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Productivity Dynamics of Work from Home since the Onset of the COVID-19 Pandemic: Evidence from a panel of firm surveys

MORIKAWA, Masayuki RIETI



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Productivity Dynamics of Work from Home since the Onset of the COVID-19 Pandemic: Evidence from a Panel of Firm Surveys

Masayuki Morikawa (RIETI and Hitotsubashi University)*

Abstract

This study documents the adoption, intensity, and productivity of work from home (WFH) practices since the onset of the COVID-19 pandemic using panel data from original firm surveys in Japan. According to the results, at the end of 2021, the ratio of WFH-adopting firms and the intensity of WFH decreased substantially compared to when the first state of emergency was declared in 2020. Second, although the mean productivity of WFH improved by a few percentage points, it is still approximately 20% lower than that at the usual workplaces. The firms' evaluation of remote workers' productivity at home is similar to the results obtained from a survey of employees engaged in WFH. Third, the majority of firms are planning to discontinue the WFH practice and revert to the conventional workstyle after the end of COVID-19, indicating that there is a large gap between firms' intentions and the desire of remote workers.

Keywords: COVID-19, working from home, productivity JEL Classification: D24, J24, J81, M12, M54

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1. Introduction

Following the onset of the COVID-19 pandemic, the number of firms and workers adopting work from home (WFH) or home-based remote work has increased substantially. In parallel, many studies have been conducted on WFH. Since WFH is an effective means of controlling the spread of infection and maintaining economic activity, many studies have indicated that the spread of WFH has mitigated its negative impact on GDP and unemployment (e.g., Eberly *et al.*, 2021; Hoshi *et al.*, 2021; Kawaguchi *et al.*, 2021).¹

Many studies have already been published on the trend in WFH practices during the COVID-19 pandemic, the characteristics of workers who perform WFH, and the effect of WFH on inequality in the labor market (e.g., Béland *et al.*, 2022; Bick *et al.*, 2020; Brynjolfsson *et al.*, 2020; Janys *et al.*, 2021).² In Japan, Kawaguchi and Motegi (2021), Morikawa (2022), and Okubo *et al.* (2021) are examples of such studies. Overall, these studies indicate that high-skill and high-wage white-collar workers tend to undertake WFH, and consequently, the diffusion of WFH after the COVID-19 pandemic has increased inequality in the labor market.

The effect of WFH in mitigating the trade-off between health and economic activity depends on the feasibility of WFH as well as its productivity. Although studies on the productivity of WFH during the COVID-19 pandemic are relatively scarce, Barrero *et al.* (2021), Etheridge *et al.* (2020), Kitagawa *et al.* (2021), and Morikawa (2022) are examples based on surveys of individual workers. As these studies cover a wide range of occupations, productivity measures are based on workers' self-assessments.³ Based on a survey in the United States, Barrero *et al.* (2021)

¹ Fujii and Nakata (2021) and Jones *et al.* (2021) are examples of using SIR-macro model to analyze the effects of telework on the tradeoff between output and infection.

² In the early phase of the pandemic, many studies use measures of teleworkability (share of jobs that can be done at home) instead of actual measure of telework to analyze the impact of WFH on labor markets (e.g., Dingel and Neiman, 2020; Kikuchi *et al.*, 2021).

³ Before the COVID-19 pandemic, some studies used objective productivity measure to analyze WFH productivity of specific occupations. Bloom *et al.* (2015), for example, presented evidence from a field experiment with call center employees in China that WFH enhanced the total factor productivity of workers and organizations. Battiston *et al.* (2021), exploiting a natural experiment with a public sector organization in the United Kingdom (the Greater Manchester Police), find that productivity is higher when teammates are in the same room, particularly for urgent and complex tasks and interpret that teleworking is unsuitable for tasks requiring face-to-face communication. Atkin *et al.* (2022), using smartphone data to measure face-to-face interaction between workers in Silicon Valley, indicate that face-to-face meetings significantly contribute to

