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Working from Home: Its Effects on Productivity and Mental Health

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Working from home: its effects on productivity and mental health[1]

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Abstract

The coronavirus disease 2019 (COVID-19) pandemic has impacted the world economy in various ways. In particular, the drastic shift to telework has dramatically changed how people work. Whether the new style of working from home (WFH) will remain in our society highly depends on its effects on workers' productivity. However, to the best of our knowledge, the effects of WFH on productivity are still unclear. By leveraging unique surveys conducted at four manufacturing firms in Japan, we identify the possible factors of productivity changes due to WFH. Our main findings are as follows. First, after ruling out the time-invariant component of individual productivity and separate trends specific to employee attributes, we find that productivity declined more for workers who worked from home than those who did not. Second, our analysis shows that poor WFH setups and communication difficulties are the major reasons for productivity losses. Third, we find that the mental health of workers who work from home is significantly better than that of workers who are unable to work from home. Our result suggests that if appropriate investments can be made in upgrading WFH setups and facilitating communication, WFH may improve productivity by improving employees' health and well-being.

Keywords: working from home, COVID-19, productivity, mental health
JEL classification: J24, J81, M50, I18

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1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has impacted the world economy in various ways. As one of the major changes, teleworking or working from home (WFH) has become widespread across countries. For example, Brynjolfsson et al. [1] suggest that in May 2020, approximately half of the workforce in the U.S. was WFH. Felstead and Rueschke [2] reported that in April 2020, the WFH percentage in the U.K. reached 43.1% and, in June 2020, remained high, 36.5%. Additionally, Eurofound [3] showed that in July 2020, nearly half of all employees in EU countries worked from home. For Japan, the Cabinet Office [4] reported that the WFH percentage was 34.5% at the end of May 2020, and Morikawa [5] reported that it was approximately 32% in June 2020 (see also Okubo [6], who reported a smaller figure: 17% in June 2020). Regarding other countries, see Pouliakas [7] for Greece and Delaporte and Pena [8] for 23 Latin American and Caribbean countries; both studies reported smaller figures. While the WFH percentages vary across countries, two common features are observed: (1) many people reported that during the crisis, it was their first time WFH (for example, see [2], [3] and [6]), and (2) the majority of workers WFH wished to continue the new working style if there were no COVID-19 restrictions ([2], [3] and [4]). This new global experience indicates that WFH may increase the welfare of workers, at least for those who are able to pursue their job at home (see Kroll and Nuesch [9], Bellmann and Hubler [10], and [11]). Although WFH may not be applicable to all occupations (see [12], [13], [14] and [11]), the experience of WFH during the crisis may lead to growth in teleworking even after the crisis abates ([3]).

This pandemic-driven WFH has dramatically changed people's way of work, and it is crucial to sustain production during this ongoing crisis. Whether the new style will remain in our society highly depends on its effects on workers' productivity. However, the effects of WFH on productivity are still unclear (OECD [15]). For example, based on a field experiment conducted in the call center of a Chinese firm, Bloom et al. [16] found that WFH had a positive effect on workers' productivity and reduced turnovers. While the paper ([16]) reporting evidence based on data collected before the COVID-19 pandemic, Emanuel and Harrington [17] also found a positive effect on the productivity of call center workers during the COVID-19 crisis. Analyzing not only specific workers but also broader occupations in the U.K., Felstead and Rueschke [2] indicated mixed results under COVID-19. Their paper showed that two-fifths of workers reported that they were able to complete as much work in June 2020 as they were able to complete six months earlier;

additionally, over a quarter of workers said that they accomplished more, while 30.2% said that their productivity had fallen. Additionally, Ipsen et al. [18] showed that among WFH workers in Denmark, 55% complete the same amount of work or more when WFH than when physically working at a workplace. They also reported that the majority of WFH workers indicated that they worked fewer hours, which suggests that WFH is more efficient and productive on a per-hour basis. On the other hand, Morikawa [5] showed that the mean WFH productivity relative to working at the usual workplace was approximately 60% to 70% in Japan, and 82% of workers reported a decline in productivity in a WFH environment during the COVID-19 crisis.

Several studies have also reported both positive and negative effects of WFH on productivity, depending on skills, education, tasks or industry. For example, Etheridge et al. [19] reported that in the U.K., while workers who have increased their intensity of WFH reported substantial productivity increases, those who previously always worked from home, women and those in low-paying jobs suffered the worst average declines in productivity (see also [20], [21], [22]). The paper ([19]) also reported that declines in productivity are strongly associated with declines in mental well-being. Using firm surveys, Bartik et al. [23] reported that employers think that there have been less productivity losses from remote working in better educated and higher-paying industries. Dutcher [24] indicated that WFH may have positive effects on productivity in creative tasks but negative effects on productivity in dull tasks. In summary, although there has been a rapid accumulation of studies on WFH and productivity, the reported evidence is mixed, and we believe that additional evidence on when WFH is productivity-enhancing is needed.

In this study, we try to contribute additional evidence on the effects of WFH by using data from our original employee-level survey conducted in cooperation with four large listed manufacturing companies in Japan from April to June 2020. On April 7, 2020, the Japanese government declared a countrywide state of emergency. Although the state of emergency ended on May 25, the request for self-restraint on movement between prefectures was extended until June 19. In the meantime, the government asked firms to let workers work from home as much as possible.[2] According to the panel survey conducted by the Japan Institute for Labour Policy and Training (JILPT) (2020), the number of WFH workers rapidly increased from early April and peaked in the second week of May 2020. It then started to decline after the state of emergency was

[2] Prime Minister Shinzo Abe (at that time) asked firms to allow at least 70% of employees to work from home during a press conference on April 7.

lifted at the end of May and dropped significantly by the end of July. Notably, although the government declared a state of emergency, it was only *on a request basis* and was not mandatory; therefore, the final decision on whether to introduce WFH was made completely at the discretion of employers. Moreover, many Japanese firms allowed each workplace to individually decide whether to use WFH. Therefore, even in the same firm, while workers in some units worked entirely from home, workers in other units had to commute to the office even though both groups of workers performed similar tasks. The variations in WFH within the same company enable us to investigate whether there are productivity losses or gains due to WFH. However, because companies and division managers had the discretion to comply with or to defy the official request, the decision to opt for WFH may be endogenous if workers with specific unobserved traits or roles in the workplace tended to be chosen for WFH. We overcome this concern over endogeneity in two ways, which we explain as part of the empirical strategy in Section 3.

The survey we use includes questions on subjective productivity and the perceived factors of productivity losses, allowing us to investigate the possible determinants of deteriorations in productivity. It also contains questions on mental health and the perceived advantages of WFH, making it possible to examine the relationship between WFH and workers' mental health.

