Why hasty adoption of telework stick? Evidence from firms' digitalization

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Abstract

The pandemic, from 2020, was expected to be a catalyst for telework to permeate. Our study empirically examines the relationship between a firm's digitalization and telework stickiness, utilizing the unique data from our firm survey conducted in Osaka, Japan. Our results show amongst the four digital technologies, online sharing of internal information impacts tele-work stickiness. This tendency is also true for firms that hastily adopted tel-ework after the pandemic.

JEL classification: D22, M20, O33

Keywords: Telework stickiness; Digitalization; COVID-19

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コロナ禍により急遽導入されたテレワークの定着理由：企業のデジタル化に関する実証

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要約

2020 年からのコロナ禍は、テレワーク浸透のきっかけになると期待されていた。本研究では、大阪府で実施した企業アンケートのデータを用いて、企業のデジタル化とテレワーク定着の関係性を実証的に検証した。結果として、４つのデジタル技術のうち、各種情報の社内外でのオンラインによる共有化がテレワークの定着にプラスの影響を与えることが示された。この傾向は、コロナ禍後に急遽テレワークを導入した企業にも当てはまる。

JEL classification: D22, M20, O33

キーワード: テレワークの定着、デジタル化、コロナ禍

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† 大阪産業経済リサーチセンターにて開催の、政策リサーチ連携推進会議における参加者の有益なコメントとご指摘に感謝する。当然ながら、残された誤りは執筆者に帰する。本稿で表明された見解はあくまでも執筆者個人のものであり、大阪府（および大阪産業経済リサーチセンター）の見解を表すものではない。

1. Introduction

The COVID-19 pandemic was a large social experiment in working style and a catalyst for telework (Barrero et al., 2021, 2023). In Japan, workstyle reform, which includes encouraging telework, was promoted by the government from 2018, just before the COVID-19 outbreak (Ministry of Health, Labour and Welfare, 2018). Since then, telework has started to get attention. The percentage of firms in Japan implementing telework rose from 17.6% just before the declaration of the pandemic by WHO on March 11, 2020, to 56.4% right after the first declaration of the state of emergency (DSE)[1] ended in Japan (survey by Tokyo Shoko Research, Ltd., TSR). Thus, many firms with the potential to adopt telework hastily adopted it. However, the number of firms adopting telework has gradually dropped from the peak of 56.4% to 37.0% in October 2021 and 29.1% in June 2022 (TSR). In other words, the percentages have dropped 27.3 percentage-points (pp) from the peak to June 2022. Even so, there is an 11.5pp increase from before the pandemic to June 2022. Barrero et al. (2023) state that 'the big shift to work from home has endured rather than reverting to pre-pandemic levels.'

The pandemic has also accelerated digitalization in firms (Jaumotte et al., 2023). Telework is defined as working from home or remotely using digital technologies, and Okubo (2022) reveals the positive relationship between digital skills and telework use. While digital technology is essential for telework feasibility (Bai et al., 2021), it is unclear which technology help firms stick to telework, especially those hastily adopt the system after the pandemic. Baldwin and Okubo (2023) study the positive relationships between automation-promoting[2] and telework-promoting software usage. However, their definition of telework-promoting software, such as Zoom, Slack, or file sharing, etc. can also be used in the office, not only for telework. Unlike these previous studies, we verify the relationship between various digital technologies and telework stickiness.

This study is the first to empirically investigate which digital technologies contributed to telework stickiness in a company using original firm survey. To briefly conclude, amongst the four digital technologies, online sharing of internal information impacts telework stickiness. This tendency is also true for firms that hastily adopted telework after the pandemic.

[1] The first DSE was from the beginning of April 2020 until the end of May 2020.
[2] Various management systems such as project, payment, attendance, sales, production, employment, human resources, accounting, business, etc. and robotic process automation.

