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TOMIURA, Eiichi
RIETI

ITO, Banri
RIETI

The Research Institute of Economy, Trade and Industry
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Impacts of globalization on the adoption of remote work: Evidence from a survey in Japan during the COVID-19 pandemic*

Eiichi Tomiura†
and
Banri Ito#

Abstract

Globalized firms manage face-to-face contacts for distant communications. Based on our survey on the responses of Japanese firms to the COVID-19 pandemic, we find that firms that exported, imported, or directly invested abroad more before the pandemic tend to adopt remote work significantly more frequently during the pandemic. We confirm this relationship even after controlling for compositions of occupations, and various firm attributes. The effect of arm's-length trade, not intra-firm trade, is especially evident. These suggest that pre-pandemic experiences in coordinating across borders are likely to facilitate the adoption of remote work during the pandemic.

Keywords: Remote work; COVID-19; international trade; FDI; productivity; firm-level data
JEL classification: F23, F61, M16, O33

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*This study is conducted as a part of the Project "Empirical analysis of firms amidst globalization, digitization and the COVID-19 pandemic" undertaken at the Research Institute of Economy, Trade, and Industry (RIETI). This study utilizes the micro data of the questionnaire information based on "the Basic Survey of Japanese Business Structure and Activities" conducted by the Ministry of Economy, Trade, and Industry (METI), and "Survey of Globalization and Reduced Face-to-face Contacts during the COVID-19 Pandemic" conducted by RIETI. The authors are grateful for helpful comments by seminar participants at RIETI. The research for this paper is partly financed by RIETI and Grant-in-Aid for Scientific Research (JSPS KAKENHI 21K01498).

† Hitotsubashi University and RIETI

Aoyama Gakuin University and RIETI

1. Introduction

International trade requires coordination with remote trading partners across national borders. Even higher skills are necessary for foreign direct investment (FDI) in managing subsidiaries in different countries. These suggest that globalized firms have accumulated skills for coordination without intense face-to-face contact. The historic COVID-19 pandemic suddenly pressurized firms to adopt remote work[3] as a measure to alleviate contagion. While remote work has attracted wide attention since the start of the COVID-19 pandemic, only a limited fraction of firms have introduced remote work. As the costs and benefits of remote work should vary across firms, this paper examines whether firms engaged in international trade or FDI before the pandemic tend to actively adopt remote work during the pandemic. For this purpose, we combine our unique survey of Japanese firms on their responses to the COVID-19 pandemic with firm-level data of basic firm attributes derived from official statistics.

Global activities, such as international trade and FDI, cannot be accomplished unless firms have acquired high skills for distant communications. While face-to-face contacts facilitate international trade especially in finding new suppliers,[4] firms do not necessarily have in-person meetings for every international transaction due to costly international travel expenses. For example, from the sample of 1989-1996 before the wide use of the Internet, Portes and Rey (2005) find that bilateral cross-border equity flows are positively associated with telephone call traffic. Corporate organizations and work styles also tend to differ between globalized firms and domestic

[3] Although other various expressions have been used, the "remote work" is best suited to describe working from workers' homes, satellite offices, coworking spaces, cafes or anywhere remotely from their offices. In contrast, "work from home" is limited to work exclusively from the workers' home, not anywhere else. "Telework" emphasizes the workers' use of telecommunication technologies, not working places. "Telecommuting" refers to work without commuting aided by telecommunication technologies. We will explain the expression used in our survey in Section 2.

[4] For instance, Cristea (2011) finds a positive relationship between international trade and business-class air travel at the U.S. state level. As a micro-level study, Startz (2021) reports that Nigerian importers travel across national borders frequently especially to find new goods from new suppliers.

firms, in such aspects as strong and effective corporate headquarters, transparent decision-making, and standardized job descriptions.[5] Erickson and Norlander (2022) argue that we can learn from past experiences of offshoring for predicting post-pandemic remote work because new work organization in both cases is enabled by new technology but limited by social interactions.

Although international economics literature has often focused on productivity premium of globalized firms, Bernard et al. (2022) formalize firms differing not only in their productivity levels but also in their relationship capabilities, defined as the (inverse of) fixed costs of supplier-customer matching, to explain empirical regularities observed in Belgium firm-level data. Juhász et al. (2020) emphasize organizational barriers to coordinating workers in their comparison of the recent shift to remote work with the historic move from home to factory-based production during the Industrial Revolution. Atkin et al. (2017) find that organizational barriers are critical for technology adoption in the case of soccer-ball producers in Pakistan. This paper examines the introduction of remote work in the context of technology adoption, as in Bloom et al. (2015) on an experimental introduction of work-from-home in a Chinese firm. Corporate organizational strengths in coordination are likely to facilitate the introduction of remote work, as this new working arrangement involves intense communications between employees in different, often distant, locations without face-to-face in-person contacts. As a classic study of slow diffusion of new technology, Griliches (1957) finds that the adoption of a new good, hybrid seed corn in his case, depends on the cross-regional variations in profitability. This paper examines whether inter-firm variations in pre-pandemic experiences of global activities are related with the firm's introduction of remote work during the COVID-19 pandemic.

While this paper focuses on the effect of cross-border activities on accumulating

[5] Guadalupe and Wolf (2010) find that international trade makes internal corporate organizational layers flatter.

coordination skills, globalization at the same time brings high risks. Firms involved in cross-border activities are often exposed to uncertainties, including volatile exchange rate fluctuations, unpredictable policy changes, and political or military conflicts. Our observation of supply chain disruptions during the COVID-19 pandemic reminds us of this risk associated with international trade and FDI, as discussed by Baldwin and Tomiura (2020). Kramarz et al. (2020) argue that exporters are strongly exposed to microeconomic demand shocks as most, even large-sized, exporters have only one or two main clients. To discuss this negative side of globalization, we consider the regional concentration of international trade as well as the trade dependence on China, the largest trading partner with Japan. To discuss the resilience of trade during the COVID-19 pandemic, the dependence on China has been examined by previous studies, including Bas et al. (2022). We will also add a variable related to liquidity constraints to consider the possibility that high dependence on international transactions may result in serious losses or deficits caused by the trade disruption during the pandemic. By inspecting the possible effect of risks originated from foreign countries, we will discuss whether globalization enhances or deteriorates the resilience of firms during the pandemic.