document that most respondents who have adopted WFH practice report productivity equal to or higher than that on business premises. Etheridge *et al.* (2020), using survey data from the United Kingdom, reported that the mean productivity of WFH, on average, is no different from productivity at the usual workplace, although the productivity of WFH is quite heterogeneous by worker characteristics. Kitagawa *et al.* (2021), in a survey of employees from four large Japanese manufacturing firms indicated that for the majority of employees engaged in WFH, their productivity decreased relative to employees who did not use WFH. Morikawa (2022), using a survey of workers in Japan, reported that the mean WFH productivity relative to working in the usual workplace was approximately 60–70%. A rare example of using an objective productivity measure is Gibbs *et al.* (2021), who used the achievement rate of assigned tasks, divided by working hours as the measure of productivity, and reported that the measured productivity decreased by about 20% in a large IT firm in Asia. In summary, studies on the productivity of WFH after the onset of the COVID-19 pandemic using worker-level data have produced very different results.

Bartik *et al.* (2020) and Morikawa (2022) are two examples of studies using firm surveys. Bartik *et al.* (2020) reported that on average, WFH reduced productivity by approximately 20%, based on a survey of small and medium-sized businesses in the United States. Morikawa (2022) indicated that among Japanese firms, the mean productivity of WFH is about 68% of the productivity in their usual workplace. However, both surveys were conducted in the first half of 2020, and WFH productivity may have changed through learning effects and related investments as the COVID-19 pandemic become prolonged.

Analyzing the productivity dynamics of this workstyle using panel data is useful to evaluate the efficacy of WFH. Morikawa (2021) used panel data of workers in 2020 and 2021 to analyze changes in the adoption, frequency, and subjective productivity of WFH in Japan. According to the results, the mean productivity of WFH is still approximately 20% lower than that of the workplace; however, it has improved by more than ten percentage points in one year. The selection effect of returning to the workplace for those with low productivity at home and the improvement in productivity of WFH through the learning effect contributed almost equally to productivity improvement at the aggregate level.

This study presents evidence of the adoption, intensity, and productivity of WFH at the firm level since the onset of the COVID-19 pandemic. This study contributes to the research field by documenting the productivity dynamics of WFH during the COVID-19 pandemic using panel data constructed from original firm surveys in Japan. Secondly, it clarifies the similarities and differences in WFH between employers and workers by comparing firm level observations with

knowledge flows between workers.

those obtained from employee surveys.

This study finds that at the end of 2021, the ratio of WFH-adopting firms and the intensity of WFH decreased substantially compared to when the first state of emergency was declared in 2020. Second, although the mean productivity of WFH improved by a few percentage points, it was still approximately 20% lower than that at the usual workplaces. The firms' evaluation of remote workers' productivity at home is similar to the result obtained from a survey of employees engaged in WFH. Third, the majority of firms are planning to discontinue the WFH practice and revert to the conventional workstyle after the end of COVID-19, indicating that there is a large gap between firms' intentions and the desire of remote workers.

The remainder of this paper is organized as follows. Section 2 explains the survey design. Section 3 reports the results on the prevalence, frequency, and productivity of WFH as well as firms' views on WFH after the COVID-19 pandemic. Section 4 summarizes the conclusions and implications of the study.

2. Design of the firm survey

This study used data from the "Survey of Corporate Management and Economic Policy" (SCMEP), designed by the author of this paper, and conducted by the Research Institute of Economy, Trade, and Industry (RIETI) in 2020 and 2021.⁴ The sample firms of the SCMEP were selected from the registered list of the Basic Survey of the Japanese Business Structure and Activities (BSJBSA), an annual statistical survey conducted by the Ministry of Economy, Trade, and Industry (METI). Firms registered in the BSJBSA have at least 50 employees and a capital of at least 30 million yen. The SCMEP does not include small firms with fewer than 50 employees or capital of less than 30 million yen.

The 2020 SCMEP was conducted between August and September 2020. The 2020 SCMEP was sent to approximately 2,498 Japanese firms that responded to the SCMEP in early 2019.⁵ The responses from these firms for the 2020 SCMEP were 1,579. The questions on WFH asked about the situation in the early phase of the COVID-19 pandemic, when the government declared the first statement of emergency. The 2021 SCMEP was conducted from October to December 2021, immediately after the lifting of the fourth state of emergency. The 2021 SCMEP was sent to 15,000 firms, including firms that responded to the 2020 SCMEP with 3,194 firms responding to

⁴ The implementation of the SCMEP was contracted out from RIETI to the Tokyo Shoko Research, Ltd.

