalisation (Table 13). Relative to before the pandemic, there has been a noticeable shift towards a more digital way of working in many firms, i.e. 36 percent in the information economy and 22 percent in the manufacturing industry. This push towards digitalisation is likely to result from the necessary adjustments in light of a shift to WFH. However, the pandemic has not only introduced a more digital way of working. In 29 percent of firms in the information economy and 19 percent in the manufacturing industry, business processes have become more digital. Furthermore, roughly 15 percent of firms have made progress in the level of digitalisation of their products and services. Finally, the share of firms reporting a surge in digitalisation depends on firm size: Larger firms are more likely to report digital progress.¹¹

As already discussed, a substantial share of roughly 33 percent of firms have indicated that they had to make short-term investments in new technologies by June 2020. In December 2020, firms in the information economy have been asked about the importance of investments in digital technologies and infrastructure enabling WFH. They could choose from a scale ranging from 1 “not important at all” to 5 “highly important”. In total, a share of 70 percent of firms stated that investments in digital technologies and infrastructure enabling WFH are important to them (Table 14). This share differs between the sub-sectors, with the highest share among ICT services (75%). Among ICT hardware manufacturers, 50 percent of firms indicated that such investments enabling WFH are important. Moreover, the importance of investments increases with firm size. In the same survey, firms have also been asked about their future plans in terms of investments. In total, 81 percent of the firms plan to invest in digital technologies and infrastructure enabling WFH within the next two years (Table 15). Out of these firms, a share of 64 percentage points planned to make small investments and 17 percentage points planned to invest on a higher level. Especially large firms plan to make high investments in digital technologies and infrastructure enabling WFH (30%).

6 Conclusion

Based on survey responses from more than 1,700 managers, this study shows that many firms in Germany expect a persistent shift to working from home induced by the COVID-19 pandemic. This result holds for the knowledge-intensive information economy as well as for the manufacturing industry. The within-firm intensity of the expected shift, however, is much more pronounced among firms in the information economy than among manufacturing firms. In addition, firms that used WFH pre-COVID are significantly more likely to expect a (more intensive) shift than firms that did not use WFH prior to the pandemic. However, even among the latter group of firms, 32 percent in the information economy and 23 percent in the manufacturing industry agreed to the statement that the pandemic will cause a long-term increase in their use of WFH.

¹¹ Nevertheless, survey evidence by Bertschek and Erdsiek (2020) indicates that self-employed individuals without employees also documented a surge in digitalisation due to COVID-19 and that those individuals were less likely to be negatively affected by the pandemic.

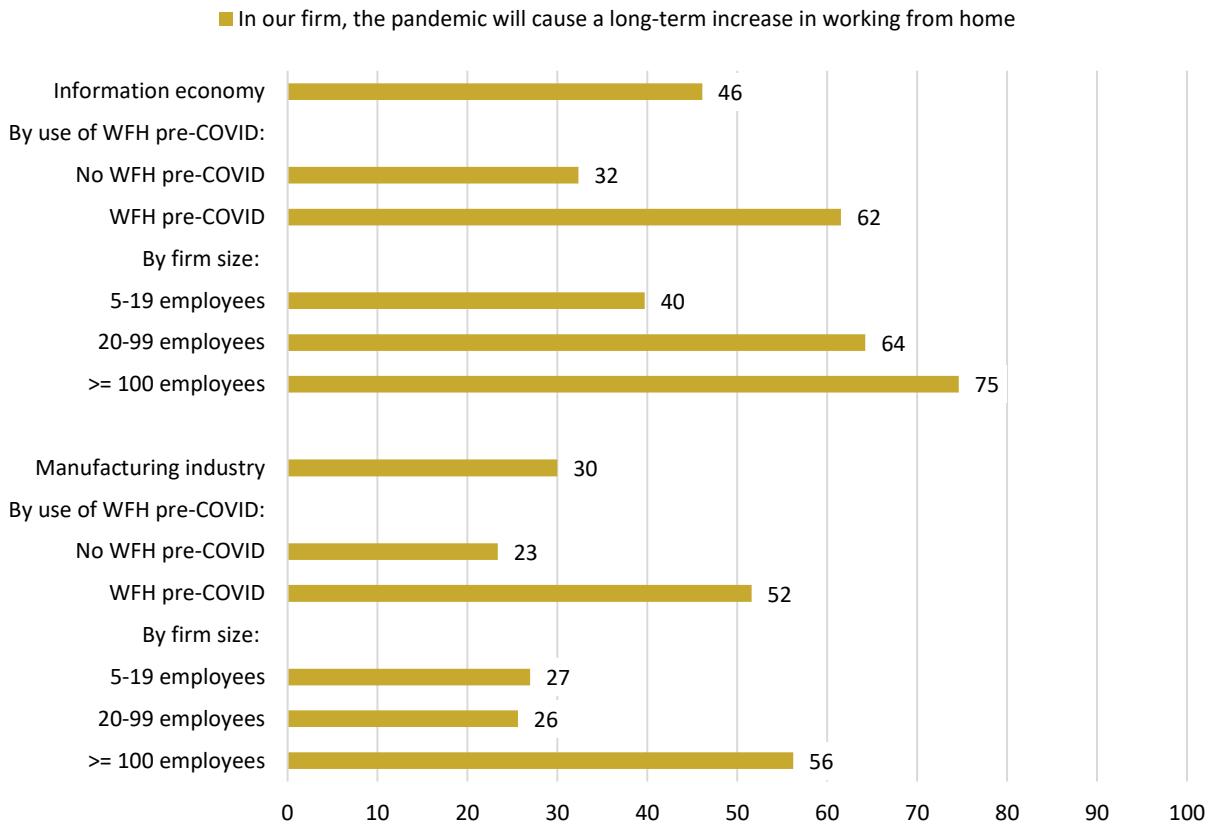
As our results indicate, underlying mechanisms for the expected shift towards WFH might include an improved perception of WFH, investments in physical and human capital, a general push in firms' digital progress, and the fact that most firms do not observe a reduction in productivity due to WFH during COVID-19. For instance, the pandemic made 53 percent of firms in the information economy and 42 percent of manufacturing firms realise that more job tasks are suited for WFH than previously expected, while roughly one third of firms had to suddenly invest in new technologies to offer WFH. As OLS results indicate, updated beliefs about the feasibility of WFH are positively correlated to expecting a (more intensive) shift to WFH. Investments in new technologies, however, are only significantly correlated with a shift to WFH for firms that did not use WFH pre-COVID. Additional results for the information economy highlight the importance of investment in human capital, as measured by investments in IT training.