2. Methodology and Data Description

The firm survey was conducted on companies located in Osaka (Fukui and Dung, 2023), one of the largest urban areas in Japan. We use this survey data and regress telework stickiness on the adoption of various digital technologies as follow,

$$Tele\_Stick_i = \alpha + \beta Digital\_adoption_i + \gamma X_i + \varepsilon_i, \quad (1)$$

where *i* is the firm index; *Tele_Stick* equals 1 if telework is expanded or maintained, and equals 0 if telework is contracted or discontinued (Q10 in Figure A.1). *Digital_adoption* is a vector of dummies indicating the adoption of digital technology; the dummy equals 1 if a digital technology is adopted, and equals 0 if it is not adopted. The digital technologies considered here are a) online business meetings with business associates and new business development (*Digital_a*), b) online sharing of internal information on sales, procurement, production, inventory, etc., both within and outside the firms (*Digital_b*), c) digitization of internal documents (*Digital_c*), and d) introduction of Artificial Intelligence (AI) and Internet of Things (IoT) (*Digital_d*) (Q5 in Figure A1).

X is a vector of control variables that includes *Tele_before* which equals 1 if telework was adopted before the pandemic and 0 if it was adopted after the pandemic. The dummy is used to consider the case that firms adopting telework after the pandemic are more likely to contract or discontinue telework. We control for firm characteristics by including: inverse hyperbolic sine (IHS) transformation of profit in 2019 (*IHS(Prof_2019)*), number of years in operation (*Year_Opt*), log of the number of workers in 2019 (*ln(Workers_2019)*), industry dummies (*Manufacturing*, *IT*, *Wholesale*). *Emp_Dens* is also included to control for employee density in the area since firms in high employee density areas are expected to stick with telework due to a higher chance of infection.

α is the constant term, β is the coefficients of digital adoption dummies, γ is a vector of coefficients of *X*, and ε is an error term. Firm's attributes used in the control variables are from the 'Basic Survey of Japanese Business Structure and Activities, 2019' by the Ministry of Economy, Trade and Industry.[3] Employee density is from the 'Economic Census for Business Activity, 2016, Boundary data database,' by the Statistics Bureau. The survey design and data are described in Appendix A. Propensity score weighting (PSW) is also used to test for robustness.

[3] This is an original calculation of questionnaire information from 'Basic Survey of Japanese Business Structure and Activities, 2019' Ministry of Economy, Trade and Industry.

3. Results and Discussion

Table 1 shows the logit estimation results of the equation (1), while Table 2 shows the results after restricting the sample to firms that adopt telework after the pandemic has started. Estimation results in Table 1 show that among the four digital technology, only the coefficients of *Digital_b* are significant, approximately 0.6, with a 5-10% significant level, implying that firms introducing online sharing of internal information are more likely to expand or maintain telework. The results in Table 2 also indicate that firms adopting *Digital_b* are more likely to stick with telework (coefficients are approximately 0.5-0.6). The positive coefficients of *Tele_before* in Table 1 can be interpreted as firms that hastily adopt telework after the pandemic has started are more likely to find themselves unprepared for telework and revert to the old work-style. Still, the adoption of *Digital_b* increases the chance that these firms stick to telework, as shown in Table 2.

PSW is utilized to deal with possible endogeneity. In PSW, each *Digital_a, b, c, d* is used as treatment variable, and all the control variables are used to calculate the propensity score. Besides inverse probability weighting (IPW; Horvitz and Thompson, 1952), we also employ a doubly robust estimator (DR; Robins, 1994) and overlap weighting (OW; Li et al., 2018, 2019). Using PSW, we infer whether there is a difference in telework stickiness with and without companies' treatment of each digital technology adoption. The estimation results using PSW in Table 3 guarantee the robustness of our main results; the coefficients of *Digital_b* are positive and significant at 5% level and other technologies such as *Digital_a, Digital_c,* and *Digital_d* show insignificant results. Since the results are expressed in the log odds ratio form, they are comparable with those in the main estimation; the values for *Digital_b* are between 0.5 and 0.6, which are similar to the coefficients of our main results. Further details of PSW are described in Appendix B.