⁵ The SCMEP in 2019 was sent to 15,000 firms that operate in the manufacturing and service industries, which were randomly selected from the registered list of the BSJBSA.

the 2021 SCMEP, of which 961 responded to both the 2020 and 2021 surveys (hereinafter referred to as "panel firms").

The major survey questions related to WFH included adoption of WFH practices, percentage of workers using WFH, mean frequency of WFH per week, mean productivity of WFH workers relative to their productivity in the usual workplace (office), and firms' intention to continue WFH after the COVID-19 pandemic. The specific wording of the questions is explained in the next section. In addition, the SCMEP collects information about various firm characteristics, such as industry (manufacturing, information, and communications (I&C), wholesale, retail, services, and other industries), firm size (number of employees), composition of employees (female ratio, ratio of nonstandard employees, and ratio of employees with university education or higher), existence of labor unions, and location of the headquarters. The relationships between these firm characteristics and WFH practices were analyzed.

This study documents the overall changes in WFH practices during the COVID-19 pandemic by linking data from these two surveys and conducts simple regressions (OLS and probit estimations) to analyze the relationships between various firm characteristics and the adoption, frequency, and productivity of WFH practices. **Table 1** lists the major variables used in the regressions and their summary statistics.

3. Results

3.1. Adoption of work from home

The SCMEP asked whether the firm had adopted the WFH practice. The percentages of firms adopting WFH in the 2020 and 2021 surveys are summarized in **Table 2**. For all firms that responded to the survey, the percentage decreased by approximately 15%, from 49.5% in 2020 to 34.5% in 2021. When the sample was limited to panel firms that responded to the two surveys, the WFH adoption rate decreased from 47.0% to 28.8%. **Table 2** shows the WFH adoption rate of panel firms by industry. The adoption rate is very different by industry and decreases between 2020 and 2021 in every industry.

We can calculate the transition rate between WFH adoption and non-adoption for the sample of panel firms; 26.0% continue WFH practices, 50.4% do not adopt WFH continuously, 20.9% exit from WFH practices, and 2.7% newly adopted WFH practices. Firms reporting lower WFH productivity in the 2020 survey tend to become non-adopters in the 2021 survey; the mean WFH productivity of firms continue WFH and discontinue WFH in 2020 are 73.9 and 58.3, respectively, suggesting that a natural selection mechanism is functioning.

Table 3 presents the probit estimation results for the relationship between observable firm characteristics and WFH adoption. Manufacturing is the reference category for industry dummies. The characteristics of firms adopting WFH are essentially the same in the 2020 and 2021 surveys. Large firms, firms belonging to the information and communications industry, firms headquartered in densely populated prefectures, and firms with a high share of university or higher education employees are associated with a higher probability of adopting WFH. Whereas, the retail industry, and firms with a high share of nonstandard employees are less likely to adopt WFH.

Even if a firm adopts WFH practice, not all employees use this workstyle and the coverage of remote work differs by firm. The question regarding the coverage of WFH is "What has been the percentage of your employees working from home? Row A in **Table 4** shows the tabulation results. The mean percentage of employees engaged in WFH decreased from 30.7% in 2020 to 21.2% in 2021. When looking at the subsample of firms continuously adopting WFH practices, the coverage level is relatively high; however, decreases from 32.9% in 2020 to 24.8% in 2021. These figures suggest that many firms increased the share of employees working in their usual workplaces following the reduced risk of infection as well as the lifting of the state of emergency. When looking at the firms exiting WFH in 2021, the share of employees engaged in WFH was 20.0% in the 2020 survey, which is lower than that of firms continuously adopting WFH practices (32.9%). As previously stated, the number of firms newly adopting WFH practices in 2021 is small, and the coverage of employees engaged in WFH in 2021 is only 9.1%.

Table 5 reports OLS estimation results to explain the coverage of employees engaged in WFH by firm characteristics. Column (1) of this table is the result of the 2021 survey (the estimation result of the 2020 survey is presented in Column (1) of **Appendix Table A1**). Firm size, industry, location, the share of nonstandard employees, and the share of employees with university education or higher—these are associated with the adoption of WFH practice—have similar associations with the coverage of WFH. In other words, these firm characteristics are related to the employees' use of WFH through extensive and intensive margins.