To estimate the impact of a firm's pre-pandemic globalization on the firm's remote work adoption during the pandemic, we regress the latter on the former at the firm level. Sharing a similar motivation, Borino et al. (2021) report that firms exporting and/or importing are more likely to adopt telework compared with firms not involved in international trade based on a survey of 4,433 firms in 133 countries.[6] While the firm size class is the only firm-level information included in Borino et al. (2021), our regressions include various detailed firm characteristics derived from confidential firm-level data files of official statistics conducted by the government

[6] Although they analyze the impact of remote work on international trade, not the impact of trade on remote work, Espitia et al. (2021) find that the negative effect of COVID-19 was mitigated in sectors amenable to remote work based on a sector-level gravity model of international trade.

with legal reporting obligations. It was almost completely impossible for firms to predict the timing of the COVID-19 pandemic. Firms were unable to fully prepare for the pandemic by introducing remote work arrangements in advance. Bai et al. (2021) defend this type of identification assumption in their analysis of the impact of pre-pandemic work-from-home feasibility on firm performance during the pandemic. Our estimation is hence not plagued by the possibility of reverse causality from remote work to globalization. To preview our main results, firms globalized before the pandemic tend to significantly more frequently adopt remote work during the pandemic, even after controlling for various firm characteristics. The effect of international trade is especially evident for arm's-length trade rather than for intra-firm trade, suggesting the importance of coordination across not only national borders but also firm boundaries.

For our empirical analysis, we conducted a unique survey for our research project at Japan's Research Institute of Economy, Trade, and Industry (RIETI). The survey covers virtually all medium- or large-sized firms in manufacturing or wholesale industries in Japan. We collect information on firms' responses to the COVID-19 pandemic at four points in time around the pandemic. We match the survey results with firm-level data derived from official statistics for a wide variety of firm attributes. The use of firm-level data is suitable for our research as the adoption of remote work was decided by each firm in Japan, where no legally mandatory lockdown or stay-at-home orders were issued.

The remainder of this paper is organized as follows. Section 2 briefly explains the regulations and policy responses to the COVID-19 pandemic in Japan, focusing on the differences from other major countries. Section 3 describes our dataset, especially our unique survey on the firms' responses to the pandemic. Section 4 explains our empirical methodology and main results for the impacts of globalization before the pandemic on the adoption of remote work during the

pandemic based on firm-level data derived from official statistics. Section 5 reports results from robustness checks. Section 6 adds concluding remarks.

2. Japanese policy responses to the COVID-19 pandemic

This section briefly explains the regulations and policy responses to the COVID-19 pandemic in Japan, especially focusing on the differences from the measures taken in other major countries. The most important point for our discussion of remote work is that no legally mandatory lockdown or stay-at-home orders were issued in Japan.

As in many other countries, the Japanese government declared a state of emergency during the COVID-19 pandemic, in April 2020 for all 47 prefectures and in January 2021 for eleven prefectures during our sample period. In 2021, the third and the fourth state of emergency were issued in April-June and July-September.

However, the COVID-19 state of emergency declaration in Japan entailed no legally mandatory obligations, such as lockdown of urban areas, nighttime curfews, or stay-at-home orders. Governments asked citizens to avoid nonessential and non-urgent outings, but no penalty was imposed for violations. Restaurants and dining businesses were asked to close early, but, instead of fines for violations, governments provided subsidies if shop owners cooperated with the request. Governments asked firms to voluntarily set the target for remote work, but no penalty was imposed even if firms ordered their employees to commute to their workplaces. As described in OECD (2021), Japan's policy reaction to the pandemic "relies more on peer pressure … rather than imposing fines" (p.13). The stringency of lockdown measures in Japan was among the lowest, comparable to Sweden, New Zealand, and Taiwan, as cited in Aksoy et al, (2022).

As a noteworthy point for our research, the adoption of remote work during the COVID-19 pandemic was basically delegated to individual firms in Japan. Previous studies (Kawaguchi and

Motegi 2021, and Okubo 2022) found the critical role of company-side factors, such as human resource management practices and digitalization, in introducing remote work in Japan during this period.[7] Central or local governments had no legal mandate to order citizens to stay and work at home.[8] Employees had limited discretion in choosing remote work as they had no choice other than following the employer's decision amid the fear of unemployment. Although some workers are allowed to switch between commuting and teleworking, such an option is given by employers/firms. These make our use of firm-level data suitable for examining remote work adoption during the COVID-19 pandemic in Japan.

3. Description of data

This section describes the dataset used for this research. We combine our original survey on the COVID-19 pandemic with firm-level data on pre-pandemic basic firm attributes.

3.1. COVID-19 survey

We conducted a survey of firms in Japan on their responses to the COVID-19 pandemic.[9] We design our survey as covering virtually all large- and mid-sized firms in manufacturing and wholesale industries in Japan.[10] The use of this firm-level dataset is informative,[11] as the decision of introducing remote work is normally made at the corporate level with little discretion

[7] Kawaguchi and Motegi (2021) find that remote work was more likely to be adopted in firms with key performance indicators or pay-for-performance. Okubo (2022) detects a positive correlation of telework with the firm's adoption of tools for file-sharing, chat, or attendance management.
[8] Even in the U.S., Goolsbee and Syverson (2021) confirm that legal restrictions explain only a limited fraction of consumer traffic decline during the pandemic.
[9] The "Survey of Globalization and Reduced Face-to-face Contacts during the COVID-19 Pandemic" was conducted by the Tokyo Shoko Research Co., Ltd. (TSR) for our research project at the Research Institute of Economy, Trade, and Industry (RIETI).
[10] Service sector is omitted since the official statistics which we link the survey data does not cover all service industries. Retail sector is omitted as firm's remote work decision is highly sensitive to its location in the case of COVID-19 with widely varying cross-regional rate of contagion.
[11] Bartik et al. (2020) uses a survey of firms in the U.S. for studying adjustments to COVID-19.

left for individual workers.[12] We set the same size threshold exactly as in the official statistics, with which we link the survey data, as follows: 50 or more employees and capital of 30 million yen or more. As most small firms are not engaged in international trade or FDI, the omission of small firms will not affect our main results on globalization. We distributed our survey questionnaires to 22,948 firms at the beginning of January 2021 and accepted responses until March from 6,722 firms with a response rate of 29.3%.