Overall, the majority of firms in the information economy is optimistic about the productivity effects of WFH during COVID-19. 60 percent of firms noticed no change and 15 percent noticed an increase in the productivity of employees who have started WFH during the pandemic, respectively. In terms of heterogeneity in beliefs, firms that used WFH before the pandemic are more likely to evaluate the productivity effects of WFH positively than firms without a prior use of WFH. In comparison to employees working on business premises, firms more often indicate that it is difficult to assess the productivity of employees working from home.

Over the course of the pandemic, many firms have made progress with regard to the digitalisation of their products and services, their business processes, or their way of working. In total, 42 percent of firms in the information economy and 26 percent of manufacturing firms have reported such a surge in digitalisation. This push in the digital progress is more wide-spread among larger firms. Furthermore, the majority of firms in the information economy indicated that investments in digital technologies and infrastructure enabling WFH are of high importance and that an additional expansion of investment activities is planned. Therefore, COVID-19 is likely to further lead to a surge in digitalisation and a shift towards WFH in the future.

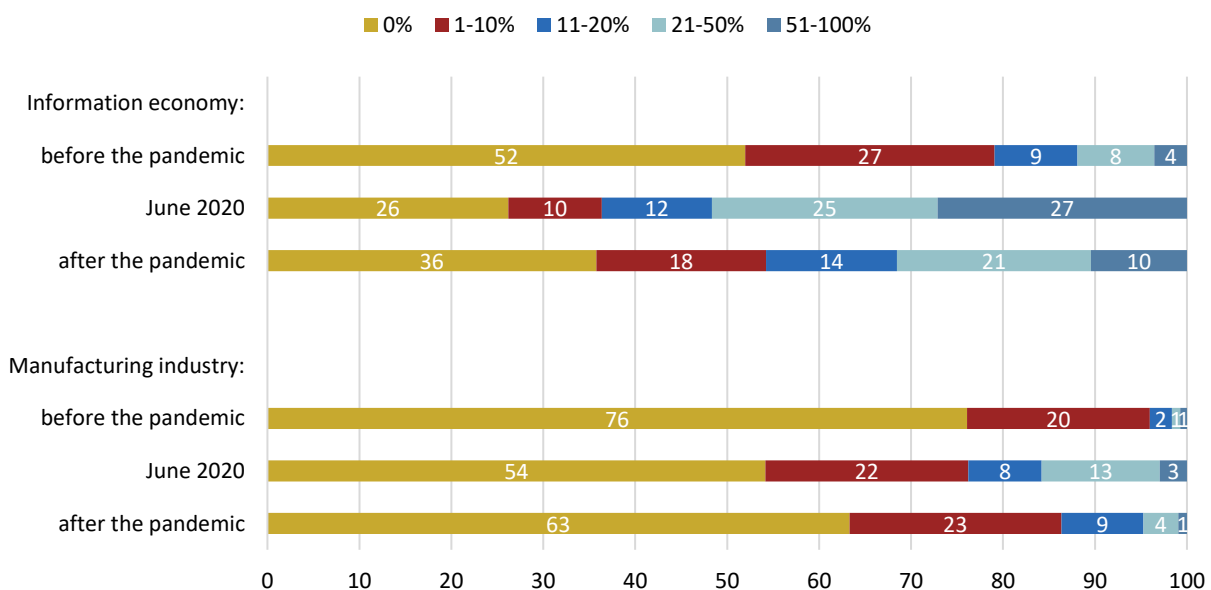
Tables and Figures

Figure 1: Share of firms indicating that the pandemic will cause a long-term increase in WFH



Note: In June 2020, 46 percent of firms in the information economy agreed with the statement: “In our firm, the pandemic will cause a long-term increase in working from home.”; *Use of WFH pre-COVID* indicates whether a firm had any employees working from home at least once a week before the pandemic. Source: ZEW Business Survey in the Information Economy, June 2020.

Figure 2: Share of employees working from home pre-COVID, in June 2020, and post-COVID



Note: In 9 percent of firms in the information economy, between 11 and 20 percent of employees worked from home at least once a week pre-COVID. After the pandemic ends, this share is estimated to be 14 percent. Source: ZEW Business Survey in the Information Economy, June 2020.

Table 1: Share of employees working from home pre-COVID, in June 2020, and post-COVID, by firm size

	0%	1-10%	11-20%	21-50%	51-100%
<u>Information economy: 5-19 employees</u>					
before the pandemic	59	20	9	8	4
June 2020	32	8	12	25	23
after the pandemic	42	15	15	19	9
<u>Information economy: 20-99 employees</u>					
before the pandemic	32	49	9	7	3
June 2020	9	17	12	24	39
after the pandemic	19	31	10	27	13
<u>Information economy: >= 100 employees</u>					
before the pandemic	17	59	10	13	2
June 2020	2	14	7	25	52
after the pandemic	9	28	16	30	17
<u>Manufacturing industry: 5-19 employees</u>					
before the pandemic	82	13	3	1	1
June 2020	67	13	6	12	2
after the pandemic	74	11	10	3	1
<u>Manufacturing industry: 20-99 employees</u>					
before the pandemic	75	23	1	1	0
June 2020	44	33	9	12	3
after the pandemic	56	34	6	3	0
<u>Manufacturing industry: >= 100 employees</u>					
before the pandemic	49	47	4	0	0
June 2020	15	41	16	21	7
after the pandemic	29	51	11	8	1