Even if an employee uses WFH, they do not necessarily work at home every working day. The question on the mean frequency of WFH is "For those employees who are working from home, what is the number of days per week on average that they do so?" Row B of **Table 4** reports the tabulation results. The mean frequency decreased by 1.2 days, from 3.67 days in 2020 to 2.47 days in 2021. Even when limiting the sample to firms continuously adopting WFH practice, the mean frequency decreased about a day, from 3.87 in 2020 to 2.88 days in 2021. The results suggest that as the number of infections decreased, the state of emergency was lifted, and the government's request for WFH weakened, there was more room for firms to adjust the frequency to the optimal level, and as a result, even employees who engaged in WFH increased the number of days working at their workplaces. Column (2) of **Table 5** shows the OLS estimation result of

the 2021 survey to explain the WFH frequency by firm characteristics (the estimation result of the 2020 survey is presented in Column (2) of **Appendix Table A1**). Most of the observable firm characteristics are insignificant, and the overall explanatory power is very limited; however, the coefficient of the I&C industry is positive and highly significant, indicating that this industry is exceptionally remote work friendly.

By multiplying the coverage of WFH employees by the frequency of mean WFH (expressed as percentages), we can calculate "WFH intensity," which is the ratio of WFH hours to total working hours).⁶ The aggregate results are presented in Row C of **Table 4**. The WFH intensity decreased significantly from 23.7% in the 2020 survey to 10.8% in the 2021 survey. However, when limiting the sample to firms continuously adopting WFH practices, the reduction in WFH intensity is relatively small (from 33.1% to 22.2%) and the level of WFH intensity is relatively high even in the fourth quarter of 2021. The OLS estimation results to explain the WFH intensity in 2021 by firm characteristics is reported in Column (3) of **Table 5** (the estimation result of the 2020 survey is presented in Column (3) of **Appendix Table A1**). With the exception of firm size, the result is similar to the estimation of WFH adoption and coverage; the coefficients for industry, population density of the headquartered prefecture, the share of nonstandard employees, and the share of employees with university or higher education have statistically significant associations with WFH intensity.

The contribution of WFH hours to total labor input at the aggregate level can be calculated using the number of firms' employees as weight and including the WFH non-adopters whose WFH intensity is regarded as zero. Of course, this is a rough estimate because we have information on only the responded firms. **Table 6** presents the calculation results by industry; the results for all industries decreased from 18.1% in the 2020 survey to 7.4% in the 2021 survey.⁷ The figure of the I&C industry is the highest; however, even in this industry, the contribution of WFH decreased from 45.9% to 23.5%. The figure for the retail industry was the lowest at 5.1% from the beginning; however, in the 2021 survey, it has further dropped to 1.4%. This result confirms that industry characteristics have a strong influence on WFH use.

3.2. Productivity of work from home

⁶ The frequency of WFH expressed in percentage is calculated as dividing the mean weekly frequency of WFH by five. A small number of firms responded that the weekly frequency of WFH as six or seven days. In these cases, the frequency of WFH is treated as 100%.

⁷ The figures for the subsample of panel firms are not reported in the table, but the result is essentially the same with the whole responding firms.

The question on the productivity of WFH is firms' subjective evaluation of their remote workers' mean productivity at home relative to productivity at the office. The specific wording of the question is "If the productivity of your employees normally achieved in the workplace is 100, roughly how much is their productivity when working at home? Please respond with the average number for all tasks specified to be done from home." It should be noted that "if your employees are more productive at home than at the workplace, please write a number greater than 100."

Table 7 presents the tabulation results; the mean WFH productivity of firms adopting WFH practices improved by about four points from 68.3 in the 2020 survey to 72.2 in the 2021 survey. However, there is a large dispersion of firm evaluations; the standard deviation is 23.5 in 2020 and 25.3 in 2021. When limiting the sample to firms continuously using WFH practices, productivity improved by about 5.5 points from 73.9 in 2020 to 79.4 in 2021. Our interpretation is that the improvement in productivity of WFH continuing firms arises from the learning effect and redistribution of work within the firm, such as returning employees and/or tasks with relatively low productivity at home to the office.