The survey asks each firm about the adoption of remote work at the following four points in time as a retrospective question: (i) just before the pandemic (December 2019), (ii) under the COVID-19 state of emergency (April or May 2020), (iii) after the state of emergency lifted (September or October 2020), and (iv) at the time of the survey (January 2021). Although it was not anticipated in our research design, our survey was conducted amid the period when the government declared a state of emergency again.[13] In answering the question on remote work, firms are requested to choose one from the following five options;[14]

(A) Remote work has been introduced in principle to all employees in our firm.

(B) Remote work has been introduced widely in our firm though with exceptions.

(C) Remote work has been introduced in our firm but is limited to selected employees.

(D) All employees in our firm are in principle required to commute to their workplaces.

(E) Others.

While we mainly focus on binary classification (adopting remote work or not), we also use this

[12] Eberly et al. (2021) find that dwellings capital and internet connections at home before the pandemic were important factors as "potential capital" on the worker side in shifting to remote work in the U.S.

[13] The state of emergency was announced for eleven prefectures in January 2021, while it was declared for all 47 prefectures in April 2020.

[14] In the questionnaire, we explicitly state that what we asked includes work from home, work from satellite offices, "workation" and other forms of remote work for at least a part of work hours. As the original survey was conducted in Japanese, we translate the text into English for this paper.

detailed four-step ordering as a robustness check. As shown in Table 1, merely nine percent of the surveyed firms adopted remote work before the COVID-19 pandemic even if we include firms introducing remote work selectively only for limited employees. As remote work was introduced only in a limited portion of firms, characterizing these firms will be informative. Section 4 will investigate whether the engagement in international trade or FDI before the pandemic influences the introduction of remote work during the pandemic.

3.2. Official statistics

We link the results from our survey explained in the previous sub-section with firm-level data derived from official statistics to examine the impact of pre-pandemic firm characteristics on the firm's adoption of remote work. We draw firm-level data from the Basic Survey of Japanese Business Structure and Activities (hereinafter abbreviated as BSJBSA, or *Kigyo Katsudo Kihon Chosa* in Japanese). Japan's Ministry of Economy, Trade, and Industry (METI) conducts this survey annually since 1995 by imposing legal reporting obligations for all qualified mid- or large-sized firms, which our RIETI survey defined exactly by the same size threshold. Firms are required to report the previous year's information on a non-consolidated firm basis.

The basic firm attributes, which we have drawn or calculated from BSJBSA, include sales, value-added, tangible and intangible assets, the number of employees, the share of employees working at corporate headquarters, as well as ICT expenditures, exports and imports (both in yen values), and FDI (yen value of stock, and the number of subsidiaries located overseas).

Among 6,722 firms covered by our RIETI survey, 5,494 firms are matched with BSJBSA. Although our RIETI survey sets the same size threshold as BSJBSA, the match is not perfect due to various factors, such as the entry-exit of firms after the last BSJBSA round.[15] Unless otherwise

[15] Some firms included in the list provided by TSR turn out to be outside of the designed industrial

noticed, this paper links our survey on COVID-19 with the firm characteristics of the year 2018 before the pandemic based on the most recent firm-level data files available when we initiated this research. The variables used for our regressions will be defined in Section 4. As shown in Table 1, around thirty percent of the firms in our matched sample are engaged in international trade (exporting or importing), and nearly twenty percent are multinationals (FDI firms), as repeatedly reported from the official statistics.

Before reporting our regression results, we show a descriptive comparison. Table 2 displays the percentage of remote work adoption by grouping sample firms according to their globalization modes in 2018. For example, about eighty percent of exporters, importers, and FDI firms adopted remote work in the t=2 period (April/May 2020), when the first state of emergency was issued, while merely 57% of domestic firms adopted remote work.[16] This contrast echoes Borino et al. (2021), as they report that telework is adopted by 41% of exporting/importing firms, while only 31% of domestic firms adopt telework. In the t=3 period (September/October 2020), when the state of emergency was lifted, the adoption rate of remote work declined overall, but the adoption rate among globalized firms remained considerably higher than that of domestic firms. We hence expect that there is some sort of relationship between globalization and the introduction of remote work, but it may simply reflect the firm size effect. In the next section, we estimate the impact of globalization on the adoption of remote work in a regression framework.

4. Estimation results

4.1. Empirical approach

coverage, but the number of these exceptional firms was limited.

[16] The limited share of remote work adoption is confirmed by other surveys in Japan, such as Okubo (2022). From a randomized experiment in a Chinese firm before the COVID-19 pandemic, Bloom et al. (2015) find evidence for gradual learning in the adoption of work-from-home arrangement.