Our major contributions are threefold. First, using employee survey data with high response rates, we exploit the heterogeneities among workers within the same companies. Specifically, we identify the effects of WFH on productivity within the same company and within the same occupation, which vary depending on the number of days spent WFH. Focusing on specific companies also allows us to exclude the differences in productivity among firms. For example, using firm panel data, Bloom et al. [25] reported evidence that productivity widely varies between firms and that the least productive firms have been disproportionately affected by COVID-19. Based on our analysis, workers who worked from home experienced a productivity decline compared with those who did not. Second, owing to the rich information available in our original surveys, we could identify the potential factors that determine deteriorations in productivity due to WFH. We find that poor WFH setups and communication difficulties are the major reasons for productivity losses. In addition, although the reasons above are common features of all occupations, we find that the major reasons that reduce productivity the most differ by occupation. Our findings provide managerial implications that are useful for designing desirable investments to improve the productivity of employees while WFH. Third, we complement our

findings by analyzing the impact of WFH on mental health. Since a lack of time series information on mental health prevents us from ruling out a time-invariant component of employees' mental status, the findings here should be handled with reservation, we find that the mental health of WFH workers is significantly better than that of workers who are unable to work from home. In addition, our results imply that better concentration, less fatigue, and a shorter commute time may contribute to better mental health. Our result suggests that if appropriate WFH investments can be made, WFH may also improve productivity by improving employees' health and well-being.

The remainder of this paper is organized as follows. Section 2 describes our data, and Section 3 presents our quantitative methods. Section 4 explains the results, and Section 5 concludes.

2. Data

We use data retrieved from our original survey on WFH productivity during the COVID-19 pandemic, which was conducted in cooperation with four listed manufacturing companies in Japan (Companies A, B, C, and D) from April to June 2020. Companies A, B, and D are chemical manufacturing companies, while Company C is an automobile manufacturing company. Companies A, B, and D have approximately 8,000, 7,000, and 27,000 employees, respectively, while Company C has more than 30,000 employees on a consolidated basis.

The survey was administered to both white- and blue-collar employees (Companies A, B, and D) or white-collar employees (Company C).[3] The employees of Companies B and D also included those of subsidiary companies. All employees of the four companies were asked to complete the survey. The survey included questions on topics such as the number of days spent WFH per week, productivity (presenteeism; details will be explained in Section 2.1.1.) before and after the state of emergency, the perceived causes of productivity losses, the respondents' mental health status (details will be explained in Section 2.1.2.), the perceived advantages of WFH, and the respondents' occupation, job grade, division, and basic individual characteristics. The response rates were high across the companies, ranging from 72% to 91%. The total sample size was 24,175, which fell to 22,815 after excluding invalid responses. Because the survey asked about the

[3] Hence, the Company C sample does not include production line workers, who regularly worked at the factory during the survey period, resulting in the smaller proportion of "no WFH" responses compared to the other companies.

respondents' productivity level both before and after the state of emergency, our analyses could rule out the time-invariant component of individual productivity.

The survey included a question on the number of days spent WFH per week during the reference period. We consolidated the answers into four categories based on the number of days spent WFH: none, once or twice, three or four times, and five times a week (i.e., exclusively WFH). Table 1 shows the percentage of employees who worked from home by the number of days worked from home per week on a company-by-company basis. It shows that among employees within the same company, there is variation in the number of days spent WFH. Moreover, the percentage of workers who completely worked from home, i.e., those who worked from home five days a week, ranged from approximately 8% to 22% across the four companies. On the other hand, the figures show that approximately 40% to 50% of employees of Companies A, B, and D and 10% of employees of Company C worked entirely at the office. Note that this share of employees not WFH is low for Company C because it asked only white-collar employees to complete the survey.

2.1. Outcome variables

2.1.1. Productivity

In our survey, productivity was measured based on answers to the questions that are modified version of the Health and Work Performance Questionnaire (HPQ), which is developed by the World Health Organization (WHO) and used to measure subjective productivity (presenteeism). Our productivity measurement was conducted based on two-stage questions following the WHO-HPQ. The first item asked respondents the following retrospective question: "(*o*)*n a scale from 0 to 10 where 0 is the worst job performance anyone could have at your job, 5 is the performance of average workers, and 10 is the performance of a top worker, how would you rate your usual job performance (in the one-year period) before the declaration of the state of emergency?*"[4] This item aimed to determine the average level of productivity of individual employees in the pre-COVID-19 period. The second question asked respondents to also apply a "0 to 10" scale to grade their overall job performance since a specific reference date, which varied by company. Taking the difference between the answers to these two questions, we calculated the changes in

[4] In the questionnaire used for Company A, the phrase "*in the one-year period"* in the parentheses was not included.

productivity before and after the state of emergency.[5] Regarding Company D, the simplified University of Tokyo version of the one-item presenteeism scale (Presenteeism-UT), which aimed to reduce the number of questions based on the HPQ, was used. For Company D, the employee survey was conducted twice, first in early March 2020 before the state of emergency was declared and again in April 2020. Therefore, unlike the other companies for which presenteeism before the state of emergency was evaluated in a retrospective manner, for Company D, presenteeism was measured at two time points—before and after the state of emergency.[6]

We use this presenteeism measure as one of our main outcome variables. Higher values indicate less presenteeism (i.e., higher productivity).

2.1.2. Mental health index

Another main outcome variable of this paper is employees' mental health. In the survey, we asked respondents to "(p)lease answer the following questions concerning your health since [the start date of the reference period]" along with the following three questions about workers' mental health: "I have been depressed," "I have felt weary or listless, " and "I have felt worried or insecure." The respondents were asked to choose from four options: "almost always," "often," "sometimes," and "almost never." We coded these responses on a 1 to 4 scale and reduced the total scores from the three questions into one dimension by using correspondence analysis; this one dimension was used as the mental health index. Correspondence analysis reduces the dimension of scales among a set of qualitatively similar categorical variables (see, for instance, [26]). Higher values indicate better mental health. Note that this variable is not available for Company A.

[5] We shall note that while some previous literature evaluate productivity when working from home, we measure total productivity before and after the declaration of the state of emergency regardless of the number of days working from home.

[6] Specifically, the Presenteeism-UT asked employees to "*Suppose that 100% is your work performance when you are neither sick nor injured. Please evaluate your current work performance*." For the April survey, the question was changed to "*Suppose that 100% is your work performance when you are neither sick nor injured before the state of emergency. Please evaluate your current work performance after April 8*." We standardized the responses to a 0-10 scale by dividing by 10.