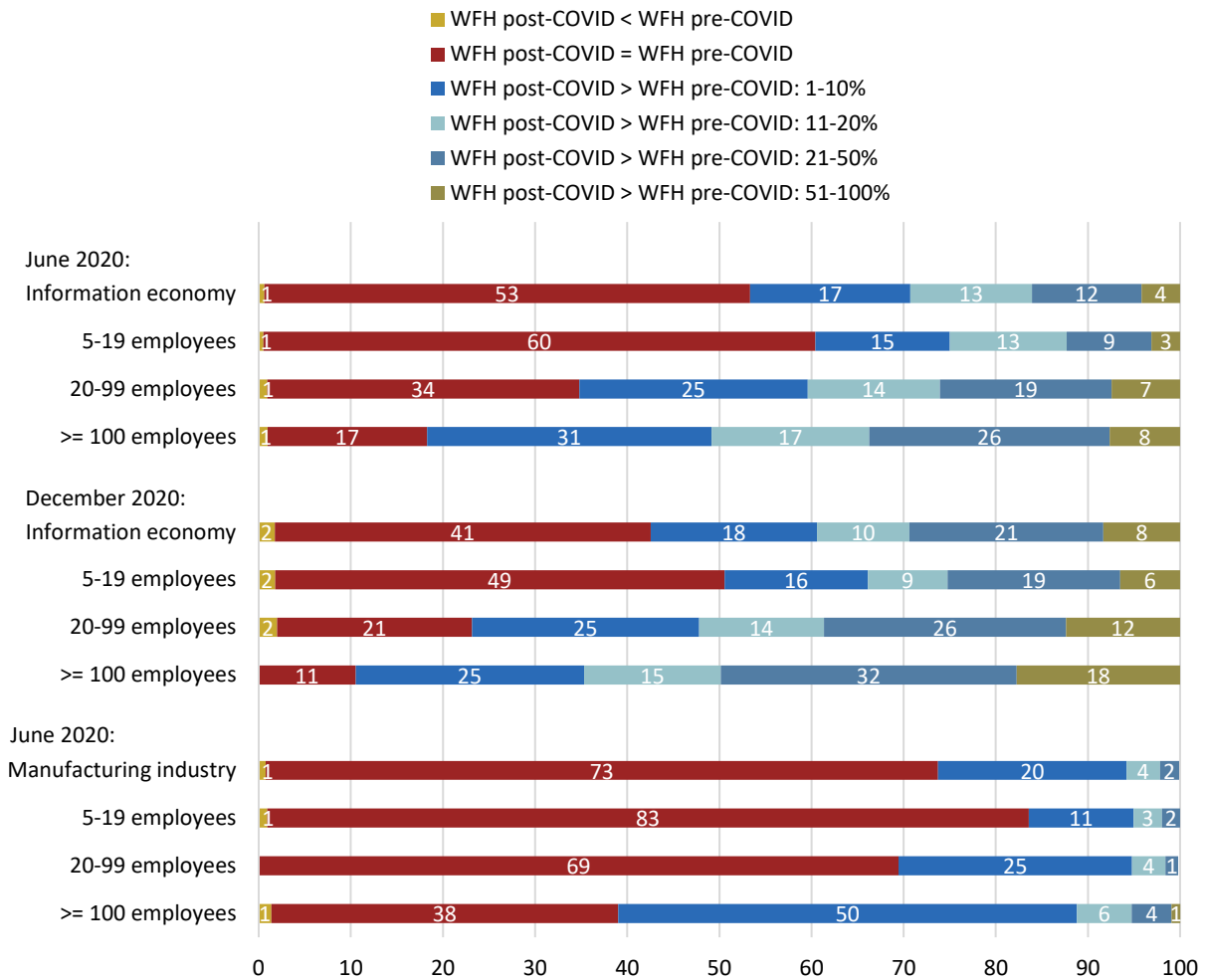
Note: In 10 percent of firms in the information economy with at least 100 employees, between 11 and 20 percent of employees worked from home at least once a week before the pandemic. After the pandemic ends, this share is estimated to be 16 percent. Source: ZEW Business Survey in the Information Economy, June 2020.

Table 2: Current use and expected use of WFH post-COVID, information economy

	0%	1-10%	11-20%	21-50%	51-100%
<u>Current use of WFH:</u>					
June 2020	26	10	12	25	27
December 2020	19	12	15	26	28
<u>Expected use of WFH after the pandemic:</u>					
June 2020	36	18	14	21	10
December 2020	28	19	12	21	21

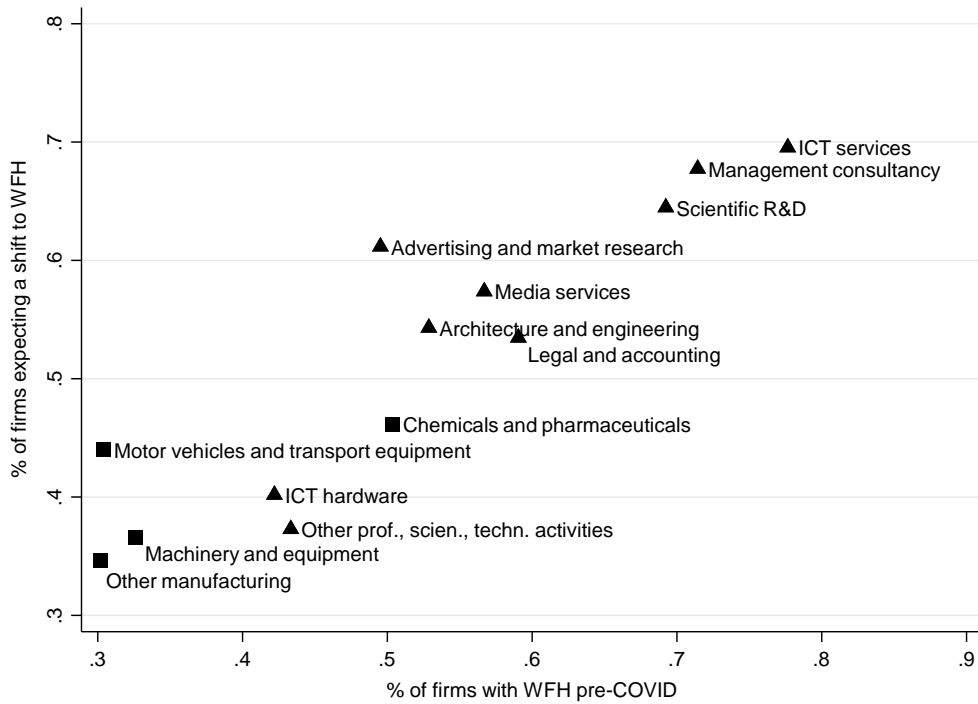
Note: In June 2020, 10 percent of firms in the information economy expected that after the pandemic ends more than 50 percent of their employees will work from home at least once a week. By December 2020, this share has increased to 21 percent of firms. Source: ZEW Business Survey in the Information Economy, June 2020, December 2020.