To examine the impacts of pre-pandemic firm attributes on remote work adoption during the pandemic, we estimate the following equation.

$$RW_{isrt} = \beta_1 \frac{Exp_{it_0}}{Sales_{it_0}} + \beta_2 \frac{Imp_{it_0}}{Pur_{it_0}} + \beta_3 \frac{FDI_{it_0}}{DDI_{it_0}+FDI_{it_0}} + X_{it_0}\gamma + \kappa_s + \lambda_r + u_{isrt} \qquad (1)$$

The dependent variable RW_{isrt} is the adoption of remote work in a binary variable (taking the value one if the firm adopts remote work at least partly or zero if the firm asks all employees to commute) of a firm *i* in sector *s* in region *r* at time *t*. As a robustness check, we also use the four-step ordering of the extent of remote work adoption *RW_extent* and estimate the same model (1) by ordered logit. To allow all the coefficients to vary across periods, we estimate (1) in a cross-section format for each period *t* in our survey (December 2019 as *t*=1, April/May 2020 as *t*=2, September/October 2020 as *t*=3, and January 2021 as *t*=4). We confirm the robustness of this cross-section estimation by pooling four periods.[17]

On the right-hand side of the regression, we include our main variables to capture the effect of the firm's pre-pandemic globalization on the adoption of remote work during the pandemic. *Exp/Sales* is the export intensity, defined by the percentage of exports in total sales. *Imp/Pur* is the percentage of imports in the firm's total purchase. *FDI/(DDI+FDI)* is the percentage of *foreign* direct investment in total direct investment (FDI plus domestic direct investment DDI). For direct investment values, we use the balance of stock investment in subsidiaries derived from firm-level data of official statistics. As the data on the number of subsidiaries are available in BSJBSA, we also use the percentage of the number of subsidiaries located overseas in total subsidiaries. While this second FDI measure is insensitive to varying sizes of subsidiaries, it may represent the number of contacts for parent MNEs. As we discuss the effect of inter-firm contacts, and as these two FDI measures are not highly correlated, we decide to include both. We confirm,

[17] Pool/panel regression results are available upon request.

however, that our main results are intact even if we include only one of these two FDI measures. While our baseline regression includes all these trade-FDI variables simultaneously, we confirm that our main results remain unchanged even if we include alternatively only one of these variables to avoid possible multicollinearity. We use the intensity or share of these globalization variables to distinguish the globalization effect from the sheer effect of firm size, but we also use the absolute yen values without normalization to check the robustness of our results in Section 5. As an additional robustness check, we also use dummies (e.g., whether the firm exported or not) to categorically separate globalized firms from domestic firms. The pre-pandemic period is denoted by t_0, for which we set 2018 as it is clearly before the COVID-19 pandemic and the most recent year in the micro-data files of BSJBSA available when we started this research. We control for other pre-pandemic firm attributes, summarized as a vector X in (1), which will be explained in detail in the next paragraph. We estimate Equation (1) as a linear probability model to include fixed effects for sectors κ (34 two-digit industries) and regions λ (47 prefectures).[18] Industry dummies are supposed to capture technological features associated with the amenability of remote work, while differences in the severity of COVID-19 contagion are likely to be controlled for by region dummies. The error term is denoted by u.

As firm-level controls X, we include the following variables derived or calculated from BSJBSA: productivity (value-added per employee in logarithm), ICT intensity (telecommunication expenses divided by sales), intangible asset intensity (intangible asset values per employee), human capital intensity (sales, general and administrative expenses divided by sales), HQ intensity (the percentage of employees working at corporate headquarters in the total number of employees), foreign ownership percentage, and the percentage of regular workers

[18] We confirm that our main results from the linear probability model are basically unchanged even if we estimate the model by probit.

in total workers (excluding workers with fixed short-term employment contracts or dispatched from temporary personnel agencies). All these variables are the firm's characteristics supposed to be correlated with the firm's decision on globalization and remote work. Firms with high ICT intensity are likely to adopt remote work based on their rich ICT equipment, as Adrjan et al. (2021) label as "digital preparedness."[19] Firms owned more by foreign stockholders are more likely to adopt remote work based on their experiences in communicating with owners in different countries. Firms intensive in intangible assets may or may not actively introduce remote work because their workers are skillful, but their tasks are difficult to standardize or codify. Firms rich in human capital or having large corporate headquarters are expected to adopt remote work based on their strong management functions. The summary statistics of these variables are shown in Table 1.

The relationship with international trade has been analyzed in previous studies on the COVID-19 pandemic. For example, Borino et al. (2021) regress the adoption of telework on the firm's engagement in international trade and find a significantly positive relationship (both in binary dummies in a linear probability model). Although they control for firm size categories along with sector- and country-fixed effects, our regressions control for many other additional firm-specific characteristics.[20]

While our main focus is on real aspects of corporate behaviors, financial factors cannot be neglected. On the impact of finance, Ding et al. (2021) find that the pandemic-induced drop in stock returns was milder among firms with stronger pre-pandemic finances based on 6,700 firms

[19] Okubo (2022) reports that telework in Japan during the COVID-19 pandemic was positively correlated with workplace digitalization, such as the use of tools for file-sharing, chat, and attendance management. Multinational enterprises often have used teleconference systems connected by dedicated lines even before the Internet, but our results are after controlling for the firm's ICT intensity.

[20] They also include the lockdown duration in their regressions but find it insignificant. Barry et al. (2022) discover that firms with low workplace flexibility (lower share of employees who can and do work from home) tend to increase labor-saving automation in the U.S.

in 61 economies. In our context, firms may be pressurized to introduce drastic reform, such as introducing remote work, under a severely negative financial shock, but they may introduce remote work only with rich internal earnings to finance expenses for ICT. To inspect this empirical question, we introduce the dependency on loans (the sum of short-term loans and long-term loans relative to total assets).