2.2. Covariates of interest

2.2.1. Perceived factors of deteriorations in productivity

The survey also asked respondents who worked from home during the reference period to choose potential factors that caused declines in their productivity. Specifically, the respondents were asked the following multiple-choice question: "what factors, if any, do you think lower productivity when working from home?" The choices were "*the inability to retrieve data from outside of the office because of security,*" *"the inability to use exclusive equipment that is available only at the office," "poor WFH setups (e.g., do not have own office space)," "lack of articulate orders and/or poor support from superiors," "poor workplace communication," "poor communication with clients," "fatigue from an excessive workload," "not feeling well physically (stiff shoulders, back pain, etc.)," "feeling mentally under the weather," and "having distractions or responsibilities to deal with (such as kids who want attention, nursing care for parents, and other family responsibilities)."*

In the survey, we also asked WFH employees another multiple-choice question about workers' perceived advantages of WFH. Specifically, we asked, "*While working from home, did you find any advantages of WFH, if any?*" The choices were "*no distractions and a quiet environment that facilitates a greater focus on work,*" "*can avoid frequent and/or unnecessary conversations with coworkers,*" *"free from stress caused by annoying relationships with coworkers and bosses," "improvement in IT skills," "zero commuting and saving time on getting ready for work," "being able to wear casual clothes," "less fatigue and having a healthier condition," "eating healthier meals," "spending more time exercising," "reducing alcohol consumption," "having extra time for sleep and rest," "less smoking," "having extra time with family and friends," "the ability to fit in household chores, parental care, and extra time with kids," "better family relationships," and "finding new hobbies due to the constraints on going out."*

2.2.2. Functional roles

Using the occupational classification of each employee, we categorized the employees into four functional roles: *corporate*, *sales*, *R&D*, and *production*. Production included not only blue-collar employees who engage in the production process but also white-collar employees who manage production and quality control. In the following, we divide our observations into subsamples by

these four categories to investigate whether the possible causes that reduce WFH productivity may differ across functional roles.

Table 2 presents the descriptive statistics of each company.

3. Empirical strategy

3.1. Main model

We are interested in identifying the impact of the individual's WFH status on the outcome variable (y_{ijt}) for individual *i* at division *j* at time *t*. We start with a simple linear model:

$$y_{ijt} = z_{ijt}\beta + X_{ijt}\gamma + \epsilon_{ijt} \quad (1)$$

where z_{ijt} is the number of days spent WFH per week or a vector of dummies (*wfh2d*, *wfh4d*, *wfh5d*); X_{ijt} is a vector of individual and division-specific characteristics; and ϵ_{ijt} is an error term. $wfh2d_i, wfh4d_i,$ and $wfh5d_i$ indicate the number of days spent WFH per week, i.e., "once or twice," "three or four times," and "five times (exclusively)," respectively. The reference is none (zero WFH days). A vector of dummies (*wfh2d*, *wfh4d*, *wfh5d*) is used when we suspect a nonlinear relationship between the frequency of WFH and the outcome.

This study used different identification strategies for the presenteeism and mental health variables. For presenteeism, our survey asked for a subjective assessment of productivity in March (i.e., prior to the declaration of the state of emergency) and in April or May (i.e., after the declaration), and we had one observation point for mental health. We first explain our approach to the former in this section and to the latter in the next section.

We can identify β using ordinary least squares (OLS) if the WFH term is orthogonal to the error term, conditional on individual characteristics. This assumption is likely to be violated if workers with specific unobserved traits or roles in the workplace tend to be chosen for WFH. If companies are more likely to allow more productive workers to work from home, the estimated β will be overestimated. Likewise, if less productive workers volunteer to work from home

disproportionately more often than more productive workers, then the estimate for β will be underestimated.

In our case, the shock to WFH adoption was mostly exogenous. Similar to the context of previous studies on the impact of WFH after the pandemic, the declaration of a state of emergency in Japan had a large and less expected impact on WFH adoption. According to Table 1, quite a large number of workers worked from home owing to the government's request in April. More than half of the employees in our sample worked from home at least once a week. Importantly, however, the government's WFH request was not mandatory. Because companies and division managers had the discretion to comply with or to defy the official request, the decision to opt for WFH may still be endogenous.

We overcome this concern over endogeneity in our subjective productivity measure in two ways. First, we take the first difference in equation (1) to rule out unobserved time-invariant individual and division-specific characteristics in the error term, which are correlated with factors affecting the WFH choice.

$$\Delta y_{ijt} = \Delta z_{ijt}\beta + \Delta X_{ijt}\gamma + \Delta \epsilon_{ijt} \quad (2)$$

where Δ is the first-difference operator.

As a result, our main sample is reduced to a cross-section of the first-differenced outcome variable. Δz_{ijt} is the difference in the number of days spent WFH during the period between the two surveys. For Company A, information on the number of days spent WFH before April is lacking. We replace Δz_{ijt} with z_{ijt} under the assumption that a very small number of employees worked from home for a limited number of days before April.

As shown below, most covariates in X_{ijt} do not have much time series variation, which means that most values in ΔX_{ijt} are zero. Additionally, although time-invariant individual and division-specific characteristics are ruled out by taking the first difference, they might still contribute to selection bias because they are likely to be correlated with time-varying unobservables that affect both the WFH choice and the outcome. For these reasons, we replace ΔX_{ijt} with X_{ijt} in equation (2). Thus, our baseline model is as follows:

$$\Delta y_{ijt} = \Delta z_{ijt}\beta + X_{ijt}\gamma + \Delta \epsilon_{ijt} \quad (3)$$

In particular, we include the following terms as X_{ijt}: a female dummy, age category dummies, and dummies for job grades and divisions. Including dummies for job grades and divisions in equation (2) essentially allows us to control for separate trends across different job levels and divisions. Controlling for such trends is important in the analysis of WFH after the pandemic because a worker's occupation and functional and technical roles within the organization could correlate with her superior's WFH choice for her. In other words, by including dummies for job grades and divisions, the coefficient β is identified mainly based on the variation within the division and job level where the variation in WFH is primarily caused by the preference and management style of the worker's supervisor, which is less likely to be correlated with the worker's productivity.

To the extent that our estimation model controls for the selection bias arising from such endogenous adoption of WFH, the estimate of β represents the causal impact of WFH adoption. One cause for concern is that some employees were transferred across divisions during the reference period. However, their functional roles rarely changed after the transfer, and the effect of the division within the same functional role was not expected to differ substantially.

Another issue that we encounter is that the measurement of presenteeism is not necessarily consistent with the measurement of WFH. In the default questionnaire that we used, presenteeism was assessed for a one-year period before the declaration of the state of emergency, while the frequency of WFH was assessed for a one-week period in early March. The measurement period for the two is consistent for the question asked for the post-declaration period. To mitigate the bias due to this time inconsistency, we add z_{ijt} as a control in some specifications. That is, we estimate the following:

$$\Delta y_{ijt} = \Delta z_{ijt}\beta_1 + z_{ijt}\beta_2 + X_{ijt}\gamma + \Delta\epsilon_{ijt} \quad (4)$$

3.2. Model for mental health

As discussed above, for our mental health variable, we have one observation point. Thus, taking the first difference is not feasible. We argue that for mental health, endogeneity bias is less of a concern for two reasons. First, it is unlikely that workers with a specific mental health condition

tend to be chosen for WFH because a person's mental health condition is not known to her supervisor until it has deteriorated so much that her doctor's recommendation of sick leave or a job transfer is submitted. Even if the supervisor knows her subordinate's mental health condition before it becomes this bad, it is not a priori obvious whether choosing WFH will be good or bad for her health. Second, we have precise information about workers' workplace and job level, which can be used to account for the technical or operational reasons underlying the WFH choice. Including division dummies and job level dummies as controls also helps us to control for variations in mental health conditions across occupations and job levels, thus mitigating the endogeneity bias with regard to WFH.