Figure 3: Within-firm difference in pre-COVID share of employees WFH and post-COVID share of employees WFH



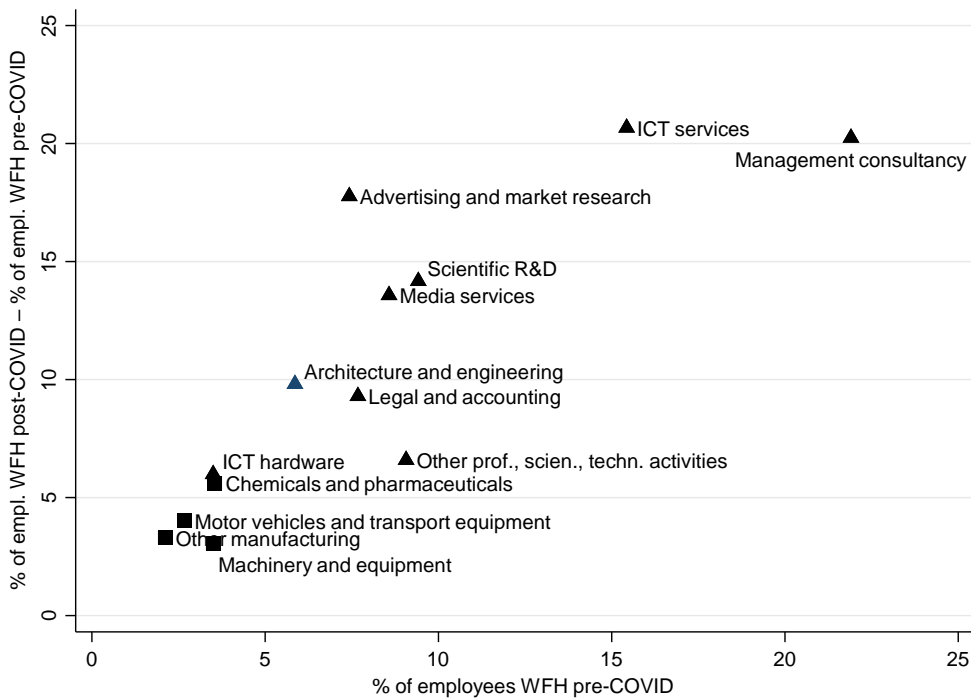
Note: This figure depicts the within-firm difference in the share of employees working from home at least once a week prior to the COVID-19 outbreak and the employers' forecast of the share of employees working from home at least once a week after COVID-19 ends. In June 2020, 17 percent of firms in the information economy expected the increase in the share of employees working from home to range from 1 to 10 percentage points. Source: ZEW Business Survey in the Information Economy, June 2020, December 2020.

Figure 4: Share of firms that used WFH pre-COVID and share of firms expecting a shift to WFH, by industry



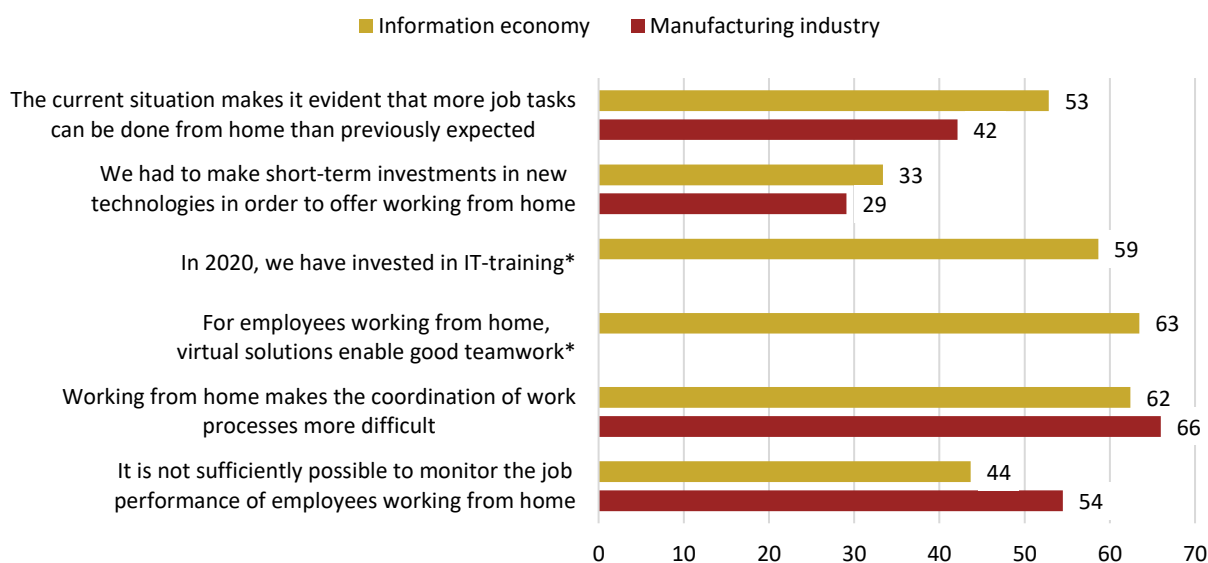
Note: Industry-averages of the share of firms that had any employees working from home (at least once a week) before the pandemic and of firms expecting a shift to WFH. Expecting a shift to WFH takes value 1 if a higher share of employees WFH post-COVID than pre-COVID, and 0 otherwise; Sub-sectors of the information economy are indicated by triangles and sub-sectors of the manufacturing industry are indicated by squares; ICT hardware manufacturers are subsumed as a sub-sector of the information economy; Unweighted. Source: ZEW Business Survey in the Information Economy, June 2020.

Figure 5: Share of employees who used WFH pre-COVID and intensity of the expected shift to WFH, by industry



Note: Industry-averages of the share of employees working from home (at least once a week) before the pandemic and the intensity of the expected shift to WFH. Intensity of the expected shift is measured as the within-firm difference between the share of employees WFH post-COVID and the share of employees WFH pre-COVID; Sub-sectors of the information economy are indicated by triangles and sub-sectors of the manufacturing industry are indicated by squares; ICT hardware manufacturers are subsumed as a sub-sector of the information economy; Unweighted. Source: ZEW Business Survey in the Information Economy, June 2020.

Figure 6: Potential mechanisms facilitating a shift to WFH



Note: In June 2020, 33 percent of firms in the information economy indicated that they had to make short-term investments in new technologies in order to offer working from home arrangements. * In December 2020, only firms in the information economy have been surveyed. Source: ZEW Business Survey in the Information Economy, June 2020, December 2020.