In addition to the firm's financial vulnerability, we also examine the dependence of international trade on a particular country. If a firm depends more on a particular market, especially hit seriously by the COVID-19 pandemic, the firm is more likely to face a tight budget constraint during the pandemic due to a serious export drop. From French firm-level data, Kramarz et al. (2020) find that exporters are exposed to idiosyncratic shocks in destination markets as one or two main clients often absorbed most of their exports. If a firm depends more on a particular source hit seriously by COVID-19, the firm is more likely to be damaged by the disruption of input supply. This type of shocks from trading partners may accelerate or deter the introduction of remote work, as discussed in the previous paragraph. To investigate this channel, we add the share of China in the firm's exports or imports.[21] This measure is motivated not only by the high dependence of Japanese trade on China but also by the tight lockdowns, which affected economic activities, particularly production, imposed in China during the COVID-19 pandemic. As shown in Table 1, around ten percent of exports or imports are with China in our sampled firms. To investigate the impacts of regional concentration of international trade, we also include the Herfindahl-Hirschman concentration index (HHI) of exports and of imports.[22]

By estimating (1), we can infer the causal impact of globalization on the firm's adoption

[21] Hong Kong is included in China in BSJBSA.
[22] HHI is calculated based on the following regional classification in BSJBSA: China, Asia excluding China, Middle East, Europe, North America, and the rest of the world. BSJBSA does not disaggregate export destinations or import sources into country-level, except for China.

decision of remote work. The identification assumption for our research strategy is the impossibility of predicting the timing of the global COVID-19 pandemic for individual firms. It was almost completely impossible for firms to fully adjust their international business engagement before the pandemic to prepare for the exogeneous shock of the COVID-19 global pandemic. Therefore, we can assume that a firm's pre-pandemic international trade and FDI decision is orthogonal to the firm's adoption of remote work during the pandemic.

4.2. Baseline regression results

This sub-section reports our baseline estimation results and discusses their interpretations. Our baseline regression results are reported in Table 3. Robust standard errors are shown in brackets for all regressions in this paper. While the first four columns include only the firm's globalization variables and industry- as well as region-fixed effects, the last four columns add firm-specific control variables.

The significantly positive estimates on the globalization variables show that firms involved more in exports, imports, or FDI before the pandemic tend to adopt remote work significantly more frequently during the COVID-19 pandemic (t=2, 3, 4) even after controlling for various firm attributes before the pandemic as well as industry- and region-specific fixed effects. This result is consistent with the previous finding of a positive correlation between international trade and remote work from OLS reported by Borino et al. (2021). As we regress the shares relative to the domestic business activities (not the absolute sizes of exports, imports or FDI), our results suggest that the pre-pandemic share of global operations, not merely the firm size, is significantly related with the firm's adoption of remote work during the pandemic. These globalization variables were not significantly related to remote work adoption before the pandemic (t=1) if we control for firm attributes, but this finding of insignificance is plausible as only limited exceptional firms

introduced remote work before the COVID-19 pandemic.

We also find that more productive firms are significantly more likely to introduce remote work. The estimates in Table 3 also show that intangibles, corporate headquarters, and human capital are significantly positively related with the remote work adoption, suggesting that organizational strength may be necessary for firms to introduce such a drastic working style as remote work. Although their relationships with remote work is statistically significant, we admit that the magnitudes of the estimated coefficients on trade/FDI variables are small (e.g., one-standard deviation or twenty percentage point increase in trade shares correlated with single-digit percentage point increase in the probability of introducing remote work). On the other hand, the impact of productivity or of intangible assets is relatively large.

As the other side of FDI, our same regression also examines how firms differ depending on the shares owned by foreign stockholders. Firms owned more by foreign stockholders tend to adopt remote work more frequently in the periods except t=2 in Table 3, but we note that the positive relationship between remote work and foreign ownership was already observed even before the pandemic (t=1), possibly due to the need to communicate regularly with distant foreign owners often with wide time zone differences. The insignificance during the period under the first state of emergency (t=2) may be due to the unexpected sudden shock of COVID-19 crisis in the spring of 2020 on all firms irrespective of ownership structures.

We also detect significant relations with some of the firm attributes. The negative coefficient on the loan-asset ratio suggests that the negative financial shock due to the COVID-19 pandemic appears to retard the introduction of a new working arrangement: remote work. Controlling for variations in ICT expenditures does not considerably improve our estimates in the case of Japanese firms. Though it is estimated to be not strongly significant in our sample, the regular worker share without direct data on skills or tasks of individual workers may not work as

a good proxy for the skills of workers.

4.3. Arm's-length trade vs. intra-firm trade

We have combined arm's-length trade with intra-firm trade in our baseline regressions, but they may differ in the required intensity or level of communications. Trading across firm boundaries is likely to demand more intensive communication to coordinate with firms without ownership relations, compared to trade within a multinational enterprise group. We exploit detailed firm-level data derived from BSJBSA and disaggregate the firm's exports or imports into arm's-length trade with unrelated firms and intra-firm trade with subsidiaries owned by the same parent firm.

Table 4 reports the regression results with disaggregated trade variables. To facilitate comparisons, we keep all other right-hand side variables, including FDI and fixed effects, as in the baseline. Significantly positively correlated with the remote work adoption is arm's-length, not intra-firm, exports and imports. This suggests that merely trading across national borders is not sufficient, but firms accumulating pre-pandemic experiences in trading with unrelated foreign firms tend to adopt remote work actively during the pandemic.

5. Robustness checks

To check the robustness of our results, we conduct three additional estimations. First, while the previous section has used shares of trade or FDI as our continuous measure of globalization, this section alternatively uses binary globalization dummies to group firms. We also estimate the same equations with yen values of trade or FDI without taking shares. Second, we additionally control for variations in compositions of occupations to take account of differences in amenability to remote work. Finally, as the COVID-19 pandemic is strongly characterized by the sudden disruption of supply chains involving China, we consider the firm's trade dependence on China

or regional concentration of international trade.

5.1. Alternative measures of firm's globalization

While we have used the shares of trade or FDI as our main measure of globalization, this sub-section introduces the following two alternative measures: the three dichotomous dummy variables (whether the firm exports or not, imports or not, and directly invests abroad or not), and the yen values without taking shares (exports, imports, or FDI values in logarithm).

The regression results with globalization dummies are shown in Table 5.[23] The same set of firm-specific control variables (in the last four columns) as well as industry dummies and region dummies (in all cases) are included in the regressions but omitted from the table to save space. Exactly as in the baseline results with continuous globalization indicators in the previous section, the globalization dummies are significantly positive during the pandemic. In line with the descriptive comparison in Table 2, the estimated coefficients on dummies are large in magnitudes. We, therefore, confirm that our main finding is basically intact even if we replace continuous globalization measures with binary dummies.