However, since the figure shows productivity at home relative to the office (=100), the firms' mean evaluation of remote workers' productivity at home is still approximately 20% lower than the usual workplaces. When dividing the responses into WFH>office, WFH=office, and WFH<office, the percentage of firms that evaluated productivity at home as lower than the office was 92.3% in the 2020 survey and 83.5% in the 2021 survey. In the 2021 survey, the percentage of firms evaluating that there is no difference in productivity between home and office work increased, but the majority of firms rated WFH as less productive than office work. The results suggest that there are technical and institutional factors that reduce the efficiency of WFH and that face-to-face information exchange is still important, even if various online communication tools have become available.

Morikawa (2021), using panel data obtained from employee surveys, reports that WFH productivity relative to office productivity is 60.6 in 2020 and 77.5 in 2021 (see **Appendix Table A2**).⁸ When limiting the sample to employees continuously engaged in WFH, the figures are 70.4 in 2020 and 78.2 in 2021. Although Morikawa's (2021) employee survey is not linked to the firm survey of this study, the self-assessed productivity of WFH in 2021 is very close to each other.

When looking at the firms that adopted WFH practice in 2020 but exited from the practice in 2021, WFH productivity in 2020 was 58.3, which is far lower than that of firms continuously adopting WFH (73.9). This result suggests that firms evaluating WFH productivity as lower are selectively exited from WFH practices. The number of firms that did not adopt WFH practice in

⁸ The panel survey of employees reported in Morikawa (2021) was conducted in June 2020 and July 2021.

2020 and started WFH in 2021 is small; only 2.7% of firms that responded to the two surveys. The WFH productivity in 2021 is 64.8, which is lower than the figure for continuously adopting WFH (79.4). Therefore, new entrants have slightly reduced the mean WFH productivity by 2021.

Table 8 shows the OLS estimation results explaining WFH productivity based on firm characteristics. According to the results of the 2021 survey, large firms, firms in the I&C industry, firms headquartered in densely populated prefectures, and firms with a high share of employees with university or higher education tend to evaluate WFH productivity as higher.

3.3. Work from home after the COVID-19 pandemic

Finally, the survey asked about the firms' view of WFH after the pandemic. The specific question was, "How do you think the WFH practice after the COVID-19 pandemic subsides?" The three choices are "We will leverage WFH the same or more than when there was the impact of COVID-19," "We will continue to leverage WFH even after the end of COVID-19, but for fewer employees and/or fewer days," and "As a rule, we will return to working at the usual workplace as before COVID-19."

Table 9 presents the tabulation results; the percentage of firms that responded as "the same or more" increased slightly, from 12.9% in the 2020 survey to 15.6% in the 2021 survey.⁹ Even for the subsample of continuing WFH firms, the change is small (from 20.8% to 22.8%). In both the 2020 and 2021 surveys, the majority of firms chose "return to working at the usual workplace," and more than 30% of firms intend to reduce the coverage of employees and/or the WFH frequency. These figures indicate that a larger majority of Japanese firms intended to substantially reduce WFH once the COVID-19 pandemic subsided.

This is in sharp contrast to the findings from the employee survey reported by Morikawa (2021), which indicates that the percentage of remote workers who want to continue frequent WFH increased between 2020 and 2021, exceeding 60% by 2021 (see **Appendix Table A3**). The results suggest a non-pecuniary benefit (or amenity value) of WFH for remote workers. There is a large gap between employers and employees regarding the intention to use WFH practices after the COVID-19 pandemic. From the viewpoint of the balance between productivity and wages as well as the theory of compensating wage differentials, a decline in the relative wages of remote workers is expected. ¹⁰ However, it is extremely difficult to accurately evaluate the productivity of

⁹ According to an estimation of ordered-probit model to explain firms' view to continue WFH practice, high WFH intensity, and high WFH productivity firms, tend to have positive intention to continue frequent WFH after the COVID-19 pandemic.

¹⁰ In normal times before the COVID-19 pandemic, some studies indicate that remote work have

individual remote workers. Therefore, there will be serious conflicts between employers and employees regarding the use of WFH after the pandemic.

4. Conclusion

This study documents the adoption, intensity, and productivity of WFH since the onset of the COVID-19 pandemic in Japan, using panel data from original firm surveys. The focus is on the change in WFH practices over the past year. In addition, an important contribution is to compare the results from the firm survey with those reported from the employee survey.