For these two reasons, estimating equation (1) using OLS will allow us to make causal interpretations, although we still cannot rule out the possibility of some bias due to selection. Therefore, as a robustness check, we also estimate a model with sample selection bias.

3.3. Analysis using the WFH sample

Some survey questions, such as the item asking about the perceived factors of productivity declines, were asked only to workers who worked from home during the reference period. Furthermore, the answer to the question is likely to be correlated with the frequency of WFH. Therefore, the OLS estimates of equation (3) for presenteeism or equation (1) for mental health are biased if

$$E[\Delta\epsilon_{ijt}|X_{ijt}, \Delta z_{ijt}, d = 1] \neq 0$$

or

$$E[\epsilon_{ijt}|X_{ijt}, z_{ijt}, d = 1] \neq 0,$$

respectively, where d denotes a dummy for WFH at least one day a week.

Given our previous discussion, we predict that the OLS estimates of the first-difference equation for presenteeism might be biased due to selection if unobservable factors that separate trends of presenteeism are correlated with the decision to work from home. On the other hand, the OLS estimate of equation (1) for mental health is unlikely to be biased if the decision to work from home is uncorrelated with mental health, conditional on individual characteristics and divisions. To investigate our predictions, we have estimated both OLS and type II Tobit model (models with sample selection biases)

4. Results

4.1. Frequency of WFH and productivity

First, we estimate equation (2) without control variables to observe how the frequency of WFH affects productivity. The results are shown in Table 3. The coefficient estimates of the difference in the number of days spent WFH (the WFH dummies for Company A) are significantly negative for all companies. In summary, the results indicate that workers who worked from home experienced declines in productivity compared with those who did not. This adverse effect was considerably large for Company D, which may have resulted from the fact that the survey was conducted in late April, two weeks after the declaration of the state of emergency. At that time, many employees were forced to work from home without full preparation, which may have temporarily resulted in a large decline in productivity.

Table 4 shows the full model including other explanatory variables(equation 4). For Company B, the first difference of the WFH days becomes statistically insignificant. On the other hand, although the magnitude of the estimates decreases, the frequency of WFH still negatively affects productivity for Company D even after controlling for various individual and job characteristics. Note that the level of WFH dummies are negative for both Companies B and D. As for Company C, the magnitude of the first difference becomes even larger. However, the WFH dummy of 5 days is positive and statistically significant. We will reconsider this in the subsample analysis below.

The full model offers another causal parameter worth mentioning. The productivity losses are greater for employees in their 30s, 40s, and 50s in Companies A, C, and D. Young workers are not significantly affected by the shift to WFH presumably because (1) they are more familiar with online communication and recent information technology than their older counterparts and (2) they are assigned more specialized or solo tasks requiring less coordination; thus, their productivity is less constrained by WFH. These results may provide evidence that, on average, employees experienced declines in productivity from WFH. Below, we investigate what factors caused such declines in productivity.

4.2. Causes of productivity losses

To identify the causes underlying the productivity losses, we add as explanatory variables the responses to the question of what factors the respondents perceived as causing their productivity

to decline.[7] Here, the sample is restricted to those who worked from home at least one day per week after the state of emergency. Any factors that are strongly correlated with productivity losses should be the main mechanism underlying the drop in productivity. Table 5 reveals two important common channels. First, "*poor WFH setups*" have a significantly negative coefficients for all companies, and "*the inability to retrieve data from outside the office*" is also negatively correlated with changes in productivity for Companies A and B. These results indicate that the lack of sufficient infrastructure for WFH hinders employee performance. Second, *"poor workplace communication" and "poor communication with clients"* are significantly negative for almost all companies. This result implies that new communication applications such as social networking services (SNSs), chat apps and conference calls cannot easily replace traditional communication methods such as face-to-face communication or phones and their role in meeting spontaneous, simultaneous or urgent needs for communication. The significance of the coefficients of the other variables varies across companies. We shall also note that "having responsibilities (childcare and/or nursing care)" is also negative and statistically significant for Companies A and C. During the state of emergency in April to May, a number of children did not attend school because of closures. Also, many daycare centers for elders have closed in order to avoid cluster infection of COVID-19. Those closures have caused temporary loss of productivity for workers who needed to take care of their family members while working from home.

Tthe first difference of WFH days and the WFH dummies become either statistically insignificant or at least their magnitude becomes small when we control for the causes. These results imply that WFH per se does not necessarily deteriorate workers' productivity and that declines in productivity while WFH can be ameliorated by addressing those undesirable factors. In particular, the infrastructure for WFH can be relatively easily improved by appropriate IT investment or by financial support provided by companies to their employees to establish a better work environment at home. In the long run, further technological development of IT security and communication devices and learning by doing among workers will help find efficient ways to communicate within and across companies.

[7] For Company D, slightly different wording was used for some questions, but what was being asked was essentially the same. However, a few questions were not available. Accordingly, "*the inability to retrieve data*" and "*having responsibilities (childcare and/or nursing care)*" are missing for Company D.

To deal with sample selection bias, we also estimated type II Tobit models (the maximum likelihood estimator and Heckman's two-step estimator) to address potential selection into WFH as a robustness check. The estimation results did not provide evidence of selection bias and were qualitatively the same as the OLS estimation results.

4.3. Subsample analysis of causes

We now take a closer look at the causes of productivity losses by conducting subsample analysis. We divide the sample into four based on functional roles, i.e., corporate, sales, R&D, and production, and we estimate the model presented in Section 4.3. Tables 6-9 present the main results. Once again, the factor that is fairly common to all four functional roles is "*poor WFH setups*," the coefficient estimates are significantly negative for most cases. Apparently, it may be more important for corporate and R&D jobs since the estimates are all significant, except in the case of Company A, where the estimates are significant only at the 10% level.

Now, we turn to the specificity of each functional role. For corporate jobs and sales jobs, "*poor workplace communication*" and "*poor communication with clients*" have significantly negative effects on productivity across companies, which is consistent with the intuition that corporate jobs and sales jobs intensively involve engagement in coordination and organization both within and outside the company. This result is reasonable considering the nature of the tasks undertaken by employees who hold these roles. For sales jobs and R&D jobs, the coefficient estimate for "*the inability to retrieve data*" is significantly negative for Companies A and B, and the coefficient estimate for "*the inability to use exclusive equipment*" is significantly negative for Companies A and C. Once again, these results are reasonable since workers engaged in R&D tend to engage with confidential information such as patents. For production jobs, the estimate for "*poor workplace communication*" is significantly negative, except in the case of Company B, and this result is also fairly consistent with the duties and tasks of workers holding such jobs.