As another robustness check, we estimate the same equations with log yen values of exports, imports, or FDI without taking shares relative to domestic operations. We add the value one before taking logarithm to include many domestic firms into our regression. We again keep the same set of control variables and fixed effects for comparison purposes. The regression results without taking shares are shown in Appendix Table A1 and confirm that our results from the shares relative to corresponding domestic values are robust even if we measure the firms' globalization in terms of absolute levels of their trade or FDI.

[23] While we include two FDI measures in our baseline regression, the dummy for FDI is defined by FDI stock values. However, our main results are qualitatively unaffected even with the dummy defined by the number of subsidiaries.

This sub-section examines the replacement of continuous globalization variables by dummies, but we depend on dummies in discussing remote work. As our survey collects detailed information on the four-step degree of remote work adoption, we can estimate the model by ordered logit. Ordered logit results, shown in Appendix Table A2, confirm our previous OLS results in that firms that exported, imported, or invested directly abroad more relative to domestic size (in the first four columns), categorically in binary dummies (in the middle four columns), or more in log yen values (in the last four columns) before the pandemic tend to adopt remote work more extensively during the pandemic, confirming our previously shown Table 3 on the binary remote work introduction dummy.

5.2. Compositions of occupations

While our regressions have controlled for the number of employees in each firm, the introduction of remote work is inherently difficult in some occupations/jobs/tasks even within the same firm. For instance, remote work is almost impossible for jobs handling tangible goods, such as transportation services or drivers. Dingel and Neiman (2020) found that the feasibility of adopting telework substantially varies across occupations/jobs.[24] To consider this variation in the feasibility of remote work, we additionally control for the composition of occupations.

For this purpose, we follow Dingel and Neiman (2020), and add the share of the following four groups of occupations: (i) managers, (ii) engineers or technicians, (iii) clerical or administrative office workers, and (iv) sales or marketing staffs, in each industry into our regressions, based on the Japan's Employment Census. Industry dummies are automatically dropped from the regressions with these industry-level measures. The regression results with the

[24] McKinsey Global Institute (2020) also proposes similar metrics for remote work potentials, which vary across tasks, jobs, and countries.

industry-level occupational composition variables are reported in Table 6. We confirm that our principal finding of significant relationship between remote work adoption during the pandemic and pre-pandemic globalization is robust even after controlling for differing compositions of occupations across industries.

As an additional robustness check, we also use the firm-specific measure, derived from firm-level data of BSJBSA. Included are the employment share of the following corporate headquarter departments: corporate planning, ICT, R&D, international affairs, and other corporate functions (including general administration, human resource management or corporate finance), the share of workers engaged in information service or service business within headquarters, the share of information service workers and the share of employees at research laboratories (both outside of corporate headquarters) in total employment. Compared with the first industry-level measure, this second firm-level measure is more detailed and directly observed for individual firms though might be endogenous. We confirm the robustness of our principal results with firm-level compositions of occupations/functions, as shown in Appendix Table A3. The estimated signs of coefficients on various occupations/functions are generally consistent with our prior expectations. Among them, in line with our main result on trade and FDI, the remote work tends to be adopted in firms with high share of employees involved in international affairs in corporate headquarters.

5.3. Vulnerability of international trade due to regional concentration

Firms are likely to be exposed to high risks if they depend on a limited number of export markets or import sources. Such regional concentration in international trade may accelerate or retard the introduction of new technology, remote work in our case. This problem is particularly acute in the case of COVID-19 pandemic, which is characterized by the sudden and sharp

disruption of cross-border supply chains, especially trading with China. To examine this issue, we estimate the following.

$$RW_{isrt} = \delta_1 \frac{Exp_{it_0}}{Sales_{it_o}} + \delta_2 \frac{Imp_{it_0}}{Pur_{it_0}} + \delta_3 \frac{FDI_{it_0}}{DDI_{it_0}+FDI_{it_0}} + \eta_1 XHHI_{it_0} + \eta_2 MHHI_{it_0} +$$

$$\theta_1 \frac{Exp_{it_0}}{Sales_{it_o}} \times XHHI_{it_0} + \theta_2 \frac{Imp_{it_0}}{Pur_{it_0}} \times MHHI_{it_0} + X_{it_0}\mu + \rho_s + \phi_r + \upsilon_{isrt} \quad (2)$$

The concentration of exports and of imports measured in terms of Herfindahl-Hirschman index (HHI) is denoted by *XHHI* and *MHHI*. We also estimate the same model by replacing HHI by the share of China in the firm's total exports or imports (*ShareChinaX* and *ShareChinaM*) to inspect the dependence on China in trade. We interact the HHI index or China's share with the export and import intensities to examine possible heterogeneous impacts. The error term is denoted by *v* in Eq.(2). The same set of firm-level control variables *X* and regional as well as sectoral dummies are included as in the baseline.

Table 7 reports the regression results with the concentration of trade. We confirm the significantly positive impact of pre-pandemic trade or FDI on the adoption of remote work during the pandemic even if we control for the dependence of firm's trade on China or regional concentration of trade. Firms with high HHI tend to introduce remote work during the pandemic, possibly responding to international trade disruptions due to COVID-19. The impact of the dependence on China may be influenced by tight lockdown measures imposed in China, though it is significantly detected only during the periods under the state of emergency (t=2 or 4). The interaction term is significantly negative in many cases, indicating that regional concentration attenuates the effect of international trade on remote work.

6. Concluding remarks

Firms engaged in international trade or FDI tend to differ from domestic firms in various

dimensions, such as strong corporate headquarters for managing distant communications with trading partners and employees across national borders under distinct cultural backgrounds. This implies that firms active in global activities are likely to face less serious frictions in introducing remote work, which requires not only ICT necessary for distant communications but also transparent decision rules and flexible management of diversity. To investigate this hypothesis, we match our unique survey results of Japanese firms with detailed firm-level data derived from official statistics. We have found that firms active in exporting, importing or FDI before the COVID-19 pandemic tend to adopt remote work significantly frequently compared with domestic firms during the pandemic. We have also detected a significant relation of remote work adoption with arm's-length trade, not intra-firm trade, suggesting an importance of experiences in coordination across firm boundaries. We confirm this relationship with globalization statistically significant at any conventional significance level and in various robustness checks, although the estimated impacts of globalization are quantitatively small in magnitudes.