Table 3: Potential mechanisms facilitating a shift to WFH, by firm size

	Information economy			Manufacturing industry			
	Firm size:	5-19	20-99	>= 100	5-19	20-99	>= 100
The current situation makes it evident that more job tasks can be done from home than previously expected		47	69	83	36	43	70
We had to make short-term investments in new technologies in order to offer working from home		30	42	46	23	34	45
In 2020, we have invested in IT-training*		53	74	80			
For employees working from home, virtual solutions enable good teamwork*		58	77	83			
Working from home makes the coordination of work processes more difficult		62	65	61	67	67	58
It is not sufficiently possible to monitor the job performance of employees working from home		44	44	36	52	59	54

Source: * In December 2020, only firms in the information economy have been surveyed. ZEW Business Survey in the Information Economy, June 2020, December 2020.

Table 4: Potential mechanisms facilitating a shift to WFH, by use of WFH pre-COVID

	Information economy		Manufacturing industry		
	Use of WFH pre-COVID:	No	Yes	No	Yes
The current situation makes it evident that more job tasks can be done from home than previously expected		46	64	37	62
We had to make short-term investments in new technologies in order to offer working from home		35	32	26	40
In 2020, we have invested in IT-training*		54	64		
For employees working from home, virtual solutions enable good teamwork*		51	75		
Working from home makes the coordination of work processes more difficult		71	56	70	61
It is not sufficiently possible to monitor the job performance of employees working from home		57	32	59	48

Note: * In December 2020, only firms in the information economy have been surveyed. *Use of WFH pre-COVID* indicates whether a firm had any employees working from home at least once a week before the pandemic. Source: ZEW Business Survey in the Information Economy, June 2020, December 2020.

Table 5: OLS results, extensive and intensive margin of an expected shift to WFH

	Expecting a shift to WFH			Intensity of expected shift to WFH		
	(1)	(2)	(3)	(4)	(5)	(6)
Feasibility of WFH	0.36*** (0.03)	0.32*** (0.03)	0.34*** (0.03)	7.52*** (0.71)	6.86*** (0.73)	6.76*** (0.71)
Invest new technologies	0.11*** (0.02)	0.11*** (0.02)	0.11*** (0.02)	1.89** (0.81)	1.98** (0.81)	1.87** (0.80)
Difficult coordination	-0.04* (0.02)	-0.04 (0.02)	-0.05** (0.02)	-2.43*** (0.93)	-2.30** (0.93)	-2.67*** (0.91)
Decreased monitoring	-0.08*** (0.02)	-0.06** (0.02)	-0.07*** (0.02)	-3.65*** (0.79)	-3.23*** (0.79)	-3.21*** (0.79)
Use of WFH pre-COVID		0.19*** (0.03)			3.48*** (0.76)	
% empl. WFH pre-COVID			0.01*** (0.00)			0.47*** (0.07)
(% empl. WFH pre-COVID) ²			-0.00*** (0.00)			-0.01*** (0.00)
<u>Firm size:</u>						
5-19 employees	ref.	ref.	ref.	ref.	ref.	ref.
20-99 employees	0.15*** (0.03)	0.13*** (0.03)	0.14*** (0.03)	2.44*** (0.90)	1.92** (0.88)	1.94** (0.88)
>=100 employees	0.31*** (0.03)	0.25*** (0.03)	0.29*** (0.03)	3.05*** (0.98)	2.06** (0.97)	2.37** (0.96)
<u>Sector:</u>						
ICT services	ref.	ref.	ref.	ref.	ref.	ref.
ICT hardware	-0.23*** (0.05)	-0.17*** (0.05)	-0.19*** (0.05)	-12.79*** (1.95)	-11.67*** (1.97)	-11.23*** (2.02)
Media services	-0.03 (0.05)	-0.00 (0.05)	-0.02 (0.05)	-5.39** (2.50)	-4.89* (2.50)	-4.64* (2.50)
Legal and accounting	-0.12** (0.05)	-0.09* (0.05)	-0.11** (0.05)	-10.46*** (2.15)	-9.86*** (2.16)	-9.75*** (2.17)
Management consultancy	-0.03 (0.06)	-0.02 (0.06)	0.03 (0.06)	-1.05 (3.13)	-0.80 (3.12)	1.35 (2.99)
Architecture & engineering	-0.09* (0.05)	-0.05 (0.05)	-0.05 (0.05)	-9.29*** (2.12)	-8.59*** (2.13)	-7.93*** (2.16)
Scientific R&D	-0.04 (0.06)	-0.03 (0.06)	-0.01 (0.06)	-5.91** (2.57)	-5.66** (2.57)	-4.64* (2.55)
Advertising & market research	0.05 (0.05)	0.09* (0.05)	0.07 (0.05)	-0.97 (2.60)	-0.35 (2.61)	-0.14 (2.62)
Other prof., sci., tech. activities	-0.21*** (0.07)	-0.16** (0.07)	-0.20*** (0.07)	-12.28*** (2.38)	-11.40*** (2.36)	-11.79*** (2.35)
Chemicals & pharmaceuticals	-0.17*** (0.05)	-0.13*** (0.05)	-0.13*** (0.05)	-13.78*** (1.88)	-13.02*** (1.89)	-12.02*** (1.95)
Machinery & equipment	-0.22*** (0.04)	-0.15*** (0.04)	-0.18*** (0.05)	-15.05*** (1.75)	-13.68*** (1.79)	-13.05*** (1.85)
Motor vehicles & tr. equipment	-0.20*** (0.05)	-0.11** (0.05)	-0.15*** (0.05)	-15.46*** (1.85)	-13.82*** (1.89)	-13.32*** (1.95)
Other manufacturing	-0.24*** (0.04)	-0.17*** (0.04)	-0.20*** (0.04)	-15.09*** (1.75)	-13.69*** (1.78)	-13.16*** (1.85)
Constant	0.33*** (0.04)	0.22*** (0.04)	0.28*** (0.04)	15.97*** (1.77)	13.92*** (1.85)	13.91*** (1.94)
Observations	1547	1547	1547	1547	1547	1547
Adjusted R2	0.31	0.34	0.34	0.24	0.25	0.28

Note: OLS estimations. *Expecting a shift to WFH* takes value 1 if a higher share of employees WFH (at least once a week) post-COVID than pre-COVID, and 0 otherwise; *Intensity of expected shift* is measured as the within-firm difference between the share of employees WFH (at least once a week) post-COVID and the share of employees WFH pre-COVID; *Feasibility of WFH* takes 1 if firm agreed to statement "The current situation makes it evident that more job tasks can be done from home than previously expected", and 0 otherwise; *Invest new technologies* takes 1 if firm agreed to statement "We had to make short-term investments in new technologies in order to offer working from home", and 0 otherwise; *Difficult coordination* takes 1 if firm agreed to statement "Working from home makes the coordination of work processes more difficult", and 0 otherwise; *Decreased monitoring* takes 1 if firm agreed to statement "It is not sufficiently possible to monitor the job performance of employees working from home", and 0 otherwise; Use of WFH pre-COVID takes 1 if firm had any employees WFH (at least once a week) pre-COVID; Unweighted; Standard errors in parentheses robust to heteroskedasticity. * p < .10, ** p < .05, *** p < .01. Source: ZEW Business Survey in the Information Economy, June 2020.