Although online interaction with business partners (*Digital_a*) is a technology that should promote the firm's productivity, it is not a decisive factor in implementing telework. The technology is utilized not only when working at home, but also at the office and, hence the insignificance for telework stickiness. While the digitization of internal documents (*Digital_c*) is also supposed to be essential to the implementation of telework, the results indicate otherwise because this technology can also be meaningful while working inside the office. About AI or IoT (*Digital_d*), the coefficients indicate that *Digital_d* is not the core technology in promoting telework. Similar to *Digital_a* and *Digital_c,* this technology also seems to be meaningful for both inside and outside the office. From our results, only access to internal information or internal systems (*Digital_b*) is essential for telework stickiness. To conduct telework, workers need to access internal information from home. Unlike other digital technologies (*Digital_a*, *Digital_c*, *Digital_d*), remote access to internal information or internal systems is meaningful mostly outside the office. Therefore, this technology is crucial for telework resilience. Even for the firms that hastily

adopted telework after the pandemic, the adoption of *Digital_b* leads to telework stickiness.

Interestingly, smaller firms (negative coefficients for (negative coefficients for *ln(workers)*) have a higher probability of maintaining or expanding the telework policy. This is presumably because new policies can be easily rolled out and managed in smaller firms. In addition, IT firms show consistently significant positive effects on telework stickiness. Barrero et al. (2023) show that IT industry has the highest telework rate.

Table 1. Estimation results for the main equation

	Dependent variable:				
	Tele_Stick				
	(1)	(2)	(3)	(4)	(5)
Digital_a	0.303				0.149
	(0.325)				(0.340)
Digital_b		0.609**			0.553*
		(0.309)			(0.333)
Digital_c			0.249		0.108
			(0.294)		(0.314)
Digital_d				0.092	(0.051)
				(0.338)	(0.360)
Tele_before	2.763***	2.779***	2.788***	2.775***	2.746***
	(0.677)	(0.678)	(0.673)	(0.676)	(0.688)
IHS(Prof2019)	0.027	0.025	0.029	0.025	0.028
	(0.048)	(0.046)	(0.048)	(0.047)	(0.047)
Year_Opt	-0.005	-0.006	-0.004	-0.004	-0.005
	(0.007)	(0.008)	(0.007)	(0.007)	(0.008)
ln(workers)	-0.307*	-0.322*	-0.297	-0.295	-0.320*
	(0.187)	(0.187)	(0.187)	(0.190)	(0.189)
Emp_dens	1.468	1.445	1.36	1.408	1.348
	(2.064)	(2.074)	(2.083)	(2.068)	(2.083)
Manufacturing	1.089	1.201	1.049	1.037	1.17
	(0.743)	(0.750)	(0.755)	(0.750)	(0.751)
IT	1.918**	2.174**	1.870**	1.914**	2.118**
	(0.900)	(0.939)	(0.902)	(0.899)	(0.950)
Wholesale	0.252	0.343	0.151	0.176	0.324
	(0.761)	(0.770)	(0.771)	(0.766)	(0.771)
Constant	0.387	0.183	0.386	0.52	0.019
	(1.172)	(1.177)	(1.164)	(1.167)	(1.217)
Observations	296	298	299	297	294
Log Likelihood	-175.4	-173.8	-176.0	-175.8	-173.0
Akaike Inf. Crit.	370.8	367.6	372.1	371.5	372.0

Note: The dependent variable equals 1 if telework is expanded or maintained, and 0 if telework is contracted or discontinued. Robust standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01

Table 2. Estimation results for the main equation (Restrict to firms that adopt telework after the pandemic has started)