Our findings suggest that firms globalized before the pandemic tend to flexibly adopt remote work during the unprecedented exogenous shock due to COVID-19 pandemic based probably on their rich experiences in coordination across national borders. While globalized firms were exposed to high risks by unpredictable disruptions of global supply chains during the pandemic, they are resilient by introducing a drastically new work style. We also know that globalized firms are on average larger, more efficient, and often with market powers. Bai et al. (2021) argue that the pandemic aggravated intra-industry inequality from their finding of positive impact of pre-pandemic work-from-home feasibility on firm performance. Firms with insufficient experience in communications across borders may be left behind in the trend of shifting toward ICT-enabled remote work.[25]

[25] While it deviates from the context of globalization, the remote work adoption has implications to

While we have detected a significant impact of globalization on remote work adoption based on firm-level data, several issues remain for future research. For instance, it will be useful to identify the underlying mechanism by which the global experience raises the probability of remote work adoption if detailed within-firm information on work style and communication modes can be assembled.

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Table 1 Summary statistics

Variable	Mean	Std. dev.	Min	Max
Remote work DUM (time=1, December 2019)	0.091	0.287	0	1
Remote work DUM (time=2, April/May 2020)	0.654	0.476	0	1
Remote work DUM (time=3, September/October 2020)	0.450	0.498	0	1
Remote work DUM (time=4, January 2021)	0.569	0.495	0	1
Remote work extent (time=1)	1.097	0.381	1	4
Remote work extent (time=2)	1.992	0.938	1	4
Remote work extent (time=3)	1.660	0.888	1	4
Remote work extent (time=4)	1.865	0.943	1	4
Export/Sales (%)	4.065	12.116	0	100
Exporter DUM	0.311	0.463	0	1
lnExp (million yen)	1.781	2.952	0	14.542
Import/Purchase (%)	6.761	18.377	0	100
Importer DUM	0.305	0.461	0	1
lnImp (million yen)	1.713	2.863	0	13.525
FDI/(DDI+FDI) (stock value, %)	14.243	32.878	0	100
FDI/(DDI+FDI) (sub #, %)	1.744	8.040	0	96.154
FDI DUM	0.193	0.394	0	1
lnFDI (stock value in million yen)	1.150	2.542	0	14.371
lnFDI (sub #)	0.068	0.297	0	4.691
lnY/L	1.821	0.506	-1.355	4.749
lnIntangible/L	0.151	0.285	0	4.265
ICT/sales (%)	0.292	1.799	0	116.558
HQ/L (%)	13.653	11.198	0	100
SGA/Sales (%)	17.046	13.297	0	118.519
Foreign owned share (%)	2.231	12.943	0	100
Loan/Asset (%)	25.551	35.074	0	1417.949
Regular workers/L (%)	84.818	17.515	1.671	100
Export/Sales, arm's-length (%)	2.802	9.688	0	100
Export/Sales, intra-firm (%)	1.263	6.107	0	100
Import/Purchase, arm's-length (%)	4.540	14.525	0	100
Import/Purchase, intra-firm (%)	2.222	10.551	0	100
ExportHHI	2489.129	3940.464	0.000	10000
ImportHHI	2700.827	4215.711	0.000	10000
Share of China in exports	0.094	0.243	0	1
Share of China in imports	0.119	0.294	0	1
Industry-level emp. share of Managers (%)	2.704	1.630	0	7.143
Industry-level emp. share of Engineers (%)	9.957	14.133	0	68.790
Industry-level emp. share of Clerical workers (%)	21.054	7.355	2.365	50
Industry-level emp. share of Sales workers (%)	16.416	17.644	0	86.364
Firm-level emp share of corporate planning dept./HQ (%)	3.163	8.802	0	100
Firm-level emp share of corporate ICT dept./HQ (%)	1.544	4.350	0	85.714
Firm-level emp share of corporate R&D dept./HQ (%)	4.066	9.601	0	96.923
Firm-level emp share of corporate International dept./HQ (%)	0.768	3.248	0	80
Firm-level emp share of other corporate dept./HQ (%)	22.924	23.861	0	100
Firm-level emp share of info services & service business/HQ (%)	5.596	18.839	0	100
Firm-level emp share of ICT workers/total workers (outside of HQ) (%)	4.725	20.057	0	100
Firm-level emp share of R&D lab workers/total workers (outside of HQ) (%)	0.926	6.247	0	100

Table 2 Remote work adoption of firms grouped by their globalization

	Dec. 2019 t=1	Apr/May 2020 t=2	Sept/Oct 2020 t=3	Jan. 2021 t=4
Domestic firms (3146)	7.7%	56.7%	37.5%	47.5%
Exporters (1708)	10.7%	78.7%	56.1%	70.8%
Importers (1679)	11.1%	80.0%	57.7%	72.3%
FDI firms (1058)	11.8%	79.1%	59.8%	72.7%
All firms (5494)	9.1%	65.4%	45.0%	56.9%

Note: Shown are percentages of firms adopting remote work in each group. The number of firms is in parenthesis.