Table 6: OLS results, extensive and intensive margin of an expected shift to WFH, information economy

	Expecting a shift to WFH			Intensity of expected shift to WFH		
	(1)	(2)	(3)	(4)	(5)	(6)
Feasibility of WFH	0.34*** (0.03)	0.32*** (0.03)	0.32*** (0.03)	10.04*** (1.14)	9.47*** (1.15)	9.18*** (1.13)
Invest new technologies	0.10*** (0.03)	0.11*** (0.03)	0.10*** (0.03)	1.98 (1.26)	2.17* (1.26)	1.94 (1.26)
Difficult coordination	0.02 (0.03)	0.02 (0.03)	0.01 (0.03)	-3.52** (1.48)	-3.50** (1.47)	-4.04*** (1.45)
Decreased monitoring	-0.08** (0.03)	-0.04 (0.03)	-0.07** (0.03)	-4.16*** (1.27)	-3.36*** (1.29)	-3.69*** (1.27)
Use of WFH pre-COVID		0.21*** (0.03)			4.33*** (1.19)	
% empl. WFH pre-COVID			0.01*** (0.00)			0.44*** (0.09)
(% empl. WFH pre-COVID) ²			-0.00*** (0.00)			-0.01*** (0.00)
Constant	0.30*** (0.05)	0.17*** (0.05)	0.27*** (0.05)	14.06*** (1.90)	11.39*** (2.07)	12.82*** (2.13)
Firm size & sector	Yes	Yes	Yes	Yes	Yes	Yes
Observations	916	916	916	916	916	916
Adjusted R ²	0.27	0.30	0.31	0.19	0.20	0.23

Note: OLS estimations. See Table 5 for definition of variables; Standard errors in parentheses robust to heteroskedasticity. * p < .10, ** p < .05, *** p < .01. Source: ZEW Business Survey in the Information Economy, June 2020.

Table 7: OLS results, extensive and intensive margin of an expected shift to WFH, manufacturing industry

	Expecting a shift to WFH			Intensity of expected shift to WFH		
	(1)	(2)	(3)	(4)	(5)	(6)
Feasibility of WFH	0.36*** (0.04)	0.32*** (0.04)	0.34*** (0.04)	3.88*** (0.54)	3.21*** (0.56)	3.24*** (0.53)
Invest new technologies	0.11*** (0.04)	0.11*** (0.04)	0.11*** (0.04)	2.13*** (0.77)	2.09*** (0.76)	2.05*** (0.74)
Difficult coordination	-0.13*** (0.04)	-0.12*** (0.04)	-0.13*** (0.04)	-1.42* (0.78)	-1.21 (0.77)	-1.28* (0.75)
Decreased monitoring	-0.07** (0.04)	-0.07* (0.04)	-0.07* (0.04)	-2.65*** (0.70)	-2.59*** (0.69)	-2.29*** (0.67)
Use of WFH pre-COVID		0.14*** (0.04)			2.54*** (0.68)	
% empl. WFH pre-COVID			0.01*** (0.00)			0.51*** (0.11)
(% empl. WFH pre-COVID) ²			-0.00*** (0.00)			-0.01*** (0.00)
Constant	0.16*** (0.05)	0.13*** (0.05)	0.13*** (0.05)	3.06*** (0.81)	2.63*** (0.81)	2.05** (0.81)
Firm size & sector	Yes	Yes	Yes	Yes	Yes	Yes
Observations	631	631	631	631	631	631
Adjusted R ²	0.34	0.36	0.36	0.16	0.18	0.21

Note: OLS estimations. See Table 5 for definition of variables; Standard errors in parentheses robust to heteroskedasticity. * p < .10, ** p < .05, *** p < .01. Source: ZEW Business Survey in the Information Economy, June 2020.

Table 8: OLS results, extensive and intensive margin of an expected shift to WFH, by use of WFH pre-COVID

	Expecting a shift to WFH				Intensity of expected shift to WFH			
	No WFH pre-COVID		WFH pre-COVID		No WFH pre-COVID		WFH pre-COVID	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Information economy:								
Feasibility of WFH	0.34***	(0.05)	0.29***	(0.05)	8.27***	(1.59)	9.95***	(1.67)
Invest new technologies	0.20***	(0.05)	0.05	(0.04)	5.00**	(1.98)	0.43	(1.73)
Difficult coordination	-0.02	(0.06)	0.03	(0.04)	-2.78	(2.03)	-4.10**	(1.98)
Decreased monitoring	-0.04	(0.06)	-0.03	(0.04)	-3.24*	(1.87)	-3.56**	(1.75)
Constant	0.22**	(0.09)	0.34***	(0.06)	10.61***	(3.86)	13.99***	(2.44)
Firm size & sector	Yes		Yes		Yes		Yes	
Observations	366		550		366		550	
Adjusted R ²	0.20		0.21		0.16		0.15	
Manufacturing industry:								
Feasibility of WFH	0.28***	(0.05)	0.42***	(0.08)	2.41***	(0.64)	5.31***	(1.12)
Invest new technologies	0.14***	(0.05)	0.07	(0.06)	2.14**	(0.84)	2.12	(1.42)
Difficult coordination	-0.10*	(0.05)	-0.14***	(0.05)	-1.03	(0.79)	-1.58	(1.42)
Decreased monitoring	-0.12**	(0.05)	-0.02	(0.05)	-1.30*	(0.71)	-4.46***	(1.24)
Constant	0.16***	(0.06)	0.22**	(0.09)	2.22***	(0.79)	4.69***	(1.71)
Firm size & sector	Yes		Yes		Yes		Yes	
Observations	388		243		388		243	
Adjusted R ²	0.25		0.29		0.09		0.13	