Across functional roles, there is a common factor of productivity losses, i.e., "*poor WFH setups*," which calls for comprehensive support for all occupations to improve the WFH conditions that employees face. In addition, our results indicate that the most important factor in improving WFH productivity differs by occupation, suggesting that employers should recognize that the optimal investment priorities may differ across occupations.

4.4. Frequency of WFH and mental health

We next study the relationship between mental health and WFH by estimating equation (1). Table 10 shows the results obtained from the regression of $mental\_health_i$ on $wfh2d_i, wfh4d_i$, and $wfh5d_i$, controlling for individual and job characteristics. Overall, employees' mental health seems to have a positive association with the frequency of WFH.[8] As one caveat, unlike the estimates for presenteeism, which were based on two time points, the evidence may be too weak to establish a causal relationship since the dependent variable is simply cross-sectional. It may be the case that more specialized jobs allow more frequent WFH and job autonomy, which help to maintain good mental health, causing a spurious correlation between the two. Notably, however, even when we estimate sample selection models, we confirmed that the results are qualitatively the same, implying that selection is presumably innocuous after controlling for the respondents' job grades, divisions, and occupations.

4.5. Benefits of WFH

To identify what factors contribute to improvements in mental health, we estimate equation (1), adding as explanatory variables the responses to the question of what factors the respondents perceived as advantages of WFH and restricting the sample to those who worked from home after the state of emergency.[9] The factors that have a strong association with better mental health, conditional on individual and job characteristics, should be the main benefits of WFH. Two potential benefits emerge from the results shown in Table 11. First, the coefficient of "*facilitates a greater focus on work*" is significantly positive across companies. Second, "*less fatigue and having a healthier condition*" and "*zero commuting and saving time*" are significantly associated with better mental health for Companies C and D, although a similar pattern cannot be observed for Company B. Notably, "*having extra time for sleep and rest*" is significant for Company D. These results suggest that WFH eliminates the need to commute to work, which can be stressful for employees, and in this regard, time savings also enable employees to gain extra health benefits

[8] Our mental health score calculated from correspondence analysis is highly correlated with the simple sum of the total Likert-based scales (the correlation coefficient is approximately 0.95 across firms). We also confirmed that even when we use the Likert-based scores, our regression results remain qualitatively the same.
[9] Notably, we estimated a sample selection model for mental health, but the evidence of selection bias was weak, and the estimates remained substantially identical.

such as additional sleep and rest. Additionally, due to fewer interruptions that would normally occur at the workplace, WFH allows for a quieter environment that can facilitate a greater focus on work. Although undesirable aspects of WFH are oftentimes emphasized by business practitioners, WFH may improve productivity by improving employees' health and well-being.

This benefit due to the longer rest period enabled by WFH should have the same impact as shorter working hours. In fact, in the literature, there is some evidence of the benefits of shorter working hours. Using data on women working in manufacturing plants to produce artillery shells for the British military during the First World War, Pencavel [27] found that the hours-productivity profile exhibits a concave, nonmonotonic shape, implying that having a longer rest period could improve productivity when workers work excessive hours. Similarly, using single-company data on Japanese construction design projects, Shangguan et al. [28] showed that team productivity and the quality of work improved when working hours were reduced during the great recession.

5. Concluding remarks

Using unique data retrieved from our original survey conducted in cooperation with four manufacturing companies in Japan, we investigated the determinants of the quality of WFH under the COVID-19 pandemic. Specifically, we examined the effects of WFH on employees' productivity and mental health. Using employee survey data with high response rates, we identified the effects of WFH on productivity and mental health within the same company and within the same occupation. Focusing on specific companies also allowed us to exclude the differences in productivity among firms.

We present four findings. First, we confirmed that frequent WFH is associated with decreased productivity. In our interpretation, most workers experienced declines in productivity, probably due to their inadequate preparation for WFH under the sudden shock of the pandemic.

Second, to confirm our interpretation, we identified the possible factors of productivity losses during pandemic-driven WFH. Our estimation results suggest that the major contributors to deteriorations in productivity are poor WFH setups and poor communication at the workplace and with clients. These results imply that companies may enhance employees' productivity by investing in their WFH setups at home and communication tools.

Third, we also examined the heterogeneity across types of jobs. We categorized occupational categories into four functional roles, i.e., corporate, sales, R&D, and production. We

have found that poor WFH setups are one of the major causes of productivity losses across the four occupation types. However, there are also several important causes that are specific to certain occupations. For corporate jobs and sales jobs, poor workplace communication and poor communication with clients seem to be the most crucial. For sales and R&D jobs, the lack of access to crucial information and exclusive equipment appear to contribute to productivity losses. Our findings provide managerial implications that are useful for designing desirable investments to improve employees' productivity while WFH.

Fourth, our results show that WFH is associated with better employee mental health. Our regression results suggest that workers benefit from a greater focus on work with a quieter environment, less fatigue, and additional time for sleep and rest as a result of the time saved by cutting commuting time. While more emphasis tends to be placed on the drawbacks of WFH, our result suggests that WFH may improve productivity by improving employees' health and well-being. To that end, let us introduce the answers to the question regarding WFH used in the Company A surveys. The question asked, "*(a)fter the situation returns to normal, how often do you prefer to work from home?"* Among 1,381 employees who worked from home, only 7.2% answered "none," while 52.3% and 22.0% answered "1-2 days per week" and "3 days or more per week," respectively. These results suggest that these workers might have realized the advantages of WFH, and they are in line with the results of Eurofound's questionnaire survey ([3]) conducted with workers in EU member states. When asked for their WFH preference if there were no COVID-19 restrictions, 32% of all respondents expressed a wish to work from home a few days a week, 13% indicated that they would like to work from home every day, and only 22% of the respondents did not wish to work from home. The WFH style may take root around the world as a new working style.

Under these circumstances, companies should not dismiss remote working out of hand as a work arrangement option because of lower productivity compared with in-office work. Rather, they need to conduct a detailed analysis of the causes of the productivity gap, make the infrastructure improvements that are necessary for increasing WFH productivity, and send a clear message from top management that WFH can be a productivity booster.[10] Such changes will create

[10] For example, Fujitsu announced that it would allow their employees to freely choose where they work, and reduce the floor area of existing offices in Japan by 50% by 2023. The company instead provide a monthly payment of 5,000 yen as a subsidy for environment maintenance costs for working from home. This decision saves a large costs of office

opportunities for people who have been unable to work full-time or work as regular employees—that is, employees who are supposed to be willing to make business trips or accept workplace transfers—because of time constraints resulting from life circumstances, such as having to raise children or care for elderly individuals or individuals suffering from illness or a disability. In a way, WFH may be an option that can be used to take full advantage of the workforce's talents that could be wasted without such arrangement.