The major findings are summarized as follows. First, at the end of 2021, both the ratio of WFHadopting firms and WFH intensity decreased substantially compared to when the first state of emergency was declared in 2020. Second, the mean productivity of WFH improved by a few percentage points through the learning effect, redistribution of tasks within firms, and the exit of low-WFH productivity firms from this practice. However, firms' evaluation of productivity at home is still about 20% lower than productivity at the usual workplace, which is quite similar to the results obtained from employee surveys. Third, the majority of firms are planning to discontinue the WFH practice and revert to the conventional workstyle after the end of the COVID-19 pandemic, indicating that there is a large gap between firms' intentions and the desire of remote workers.

It should be noted that this study depends on firms' subjective evaluations of remote workers' productivity at home, which is obviously not an objective measure. In addition, since the survey data used in this study are not employer-employee linked, the comparison with employee surveys is not a comparison within the same firms.

a negative impact on wages in the United States (Golden and Eddleston, 2020; Kouki and Sauer, 2022).

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Table 1. Summary statistics

	(1) 2020 survey			(2) 2021 survey		
	Nobs.	Mean	SD	Nobs.	Mean	SD
WFH adoption	1,579	0.495	0.500	3,123	0.345	0.476
WFH coverage	778	30.717	28.735	1,617	21.232	25.808
WFH frequency (weekly)	771	3.667	1.234	1,654	2.467	2.625
WFH intensity	759	0.305	0.289	1,540	0.188	0.250
WFH productivity	762	68.281	23.440	1,613	72.241	25.363
In Employees	1,561	4.973	0.879	3,018	5.041	0.964
In Population density	1,561	6.576	1.495	3,123	6.727	1.513
Ratio of female workers	1,561	0.311	0.196	3,018	0.317	0.201
Ratio of non-standard workers	1,552	0.234	0.240	2,976	0.243	0.245
Ratio of high education workers	1,547	0.318	0.249	2,663	0.350	0.266
Labor union	1,570	0.314	0.464	3,088	0.310	0.463

Note. Work from home: WFH.

Table 2. Percentage of firms adopting work from home

	2020 survey	2021 survey	Change
All firms	49.5%	34.5%	-14.9%
Panel firms	47.0%	28.8%	-18.2%
Manufacturing	42.6%	25.9%	-16.7%
Informations and communications (I&C)	94.0%	77.8%	-16.2%
Wholesale	59.4%	26.4%	-33.0%
Retail	30.6%	19.2%	-11.4%
Services	34.6%	25.9%	-8.6%
Other industries	63.3%	50.0%	-13.3%

Note: Panel firms respond to both the 2020 and 2021 surveys (N=961). Work from home: WFH.

	(1) 2020		(2) 2021
	Coef.	Robust SE	Coef.	Robust SE
In Employees	0.147	(0.024) ***	0.105	(0.013) ***
I&C	0.435	(0.066) ***	0.377	(0.054) ***
Wholesale	-0.024	(0.047)	-0.046	(0.028)
Retail	-0.224	(0.053) ***	-0.156	(0.030) ***
Services	-0.078	(0.056)	-0.029	(0.036)
Other industries	0.101	(0.092)	0.090	(0.059)
In Population density	0.098	(0.011) ***	0.088	(0.007) ***
Female ratio	0.095	(0.096)	0.070	(0.065)
Non-standard ratio	-0.249	(0.081) ***	-0.150	(0.057) ***
Ratio of university or higher	0.671	(0.084) ***	0.393	(0.045) ***
Labor union	-0.010	(0.036)	0.054	(0.024) **
Nobs.	1,320		2,582	
Pseudo R2	0.2221		0.2149	

Table 3. Characteristics of work from home adopting firms

Notes: The probit estimation results with robust standard errors are in parentheses. ***: p<0.01, **: p<0.05. Work from home: WFH.