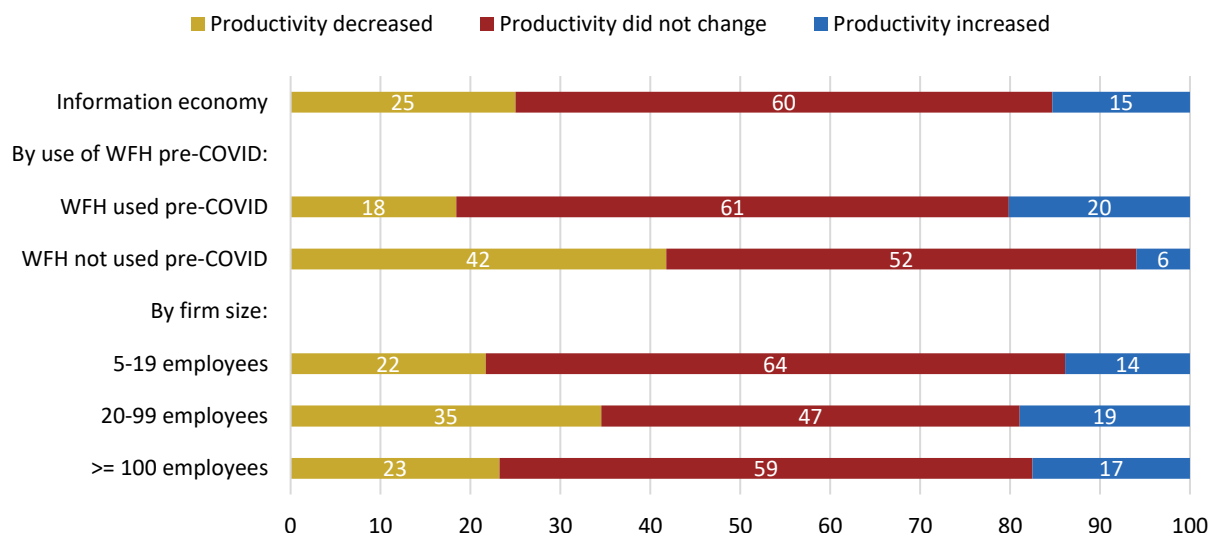
Note: OLS estimations. See Table 5 for definition of variables; *WFH pre-COVID* indicates whether a firm had any employees working from home at least once a week before the pandemic; Standard errors in parentheses robust to heteroskedasticity. * p < .10, ** p < .05, *** p < .01. Source: ZEW Business Survey in the Information Economy, June 2020.

Table 9: OLS results, extensive and intensive margin of an expected shift to WFH, human capital and teamwork, information economy

	Expecting a shift to WFH			Intensity of expected shift to WFH		
	(1)	(2)	(3)	(4)	(5)	(6)
Invest new technologies (TECH)	0.03	0.02	0.02	-2.48	-2.58	-2.75
	(0.08)	(0.08)	(0.07)	(2.57)	(2.56)	(2.55)
Invest IT training (TRAIN)	0.11**	0.10*	0.10**	3.15	2.92	2.75
	(0.05)	(0.05)	(0.05)	(1.93)	(1.91)	(1.88)
TECH * TRAIN	0.16***	0.17***	0.15***	3.85*	3.88*	3.30
	(0.05)	(0.05)	(0.05)	(2.11)	(2.12)	(2.10)
Virtual solutions for teamwork	0.14***	0.12***	0.14***	3.28***	2.92**	3.26**
	(0.05)	(0.05)	(0.05)	(1.26)	(1.29)	(1.28)
Other mechanisms:	Yes	Yes	Yes	Yes	Yes	Yes
Use of WFH pre-COVID:		Yes			Yes	
% empl. WFH pre-COVID (x ²):			Yes			Yes
Firm size & sector	Yes	Yes	Yes	Yes	Yes	Yes
Observations	525	525	525	525	525	525
Adjusted R ²	0.28	0.30	0.31	0.22	0.22	0.28

Note: OLS estimations. *Expecting a shift to WFH* takes value 1 if a higher share of employees WFH (at least once a week) post-COVID than pre-COVID, and 0 otherwise; *Intensity of expected shift* is measured as the within-firm difference between the share of employees WFH (at least once a week) post-COVID and the share of employees WFH pre-COVID; *Invest IT training* takes 1 if firm agreed to statement "In 2020, we have invested in IT training", and 0 otherwise; *TECH*TRAIN* indicates the interaction effect of *Invest new technologies* and *Invest IT training*; *Virtual solutions for teamwork* takes 1 if firm agreed to statement "For employees working from home, virtual solutions enable good teamwork", and 0 otherwise; Standard errors in parentheses robust to heteroskedasticity. * p < .10, ** p < .05, *** p < .01. Source: ZEW Business Survey in the Information Economy, June 2020, December 2020.

Figure 7: Change in productivity of employees who started WFH during COVID-19, information economy



Note: 15 percent of firms in the information economy report that the productivity of their employees who started WFH during the pandemic has increased. 20 percent of firms in which some of the employees have already worked from home at least once a week before the pandemic indicate that the productivity of their employees who started WFH during the pandemic has increased. Source: ZEW Business Survey in the Information Economy, December 2020.

Table 10: Level of difficulty to assess the productivity of employees, information economy

	not difficult at all / rather not difficult	neutral	rather difficult / very difficult
<u>For employees working from home:</u>			
Information economy	46	30	24
5-19 employees	49	29	21
20-99 employees	38	31	31
>= 100 employees	27	36	37
<u>For employees working on business premises:</u>			
Information economy	75	22	3
5-19 employees	77	20	3
20-99 employees	71	25	3
>= 100 employees	66	27	7

Note: 37 percent of large firms with at least 100 employees in the information economy find it difficult to assess the productivity of employees working from home. Source: ZEW Business Survey in the Information Economy, December 2020.

Table 11: Share of employees whose job tasks are – in theory – suited for WFH, information economy

	0%	1-10%	11-20%	21-50%	51-100%
Information economy	11	8	11	25	45
<u>By subsector:</u>					
ICT hardware	17	33	6	29	14
ICT services	6	6	5	20	63
Media services	14	13	8	30	35
Prof., scien., & tech. activities	12	8	14	25	41
<u>By firm size:</u>					
5-19 employees	14	8	13	23	42
20-99 employees	4	10	7	28	52
>= 100 employees	2	8	3	31	58

Note: 45 percent of firms in the information economy estimate that more than half of their employees have a job that is - in theory - suited for working from home. Source: ZEW Business Survey in the Information Economy, December 2020.