	Dependent variable:				
	Tele_Stick				
	(1)	(2)	(3)	(4)	(5)
Digital_a	0.253				0.101
	(0.326)				(0.342)
Digital_b		0.592*			0.547*
		(0.315)			(0.332)
Digital_c			0.233		0.109
			(0.301)		(0.325)
Digital_d				0.066	(0.070)
				(0.354)	(0.375)
IHS(Prof2019)	0.027	0.025	0.03	0.026	0.028
	(0.050)	(0.049)	(0.051)	(0.050)	(0.050)
Year_Opt	-0.007	-0.007	-0.006	-0.005	-0.007
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
ln(workers)	-0.353*	-0.368*	-0.338*	-0.336*	-0.367*
	(0.200)	(0.201)	(0.200)	(0.203)	(0.204)
Emp_dens	1.807	1.74	1.709	1.756	1.634
	(2.092)	(2.109)	(2.124)	(2.106)	(2.137)
Manufacturing	1.167	1.275*	1.131	1.12	1.244
	(0.749)	(0.756)	(0.760)	(0.755)	(0.760)
IT	1.815**	2.060**	1.767*	1.815**	2.027**
	(0.912)	(0.954)	(0.915)	(0.910)	(0.964)
Wholesale	0.207	0.299	0.107	0.132	0.279
	(0.774)	(0.783)	(0.783)	(0.778)	(0.786)
Constant	0.686	0.458	0.627	0.75	0.325
	(1.243)	(1.252)	(1.238)	(1.240)	(1.284)
Observations	250	250	251	250	249
Log Likelihood	-163.8	-162.2	-164.3	-164.0	-161.6
Akaike Inf. Crit.	345.5	342.4	346.5	346.0	347.2

Note: The dependent variable equals 1 if telework is expanded or maintained, and 0 if telework is contracted or discontinued. Robust standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01

Table 3. Estimation results using propensity score weighting

	Dependent variable: Tele_Stick		
	IPW	DR	OW
Digital_a	0.241	0.274	0.265
	(0.263)	(0.253)	(0.275)
Digital_b	0.543**	0.543**	0.523**
	(0.245)	(0.242)	(0.247)
Digital_c	0.190	0.125	0.230
	(0.243)	(0.240)	(0.248)
Digital_d	0.034	0.032	0.059
	(0.279)	(0.278)	(0.266)

Note: The dependent variable equals 1 if telework is expanded or main-tained, and 0 if telework is contracted or discontinued. Standard errors are in parentheses. The estimations are conducted using pro-pensity score as weights. The analysis is performed for each treat-ment variable, *Digital_a* , *Digital_b* , *Digital_c* , and *Digital_d* . *p<0.1; **p<0.05; ***p<0.01.

4. Conclusion

Since the Japanese government has been promoting work-style reforms from 2018, telework has attracted attention among firms in Japan. The COVID-19 pandemic hit right after that and was expected to be a catalyst for telework to permeate. We examined how adopting digital technology affects the stickiness of telework. Among the four types of digital technology (all of these seem to be related to telework), access to internal information or systems from outside the company, such as from home, is the most likely to lead to the stickiness of telework. Unlike other digital technologies, remote access to internal information or internal systems is meaningful mostly outside the office. Firms that introduced telework hastily after the pandemic are likely to contract or discontinue telework. Even for such firms, adopting the technology of access to internal information or systems has allowed telework to stick.

Our study has some limitations. Firstly, the survey is limited to Osaka, Japan, hence, the results cannot be generalized. Secondly, our survey is cross-sectional and thus can only emphasize the preliminary impacts of the pandemic. Although our survey does not cover the background of firms' management strategies, previous literature shows that telework is more likely to stick for firms with high management scores (Groenewegen and Hardeman, 2023; Schivardi, et al., 2022). Examining the relationship between work-style reform or digitalization and the management strategy of firms in Japan is our future work.

Appendix

A. Survey Design

The survey, conducted by the Osaka prefectural government, is designed to collect information on firms' current business operations during the pandemic (Fukui and Dung, 2023). The questions ask about the changes in operations due to COVID-19, including telework and digitalization. Surveyed firms are selected based on the following conditions: 1) have 50 or more workers, 2) have headquarter in Osaka prefecture, and 3) are operating in the manufacturing, IT, wholesale, or service industry. The survey was conducted in November 2022 and asked about the firms' operations until October 2022. Out of 2,000 surveys that are sent, there are 496 valid responses.