Table 4. Means of coverage, frequency, and intensity of work from home

		2020 survey	2021 survey	Change
A. WFH coverage	All firms	30.7%	21.2%	-9.5%
	Panel firms	27.1%	18.5%	-8.6%
	Continuing WFH	32.9%	24.8%	-8.1%
B. WFH frequency	All firms	3.67	2.47	-1.20
(weekly)	Panel firms	3.72	2.61	-1.11
	Continuing WFH	3.87	2.88	-0.99
C. WFH intensity	All firms	23.7%	10.8%	-12.9%
	Panel firms	21.3%	9.6%	-11.7%
	Continuing WFH	33.1%	22.2%	-11.0%

Notes: WFH frequency is the mean WFH per week. At the firm level, the contribution of WFH hours to the total labor input is calculated as the WFH coverage multiplied by the frequency of WFH per week (converted into percentage). Work from home: WFH.

	(1) WF	H coverage	(2) WFI	H frequency	(3) WF	H intensity
In Employees	1.615	(0.686) **	-0.026	(0.046)	0.005	(0.004)
I&C	19.081	(2.740) ***	0.677	(0.179) ***	0.140	(0.019) ***
Wholesale	4.186	(1.750) **	0.059	(0.137)	0.016	(0.010)
Retail	-1.973	(2.310)	0.881	(1.119)	-0.014	(0.012)
Services	7.998	(2.564) ***	0.132	(0.171)	0.048	(0.015) ***
Other industries	12.623	(3.994) ***	0.074	(0.180)	0.061	(0.021) ***
In Population density	3.669	(0.419) ***	-0.051	(0.039)	0.019	(0.002) ***
Female ratio	0.136	(3.622)	-0.750	(0.714)	-0.005	(0.022)
Non-standard ratio	-9.206	(3.651) **	-0.234	(0.293)	-0.046	(0.024) **
Ratio of university or higher	25.171	(3.029) ***	-0.291	(0.318)	0.136	(0.018) ***
Labor union	-0.503	(1.334)	-0.291	(0.199)	-0.008	(0.007)
Cons.	-27.130	(4.197) ***	3.305	(0.503) ***	-0.128	(0.024) ***
Nobs.	1,341		1,371		1,327	
<u>R2</u>	0.2923		0.0142		0.2983	

Table 5. Firm characteristics and work from home intensity: Result from the 2021 survey

Notes: OLS estimations with robust standard errors are given in parentheses. ***: p < 0.01, **:

p<0.05. Work from home: WFH.

Table 6. Contribution of work from home to total working hours

	2020 survey	2021 survey
All industries	18.1%	7.4%
Manufacturing	19.9%	8.2%
I&C	45.9%	23.5%
Wholesale	20.0%	10.0%
Retail	5.1%	1.4%
Services	13.6%	8.6%
Other industries	34.7%	11.9%

Note: The percentages are the weighted average of the WFH intensity, which is calculated using the number of firms' employees as weight and including the WFH non-adopters (838 firms) whose WFH intensity is regarded as zero. Work from home: WFH.

		2020 survey	2021 survey	Change
All firms	Mean	68.3	72.2	4.0
	Std. Dev.	23.5	25.3	1.8
	WFH>Office	1.2%	1.5%	0.3%
	WFH=Office	6.6%	15.0%	8.4%
	WFH <office< td=""><td>92.3%</td><td>83.5%</td><td>-8.7%</td></office<>	92.3%	83.5%	-8.7%
Panel firms	Mean	66.9	70.8	3.9
	Std. Dev.	24.9	25.8	0.8
	WFH>Office	1.6%	1.6%	0.0%
	WFH=Office	5.9%	13.1%	7.1%
	WFH <office< td=""><td>92.4%</td><td>85.3%</td><td>-7.1%</td></office<>	92.4%	85.3%	-7.1%
Continuing WFH	Mean	73.9	79.4	5.5
	Std. Dev.	19.9	20.1	0.2
	WFH>Office	2.9%	2.9%	0.0%
	WFH=Office	8.6%	19.0%	10.4%
	WFH <office< td=""><td>88.5%</td><td>78.1%</td><td>-10.4%</td></office<>	88.5%	78.1%	-10.4%

Table 7. Productivity of work from home

Notes: Mean WFH productivity is a subjective assessment of employees' productivity at home relative to the office (=100). WFH>office, WFH=office, and WFH<office are percentages of firms. Work from home: WFH.