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Table 1. The proportion of workers working from home

	Company A	Company B	Company C	Company D
Sample	All employees	All employees (incl. subsidiaries)	All employees (excl. production line workers)	All employees (incl. subsidiaries)
Reference period	From April 1 to the date of reponse	From May 11 to the date of reponse	From May 11 to the date of reponse	From April 8 to the date of reponse
Survey period	May 20-26	May 20-June 3	June 17-26	April 23-May 7
Days spend WFH per week (%)				
5 days	8.1	22.5	18.4	21.2
3-4 days	14.9	9.9	31.4	17.0
1-2 days	25.0	19.6	41.0	18.7
None	52.0	48.0	9.2	43.1
Number of Observations	2877	3458	3989	12941
% of those who worked from home in early March	NA	35.2	20.1	10.7

Table 2. Descriptive statistics

	Company A		Company B		Company C		Company D	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
prsnt_dif (presenteeism change)	-0.241	1.240	0.012	1.863	-0.776	1.540	-0.812	2.539
mental_health (mental health)	-	-	-0.001	1.000	0.000	1.000	0.000	1.000
wfh_dif (WFH frequency change)	-	-	0.775	1.654	1.893	2.445	1.574	2.135
wfh_5d (5 WFH days per week)	0.081	0.272	0.225	0.418	0.184	0.388	0.212	0.409
wfh_4d (3-4 WFH days per week)	0.149	0.357	0.099	0.299	0.314	0.464	0.170	0.375
wfh_2d (1-2 WFH days per week)	0.250	0.433	0.196	0.397	0.410	0.492	0.187	0.390
wfh_bf (at least one WFH day in March)	-	-	0.352	0.478	0.201	0.401	0.107	0.310
Perceived factors of productivity loss								
Inability to retrieve data	0.190	0.393	0.331	0.471	0.307	0.461	-	-
Inability to use exclusive equipment	0.207	0.405	0.408	0.492	0.498	0.500	-	-
Poor WFH setups	0.080	0.272	0.276	0.447	0.364	0.481	0.381	0.486
Lack of support and/or instruction from the supervisor	0.019	0.136	0.117	0.321	0.203	0.402	-	-
Poor workplace communication	0.115	0.319	0.448	0.497	0.584	0.493	0.443	0.497
Poor communication with clients	0.140	0.348	0.292	0.455	0.248	0.432	0.351	0.477
Fatigue from an excessive workload	0.012	0.107	0.090	0.286	0.092	0.289	-	-
Not feeling well physically	0.029	0.168	0.281	0.450	0.216	0.412	0.496	0.500
Feeling mentally under the weather	0.020	0.139	0.103	0.304	0.113	0.317	0.106	0.307
Having responsiblities (childcare and/or nursing care)	0.030	0.172	0.109	0.311	0.107	0.310	-	-
Miscellaneous	0.031	0.174	0.198	0.399	0.111	0.315	-	-
Perceived advantages of WFH								
Facilitates a greater focus on work	-	-	0.327	0.469	0.302	0.459	0.247	0.431
Can avoid unnecessary communication	-	-	0.206	0.404	0.206	0.404	0.246	0.431
Free from annoying relationship	-	-	0.268	0.443	0.258	0.438	-	-
Improvement in IT skills	-	-	0.090	0.286	0.120	0.324	0.193	0.395

Zero commuting and saving time	-	-	0.806	0.395	0.841	0.366	0.775	0.417
Being able to wear casual clothes	-	-	0.581	0.493	0.560	0.496	0.561	0.496
Less fatigue and having a healthier condition	-	-	0.114	0.317	0.129	0.335	0.131	0.338
Eating healthier meals	-	-	0.128	0.334	0.094	0.291	0.150	0.357
Spending more time exercising	-	-	0.048	0.214	0.060	0.237	0.055	0.227
Reducing alcohol consumption	-	-	0.052	0.222	0.024	0.154	0.056	0.229
Having extra time for sleep and rest	-	-	0.245	0.430	0.351	0.477	0.275	0.447
Less smoking	-	-	0.013	0.114	0.011	0.105	0.023	0.149
Having extra time with family and friends	-	-	0.252	0.434	0.251	0.434	0.299	0.458
Able to fit in household chores	-	-	0.161	0.367	0.177	0.382	0.164	0.370
Better family relationship	-	-	0.105	0.307	0.091	0.288	0.099	0.299
Finding new hobbies	-	-	0.072	0.258	0.080	0.271	0.068	0.251
Functional roles								
corporate function	0.379	0.485	0.271	0.445	0.151	0.358	0.260	0.438
sales	0.220	0.414	0.116	0.320	0.132	0.338	0.265	0.441
R&D	0.186	0.389	0.246	0.431	0.408	0.492	0.166	0.372
production	0.214	0.411	0.366	0.482	0.310	0.462	0.099	0.299
Age dummies (The base category is those under 30)								
age30 (30-39 years old)	0.229	0.421	0.216	0.412	0.259	0.438	0.190	0.392
age40 (40-49 years old)	0.277	0.447	0.311	0.463	0.261	0.439	0.311	0.463
age50 (50-59 years old)	0.314	0.464	0.314	0.464	0.247	0.431	0.275	0.447
age60 (60+ years old)	0.070	0.254	0.046	0.209	0.066	0.249	0.056	0.231
female dummy	0.139	0.346	0.189	0.392	0.147	0.354	0.208	0.406

Note: The number of observations vary across sets of variables. For Company A, the number of observations is 2877 for presenteeism change, WFH frequency dummies, age, and gender, 1381 and 2868 for perceived factors of productivity loss and functional role dummies, respectively. For Company B, the number of observations is 3749 for presenteeism change, 3498 for mental health, 3453 for WFH frequency change, 3458 for WFH frequency dummies, 3558 for the WFH in March dummy, 1833 for perceived factors of productivity loss, 1813 for percieved advantages of WFH, 3117 for functional roles, 3132 for age, and 3133 for gender. For Company C, the number of observations is 4032 for functional roles, and age, 3989 for WFH frequency change and WFH frequency dummies, 3622 for preceived factors of productivity loss and perceived advatnages of WFH, 3980 for gender. For Company D, the number of observations is 11497 for presenteeism change, 13281 for mental health, functional roles, and age, 12426 for WFH frequency change, 12941 for WFH frequency dummies, 12572 for the WFH in March dummy, 7216 for perceived factors of productivity loss, 4782 for perceived advantages of WFH, 13189 for gender.