Table 12: Within-firm difference in potential for WFH and current use of WFH, information economy

	WFH potential < WFH use	WFH potential = WFH use	WFH potential > WFH use: 1-20%	WFH potential > WFH use: 21-100%
Information economy	13	33	28	26
<u>By subsector:</u>				
ICT hardware	11	42	40	7
ICT services	16	39	26	20
Media service providers	11	45	31	14
Prof., scien., & tech. activities	13	30	28	29
<u>By firm size:</u>				
5-19 employees	12	35	25	28
20-99 employees	15	28	38	19
>= 100 employees	28	30	31	12

Note: The potential for WFH is measured by the question: "How high do you estimate the share of your employees whose job tasks are – in theory – suited for working from home?"; The current use of WFH is measured by the question: "How high do you estimate the share of your employees who work from home at least once a week?". In 28 percent of firms, the potential for WFH exceeds the share of employees currently using WFH by 1 to 20 percent of employees. Source: ZEW Business Survey in the Information Economy, December 2020.

Table 13: Share of firms that have increased their level of digitalisation since the start of COVID-19, by firm size

Surge in digitalisation in ...	Information economy				Manufacturing industry			
	All	5-19	20-99	>= 100	All	5-19	20-99	>= 100
... our way of working	36	32	47	55	22	13	30	49
... our business processes	29	25	42	43	19	10	27	40
... our products and services	15	12	26	18	13	10	17	18
... at least one of the above	42	38	53	57	26	14	38	52

Note: In September 2020, 36 percent of firms in the information economy have stated that they have increased the digitalisation of their way of working. Source: ZEW Business Survey in the Information Economy, September 2020.

Table 14: Importance of investments in digital technologies & infrastructure enabling WFH, information economy

	not important at all			highly important	
	(1)	(2)	(3)	(4)	(5)
Information economy	8	8	14	33	37
<u>By subsector:</u>					
ICT hardware	15	12	22	28	22
ICT services	6	6	13	26	49
Media service providers	14	9	15	33	29
Prof., scien., & tech. activities	8	8	14	35	35
<u>By firm size:</u>					
5-19 employees	9	9	15	33	34
20-99 employees	5	6	11	33	45
>= 100 employees	3	3	11	33	51

Note: 37 percent of firms in the information economy state that investments in digital technologies and infrastructure enabling working from home are highly important for them. Source: ZEW Business Survey in the Information Economy, December 2020.

Table 15: Investments in digital technologies & infrastructure enabling WFH in next 2 years, information economy

	small extent	high extent
Information economy	64	17
<u>By subsector:</u>		
ICT hardware	55	13
ICT services	55	22
Media service providers	67	9
Prof., scien., & tech. activities	67	16
<u>By firm size:</u>		
5-19 employees	66	14
20-99 employees	59	25
>= 100 employees	59	30

Note: 64 (17) percent of the firms plan to invest to a small extent (high extent) in digital technologies and infrastructure enabling working from home within the next two years. Source: ZEW Business Survey in the Information Economy, December 2020.

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Appendix

Table A1: Classification of industries

	NACE Rev. 2	
	Code	Section
Information economy		
<u>ICT hardware</u>		
Manufacture of electronic components and boards	26.1	C – Manufacturing
Manufacture of computers and peripheral equipment	26.2	C – Manufacturing
Manufacture of communication equipment	26.3	C – Manufacturing
Manufacture of consumer electronics	26.4	C – Manufacturing
Manufacture of magnetic and optical media	26.8	C – Manufacturing
<u>ICT services</u>		
Software publishing	58.2	J – Information and Communication
Telecommunications	61	J – Information and Communication
Computer programming, consultancy and related activities	62	J – Information and Communication
Data processing, hosting & related activities; web portals	63.1	J – Information and Communication
<u>Media services</u>		
Publishing of books, periodicals and other publ. activities	58.1	J – Information and Communication
Motion picture, video and television programme production, sound recording and music publishing activities	59	J – Information and Communication
Programming and broadcasting activities	60	J – Information and Communication
Other information service activities	63.9	J – Information and Communication
<u>Professional, scientific, and technical activities^a</u>		
Legal and accounting activities	69	M – Prof., Scien., and Tech. Activities
Management consultancy activities	70.2	M – Prof., Scien., and Tech. Activities
Architectural and engineering activities; technical testing and analysis	71	M – Prof., Scien., and Tech. Activities
Scientific research and development	72	M – Prof., Scien., and Tech. Activities
Advertising and market research	73	M – Prof., Scien., and Tech. Activities
Other professional, scientific and technical activities	74	M – Prof., Scien., and Tech. Activities
Manufacturing industry		
Manufacture of chemical products and pharmaceuticals	20, 21	C – Manufacturing
Manufacture of machinery and equipment	28	C – Manufacturing
Manufacture of motor vehicles, trailers and semi-trailers, and of other transport equipment	29, 30	C – Manufacturing
Other manufacturing	10-33 ^b	C – Manufacturing

Note: ^a Out of the NACE Rev. 2 Section “M - Professional, scientific and technical activities” the following subsections are not included in our analysis: Activities of head offices 70.1; Veterinary activities 75. ^b Other manufacturing includes the NACE Rev. 2 Section “C – Manufacturing” (Codes 10-33) except for the codes already covered by before mentioned industries.

Table A2: Number of observations in June, September, and December 2020

	Number of observations		
	June 2020	September 2020	December 2020
Information economy			
ICT hardware	108	85	91
ICT services	180	165	172
Media service providers	127	122	112
Legal and accounting activities	110	91	91
Management consultancy activities	63	57	61
Architectural and engineering activities	157	145	152
Scientific research and development	76	66	65
Advertising and market research	107	91	99
Other prof., sci., and tech. activities	63	52	45
Manufacturing industry			
Chemical products and pharmaceuticals	146	116	
Machinery and equipment	195	114	
Motor vehicles and other transport equipment	105	74	
Other manufacturing	329	239	
Total	1,766	1,417	888

Source: ZEW Business Survey in the Information Economy, June, September, December 2020.



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