	(1)	2020	(2)	2021
In Employees	2.331	(0.985) **	2.941	(0.682) ***
I&C	11.918	(3.357) ***	8.979	(2.109) ***
Wholesale	-4.088	(2.845)	-5.671	(1.908) ***
Retail	-13.019	(4.964) ***	-5.407	(3.145) *
Services	-5.393	(3.910)	-7.857	(2.937) ***
Other industries	-1.325	(4.092)	-0.754	(3.736)
In Population density	1.365	(0.645) **	1.948	(0.473) ***
Female ratio	7.050	(6.161)	9.562	(4.895) *
Non-standard ratio	-1.607	(5.223)	-2.068	(3.828)
Ratio of university or higher	3.940	(4.268)	11.947	(2.851) ***
Labor union	-2.306	(2.225)	-0.583	(1.623)
Cons.	44.230	(6.431) ***	36.783	(4.647) ***
Nobs.	627		1,350	
R2	0.0631		0.0875	

Table 8. Firm characteristics and work from home productivity

Notes: OLS estimations with robust standard errors are given in parentheses. ***: p<0.01, **: p<0.05, *: p<0.10.

		(1) Same or more	(2) Continue WFH even	(3) As a rule,
		than when there	after the end of COVID-	return to the
		was the impact of	19, but for fewer people	workstyle as
		COVID-19	and/or fewer days	before COVID-19
WFH firms	2020	12.9%	35.3%	51.8%
	2021	15.6%	32.9%	51.5%
Panel firms	2020	13.4%	32.3%	54.3%
	2021	13.8%	29.8%	56.4%
WFH continuing firms	2020	20.8%	42.4%	36.8%
	2021	22.8%	46.3%	30.9%

Table 9. Firms' view on work from home after the COVID-19 pandemic

Notes: Panel firms correspond to the 2020 and 2021 surveys (N=961). Continuing WFH firms are those adopting WFH practices in the 2020 and 2021 surveys (N=250). Work from home: WFH.

Appendix tables

	(1) WF	H coverage	(2) WFI	H frequency	(3) WF	H intensity
In Employees	0.639	(1.110)	0.135	(0.053) **	0.012	(0.010)
I&C	28.517	(3.798) ***	0.487	(0.174) ***	0.288	(0.039) ***
Wholesale	9.418	(2.644) ***	-0.414	(0.138) ***	0.056	(0.023) **
Retail	-0.589	(4.196)	-0.451	(0.254) *	-0.023	(0.034)
Services	18.918	(4.149) ***	0.032	(0.189)	0.165	(0.037) ***
Other industries	23.847	(5.395) ***	-0.074	(0.253)	0.200	(0.048) ***
In Population density	5.299	(0.642) ***	-0.032	(0.033)	0.042	(0.006) ***
Female ratio	9.528	(6.096)	0.648	(0.330) *	0.094	(0.051) *
Non-standard ratio	-17.963	(4.717) ***	-0.273	(0.278)	-0.167	(0.042) ***
Ratio of university or higher	26.453	(4.576) ***	0.533	(0.231) **	0.226	(0.041) ***
Labor union	-1.751	(1.939)	-0.150	(0.117)	-0.021	(0.017)
Cons.	-27.937	(7.226) ***	2.983	(0.346) ***	-0.268	(0.063) ***
Nobs.	639		636		636	
R2	0.4294		0.0651		0.4228	

Table A1. Firm characteristics and work from home intensity: Results from the 2020 survey

Notes: OLS estimations with robust standard errors are given in parentheses. ***: p<0.01, **: p<0.05, *: p<0.10. Work from home: WFH.

Table A2. Work from home productivity: Employees' evaluation

	2020 survey	2021 survey	Change
All WFH employees	60.6	77.5	16.9
Panel respondents	61.4	76.6	15.2
Continuing WFH	70.4	78.2	7.8

Note: The figures are taken from Morikawa (2021). Work from home: WFH.

Table A3. Employees' Desire to continue work from home after the COVID-19 pandemic

	2020 survey	2021 survey
1) I want to do WFH as frequently as I do now.	38.1%	62.6%
2) I want to do WFH, although less frequently than now.	36.6%	26.5%
3) I want to work at my workplace instead of WFH.	25.2%	10.9%
Nobs.	876	1,012

Note: The figures are taken from Morikawa (2021). Work from home: WFH.