Table 3. Regression of productivity changes on WFH

	Company A	Company B	Company C	Company D
	prsnt_dif			
wfh_5d	-0.321***	-	-	-
	(0.104)	-	-	-
wfh_4d	-0.597***	-	-	-
	(0.0956)	-	-	-
wfh_2d	-0.400***	-	-	-
	(0.0653)	-	-	-
wfh_dif	-	-0.0811***	-0.0350***	-0.249***
	-	(0.0245)	(0.0100)	(0.0349)
Constant	-0.0304	0.0517	-0.711***	-0.413***
	(0.0380)	(0.0400)	(0.0472)	(0.141)
Divisions	No	No	No	No
Job grades	No	No	No	No
Observations	2,798	3,404	3,989	10,753
R-squared	0.037	0.005	0.003	0.044

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Regression of productivity changes on WFH with controls

	Company A	Company B	Company C	Company D
	prsnt_dif			
wfh_5d	-0.227*	-0.369***	0.437**	-0.963***
	(0.134)	(0.123)	(0.174)	(0.249)
wfh_4d	-0.457***	-0.396**	0.107	-1.152***
	(0.109)	(0.157)	(0.143)	(0.192)
wfh_2d	-0.337***	-0.169	-0.0453	-0.906***
	(0.0878)	(0.125)	(0.0980)	(0.149)
wfh_dif	-	-0.00550	-0.0861***	-0.0507**
	-	(0.0308)	(0.0183)	(0.0196)
female	0.0134	-0.0202	0.126	0.268***
	(0.0619)	(0.0842)	(0.0862)	(0.0694)
age30	-0.239**	-0.141	-0.325***	-0.241***
	(0.0926)	(0.123)	(0.0902)	(0.0635)
age40	-0.248***	0.0764	-0.193**	-0.404***
	(0.0791)	(0.122)	(0.0937)	(0.0774)
age50	-0.228**	0.0520	-0.118	-0.413***
	(0.0837)	(0.106)	(0.110)	(0.0871)
age60	-0.278	-0.144	0.0309	-0.629***
	(0.176)	(0.134)	(0.107)	(0.166)
Constant	-0.0691	-0.0560	-0.552***	3.428***
	(0.149)	(0.157)	(0.125)	(0.193)
Divisions	Yes	Yes	Yes	Yes
Job grades	Yes	Yes	Yes	Yes
Observations	2,798	2,827	3,720	10,690
R-squared	0.065	0.038	0.067	0.157

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Regression of productivity changes on the perceived factors of productivity losses

	Company A	Company B	Company C	Company D
	prsnt_dif			
wfh_5d	0.150	-0.259	0.378***	0.0249
	(0.147)	(0.152)	(0.116)	(0.101)
wfh_4d	0.0819	-0.242	0.118	-0.170
	(0.0586)	(0.159)	(0.0758)	(0.103)
wfh_dif	-	0.0148	-0.0748***	-0.0597***
	-	(0.0315)	(0.0183)	(0.0202)
Inability to retrieve data	-0.459***	-0.341***	-0.0596	-
	(0.157)	(0.0694)	(0.0557)	-
Inability to use exclusive equipment	-0.589***	-0.0787	-0.168***	-
	(0.0975)	(0.116)	(0.0560)	-
Poor WFH setups	-0.536***	-0.506***	-0.415***	-0.641***
	(0.162)	(0.0585)	(0.0590)	(0.0767)
Lack of support and/or instruction from the supervisor	-0.144	-0.256	-0.0553	-
	(0.274)	(0.195)	(0.0660)	-
Poor workplace communication	-0.503***	-0.0906	-0.387***	-0.148**
	(0.136)	(0.0950)	(0.0504)	(0.0610)
Poor communication with clients	-1.028***	-0.382***	-0.114*	-0.517***
	(0.101)	(0.0964)	(0.0685)	(0.0961)
Fatigue from an excessive workload	-0.717	0.444***	0.0449	-
	(0.604)	(0.140)	(0.0992)	-
Not feeling well physically	-0.111	0.174*	-0.0480	0.334***
	(0.241)	(0.0965)	(0.0682)	(0.0530)
Feeling mentally under the weather	-0.306	-0.372***	-0.0949	0.276***
	(0.316)	(0.109)	(0.0937)	(0.102)
Having responsiblities (childcare and/or nursing care)	-0.985***	0.414	-0.284***	-
	(0.335)	(0.324)	(0.0906)	-
Miscellaneous	0.388	-0.570***	-0.402***	-
	(0.320)	(0.194)	(0.0918)	-
female	0.0278	-0.110	0.0833	0.129*
	(0.0672)	(0.127)	(0.0811)	(0.0703)
age30	-0.207*	-0.299***	-0.202**	-0.271**
	(0.116)	(0.0988)	(0.0931)	(0.105)
age40	-0.166	-0.187*	-0.0610	-0.528***
	(0.0990)	(0.107)	(0.0953)	(0.112)
age50	-0.243**	-0.305**	0.00719	-0.611***
	(0.0893)	(0.115)	(0.105)	(0.112)
age60	-0.248	-0.374**	0.147	-0.727***
	(0.184)	(0.169)	(0.116)	(0.146)
Constant	0.564***	0.339**	-0.212*	1.252***
	(0.167)	(0.153)	(0.112)	(0.160)
Divisions	Yes	Yes	Yes	Yes
Job grades	Yes	Yes	Yes	Yes
Observations	1,352	1,517	3,376	6,071
R-squared	0.354	0.090	0.122	0.120

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6. Subsample analysis (corporate)

	Company A	Company B	Company C	Company D
	prsnt_dif			
Inability to retrieve data	0.211	-0.267	-0.144	-
	(0.203)	(0.198)	(0.157)	-
Inability to use exclusive equipment	-0.765***	-0.0780	0.0972	-
	(0.116)	(0.182)	(0.166)	-
Poor WFH setups	-0.686*	-0.412***	-0.378**	-0.776***
	(0.366)	(0.141)	(0.141)	(0.127)
Lack of support and/or instruction from the supervisor	0.306	-0.214	-0.147	-
	(0.411)	(0.208)	(0.219)	-
Poor workplace communication	-0.780***	-0.298	-0.314***	-0.364***
	(0.135)	(0.173)	(0.0992)	(0.133)
Poor communication with clients	-1.100***	-0.321*	-0.168	-0.493***
	(0.205)	(0.184)	(0.133)	(0.162)
Controls	Yes	Yes	Yes	Yes
Observations	402	579	522	1,621
R-squared	0.334	0.140	0.147	0.166

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The controls include the difference of WFH, dummies for the WFH frequency after the state of emergency, other perceived factors, gender, age, job grades, divisions, and functional roles.

Table 7. Subsample analysis (sales)

	Company A	Company B	Company C	Company D
	prsnt_dif			
Inability to retrieve data	-0.590***	-0.478*	0.170	-
	(0.194)	(0.247)	(0.172)	-
Inability to use exclusive equipment	-0.588***	0.00242	-0.197	-
	(0.165)	(0.525)	(0.126)	-
Poor WFH setups	-0.399*	-0.474***	-0.290	-0.394***
	(0.206)	(0.105)	(0.198)	(0.118)
Lack of support and/or instruction from the supervisor	-0.556	-0.707**	0.127	-
	(0.621)	(0.258)	(0.118)	-
Poor workplace communication	-0.180	-0.159***	-0.422**	-0.0528
	(0.244)	(0.0445)	(0.159)	(0.134)
Poor communication with clients	-1.022***	-0.385	-0.301**	-0.482***
	(0.0979)	(0.233)	(0.119)	(0.136)
Controls	Yes	Yes	Yes	Yes
Observations	444	320	468	1,536
R-squared	0.456	0.207	0.103	0.187

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The controls include the difference of WFH, dummies for the WFH frequency after the state of emergency, other perceived factors, gender, age, job grades, divisions, and functional roles.