The questionnaire questions which we use in our investigation are listed in Figure A.1. For this study, the sample is limited to those who have or had adopted telework (those who answered 1 or 2 in Q9). Thus, we end up with a sample of 313 firms. The distribution of the $Tele\_Stick$ shows that 171 firms are expanded or maintained, while 142 firms are contracted or discontinued telework. Table A.1 below shows the number of firms that adopts (does not adopt) a specific technology. We match the original data of our survey and the firm's attributes data and location data on a per-firm basis.

Table A.1. Descriptive analysis of firm's adoption of digital technologies

	Digital_a	Digital_b	Digital_c	Digital_d
Adopts	241	222	217	67
Does not adopt	55	76	82	230

Q10 Please compare the degree of telework adoption at your company from the initial adoption to October 2022.

1) Telework has expanded compared to the initial adoption
2) Telework has been maintained
3) Telework has contracted compared to the initial adoption
4) Telework has been adopted but discontinued.

Q9 Please answer the following questions about your company's telework adoption.

1) Adopted before the COVID-19 pandemic (before January 2020)
2) Adopted after the COVID-19 pandemic (after February 2020)
3) Under consideration/planning
4) Not yet adopted (never adopted in the past)

Q5 Please answer the following questions about your company's digitalization adoption.

a. Online business meetings with business associates and new business development.

1) Adopted before the COVID-19 pandemic (before January 2020)
2) Adopted after the COVID-19 pandemic (after February 2020)
3) Under consideration/planning
4) Not yet adopted

b. Online sharing of internal information on sales, procurement, production, inventory, etc., both within and outside the firms.

1) Adopted before the COVID-19 pandemic (before January 2020)
2) Adopted after the COVID-19 pandemic (after February 2020)
3) Under consideration/planning
4) Not yet adopted

c. Digitization of internal documents.

1) Adopted before the COVID-19 pandemic (before January 2020)
2) Adopted after the COVID-19 pandemic (after February 2020)
3) Under consideration/planning
4) Not yet adopted

d. Introduction of AI and Internet of Things (IoT).

1) Adopted before the COVID-19 pandemic (before January 2020)
2) Adopted after the COVID-19 pandemic (after February 2020)
3) Under consideration/planning
4) Not yet adopted

Figure A.1. Excerpts from the questionnaire questions.

Source: Fukui and Dung (2023)

B. Further details of the propensity score weighting

Propensity score weighting is conducted using R library, 'PSweight.' The balancing check of propensity score weighting for the inference for *Digital_b* is displayed in Table B.1. All of the absolute standardized mean differences are below 0.1 after the weighting (Austin and Stuart, 2015), therefore, common support is ensured. In estimating effects after weighting, we use the same specification as equation (1) in the main estimation using the logit model.

Table B.1. Summary of balance for the propensity score weighting

Unweighted			
	Means Control	Means Treated	Std. Mean Diff.
Tele_before	0.145	0.167	0.060
IHS(Prof2019)	5.435	5.755	0.110
Year_Opt	58.539	63.059	0.228
ln(workers)	5.042	5.210	0.217
Emp_dens	0.056	0.050	0.079
Manufacturing	0.645	0.685	0.084
IT	0.158	0.072	0.270
Wholesale	0.184	0.203	0.047
IPW			
	Means Control	Means Treated	Std. Mean Diff.
Tele_before	0.155	0.160	0.013
IHS(Prof2019)	5.677	5.675	0.001
Year_Opt	60.677	61.724	0.053
ln(workers)	5.162	5.165	0.003
Emp_dens	0.050	0.051	0.018
Manufacturing	0.683	0.675	0.018
IT	0.096	0.095	0.002
Wholesale	0.184	0.196	0.032
OW			
	Means Control	Means Treated	Std. Mean Diff.
Tele_before	0.145	0.145	0.000
IHS(Prof2019)	5.513	5.513	0.000
Year_Opt	59.545	59.545	0.000
ln(workers)	5.076	5.076	0.000
Emp_dens	0.053	0.053	0.000
Manufacturing	0.670	0.670	0.000
IT	0.125	0.125	0.000
Wholesale	0.188	0.188	0.000

Note: *Digital_b* is used as treatment variable

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