Table 8. Subsample analysis (R&D)

	Company A	Company B	Company C	Company D
	prsnt_dif			
Inability to retrieve data	-0.925***	-0.516***	-0.108	-
	(0.153)	(0.123)	(0.0872)	-
Inability to use exclusive equipment	-0.501*	0.0137	-0.186**	-
	(0.265)	(0.205)	(0.0793)	-
Poor WFH setups	-0.645*	-0.589***	-0.524***	-0.638***
	(0.295)	(0.151)	(0.0935)	(0.186)
Lack of support and/or instruction from the supervisor	-0.575**	0.0617	-0.0519	-
	(0.235)	(0.433)	(0.126)	-
Poor workplace communication	-0.0500	0.0144	-0.353***	-0.230
	(0.292)	(0.178)	(0.0808)	(0.139)
Poor communication with clients	-1.676***	-0.541	-0.108	-0.0372
	(0.510)	(0.415)	(0.130)	(0.106)
Controls	Yes	Yes	Yes	Yes
Observations	387	342	1,427	1,186
R-squared	0.479	0.136	0.123	0.131

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The controls include the difference of WFH, dummies for the WFH frequency after the state of emergency, other perceived factors, gender, age, job grades, divisions, and functional roles.

Table 9. Subsample analysis (production)

	Company A	Company B	Company C	Company D
	prsnt_dif			
Inability to retrieve data	-0.581***	-0.294	-0.0217	-
	(0.175)	(0.235)	(0.0849)	-
Inability to use exclusive equipment	-0.464	-0.149	-0.286***	-
	(0.641)	(0.164)	(0.0998)	-
Poor WFH setups	-1.617***	-0.579*	-0.325***	-0.822**
	(0.260)	(0.305)	(0.0835)	(0.404)
Lack of support and/or instruction from the supervisor	0.279	-0.205	-0.0777	-
	(0.721)	(0.481)	(0.0820)	-
Poor workplace communication	-1.082***	0.422	-0.438***	-1.106**
	(0.288)	(0.268)	(0.0901)	(0.529)
Poor communication with clients	-0.609	-0.190	-0.0428	0.167
	(0.420)	(0.353)	(0.120)	(0.589)
Controls	Yes	Yes	Yes	Yes
Observations	115	271	959	162
R-squared	0.523	0.150	0.114	0.437

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The controls include the difference of WFH, dummies for the WFH frequency after the state of emergency, other perceived factors, gender, age, job grades, divisions, and functional roles.

Table 10. Regression of mental health on WFH frequency

	Company B	Company C	Company D
	mental_health		
wfh_5d	0.171*	0.196**	0.109***
	(0.0842)	(0.0748)	(0.0324)
wfh_4d	0.0950	0.125**	0.169***
	(0.0624)	(0.0615)	(0.0318)
wfh_2d	0.0669	0.0652	0.0877***
	(0.0412)	(0.0574)	(0.0267)
wfh_bf	0.0205	0.00883	-0.0933***
	(0.0473)	(0.0411)	(0.0265)
female	-0.0107	0.154***	-0.190***
	(0.0624)	(0.0583)	(0.0262)
age30	-0.189***	0.122*	0.100***
	(0.0681)	(0.0617)	(0.0300)
age40	-0.0580	0.0746	0.161***
	(0.0827)	(0.0552)	(0.0325)
age50	0.0454	0.225***	0.229***
	(0.0597)	(0.0661)	(0.0335)
age60	0.452***	0.425***	0.524***
	(0.0548)	(0.0812)	(0.0501)
Sales	-0.0417	0.237***	-0.102***
	(0.0523)	(0.0304)	(0.0319)
R&D	-0.0333	-0.177***	0.00342
	(0.0557)	(0.0247)	(0.0265)
Production	-0.112	0.106***	-0.208***
	(0.0816)	(0.0378)	(0.0420)
Constant	0.0891	0.0375	-0.0492
	(0.0782)	(0.0946)	(0.0383)
Section	Yes	Yes	Yes
Job Grade	Yes	Yes	Yes
Observations	2,789	3,720	12,380
R-squared	0.065	0.065	0.066

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11. Regression of mental health on the perceived advantages of WFH

	Company B	Company C	Company D
		mental_health	
Facilitates a greater focus on work	0.135***	0.290***	0.240***
	(0.0366)	(0.0376)	(0.0309)
Can avoid unnecessary communication	-0.0721	-0.0160	0.0263
	(0.0606)	(0.0413)	(0.0319)
Free from annoying relationship	-0.260***	-0.206***	
	(0.0789)	(0.0437)	
Improvement in IT skills	-0.0860	0.0667	0.0436*
	(0.0588)	(0.0481)	(0.0261)
Zero commuting and saving time	0.0476	0.118**	0.106***
	(0.0473)	(0.0498)	(0.0286)
Being able to wear casual clothes	0.0442	0.0560*	-0.0317
	(0.0429)	(0.0323)	(0.0347)
Less fatigue and having a healthier condition	0.0529	0.323***	0.228***
	(0.0906)	(0.0430)	(0.0428)
Eating healthier meals	0.0837	-0.0179	0.0452
	(0.0716)	(0.0603)	(0.0328)
Spending more time exercising	0.137	0.125**	0.0538
	(0.116)	(0.0597)	(0.0547)
Reducing alcohol consumption	0.0763	-0.0286	0.0108
	(0.0645)	(0.0976)	(0.0442)
Having extra time for sleep and rest	0.0725	0.0507	0.0835***
	(0.0999)	(0.0430)	(0.0247)
Less smoking	-0.145	0.00788	0.0193
	(0.102)	(0.178)	(0.0766)
Having extra time with family and friends	-0.0107	0.0542	0.0297
	(0.0619)	(0.0368)	(0.0291)
Able to fit in household chores	0.0829	0.0446	0.0394
	(0.0560)	(0.0476)	(0.0397)
Better family relationship	0.233***	0.0433	0.0447
	(0.0794)	(0.0649)	(0.0430)
Finding new hobbies	-0.0349	0.0511	0.0180
	(0.0695)	(0.0532)	(0.0484)
Sales	-0.0532	0.212***	-0.0346
	(0.0443)	(0.0452)	(0.0367)
R&D	-0.0592	0.0116	-0.0126
	(0.0549)	(0.0342)	(0.0363)
Production	-0.285***	0.139***	-0.155
	(0.0709)	(0.0465)	(0.137)
Controls	Yes	Yes	Yes
Observations	1,535	3,376	4,612
R-squared	0.108	0.120	0.106

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The controls include dummies for the WFH frequency after the state of emergency, a dummy for WFH experience in March, other perceived advantages, gender, age, job grades, and divisions.