Table 3 Baseline results

VARIABLES	[1-1] t=1	[1-2] t=2	[1-3] t=3	[1-4] t=4	[2-1] t=1	[2-2] t=2	[2-3] t=3	[2-4] t=4
Exp/Sales	0.00114***	0.00279***	0.00252***	0.00230***	0.000687	0.00208***	0.00154***	0.00147***
	[0.000441]	[0.000496]	[0.000596]	[0.000559]	[0.000425]	[0.000477]	[0.000586]	[0.000547]
Imp/Pur	0.000517*	0.00150***	0.00138***	0.00176***	0.000209	0.00124***	0.000886**	0.00140***
	[0.000293]	[0.000297]	[0.000368]	[0.000328]	[0.000288]	[0.000308]	[0.000378]	[0.000341]
FDI/(DDI+FDI) (stock value)	0.0000332	0.000912***	0.00100***	0.00112***	-0.0000124	0.000767***	0.000871***	0.000967***
	[0.000134]	[0.000188]	[0.000219]	[0.000202]	[0.000131]	[0.000187]	[0.000216]	[0.000201]
FDI/(DDI+FDI) (sub #)	0.000724	0.00192***	0.00278***	0.00200**	0.000373	0.00181**	0.00252***	0.00179**
	[0.000610]	[0.000714]	[0.000836]	[0.000788]	[0.000596]	[0.000706]	[0.000837]	[0.000787]
lnY/L					0.0207**	0.119***	0.101***	0.115***
					[0.00987]	[0.0143]	[0.0157]	[0.0149]
lnIntangible/L					0.107***	0.0677***	0.123***	0.0814***
					[0.0203]	[0.0183]	[0.0228]	[0.0202]
ICT/Sales					-0.000298	-0.000196	-0.00138	-0.00232
					[0.00104]	[0.00383]	[0.00293]	[0.00286]
HQ/L					0.000791*	0.000906*	0.00134**	0.00143**
					[0.000407]	[0.000542]	[0.000587]	[0.000569]
SGA/Sales					0.000214	0.00243***	0.00118**	0.00160***
					[0.000372]	[0.000473]	[0.000524]	[0.000500]
Foreign own					0.00179***	0.000524	0.00235***	0.00110***
					[0.000461]	[0.000361]	[0.000427]	[0.000385]
Loan/Asset					2.51E-06	-0.000483***	-0.000455**	-0.000382**
					[9.60e-05]	[0.000168]	[0.000191]	[0.000171]
Regular/L					-0.000274	-0.000906**	-0.000764*	-0.000773*
					[0.000247]	[0.000404]	[0.000430]	[0.000422]
Observations	5,483	5,483	5,483	5,483	5,483	5,483	5,483	5,483
R-squared	0.056	0.206	0.174	0.206	0.078	0.226	0.197	0.224

Notes: Robust standard errors in brackets

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

Industry dummies and prefecture dummies are included in all cases but omitted from the table.

The same notes apply to all the following tables, unless otherwise noticed.

Table 4 Arm's-length vs. intra-firm trade

	[1]	[2]	[3]	[4]
VARIABLES	t=1	t=2	t=3	t=4
Exp/Sales (arm's-length)	0.00043	0.00206***	0.00201***	0.00195***
	[0.000481]	[0.000612]	[0.000741]	[0.000688]
Exp/Sales (intra-firm)	0.00134	0.00215***	0.000367	0.000283
	[0.000952]	[0.000721]	[0.000934]	[0.000919]
Imp/Pur (arm's-length)	0.000253	0.00142***	0.00108**	0.00182***
	[0.000352]	[0.000386]	[0.000468]	[0.000415]
Imp/Pur (intra-firm)	0.000104	0.000874*	0.000503	0.000555
	[0.000482]	[0.000483]	[0.000618]	[0.000576]
FDI/(DDI+FDI) (stock value)	-0.0000271	0.000784***	0.000928***	0.00105***
	[0.000133]	[0.000188]	[0.000217]	[0.000202]
FDI/(DDI+FDI) (sub #)	0.000372	0.00180**	0.00251***	0.00177**
	[0.000596]	[0.000707]	[0.000836]	[0.000787]
lnY/L	0.0207**	0.119***	0.101***	0.114***
	[0.00988]	[0.0143]	[0.0157]	[0.0149]
Intangible/L	0.106***	0.0670***	0.124***	0.0815***
	[0.0203]	[0.0184]	[0.0229]	[0.0203]
ICT/Sales	-0.000307	-1.92E-04	-0.00136	-0.00229
	[0.00104]	[0.00384]	[0.00294]	[0.00287]
HQ/L	0.000797*	0.000904*	0.00133**	0.00141**
	[0.000407]	[0.000542]	[0.000587]	[0.000570]
SGA/Sales	0.000223	0.00243***	0.00116**	0.00157***
	[0.000372]	[0.000473]	[0.000524]	[0.000500]
Foreign own	0.00178***	0.000597	0.00249***	0.00133***
	[0.000463]	[0.000371]	[0.000452]	[0.000402]
Loan/Asset	9.56E-06	-0.000484***	-0.000471**	-0.000401**
	[9.59e-05]	[0.000169]	[0.000191]	[0.000174]
Regular/L	-0.00027	-0.000901**	-0.000764*	-0.000769*
	[0.000248]	[0.000404]	[0.000430]	[0.000422]
Observations	5,483	5,483	5,483	5,483
R-squared	0.078	0.226	0.197	0.225

Notes: Industry dummies, prefecture dummies, and constant term are included but omitted from the table.

Table 5 Globalization dummies

	[1-1]	[1-2]	[1-3]	[1-4]	[2-1]	[2-2]	[2-3]	[2-4]
	t=1	t=2	t=3	t=4	t=1	t=2	t=3	t=4
Exporter DUM	0.00711	0.0964***	0.0676***	0.0931***	0.0016	0.0774***	0.0496***	0.0745***
	[0.0112]	[0.0166]	[0.0182]	[0.0176]	[0.0111]	[0.0165]	[0.0181]	[0.0174]
Importer DUM	0.0149	0.0946***	0.0877***	0.103***	0.00531	0.0856***	0.0718***	0.0901***
	[0.0110]	[0.0159]	[0.0177]	[0.0171]	[0.0110]	[0.0159]	[0.0176]	[0.0170]
FDI DUM	0.0238*	0.0684***	0.104***	0.0838***	0.0144	0.0567***	0.0890***	0.0704***
	[0.0128]	[0.0160]	[0.0191]	[0.0175]	[0.0125]	[0.0159]	[0.0189]	[0.0173]
Firm-specific control variables	No	No	No	No	Yes	Yes	Yes	Yes
Industry DUM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture DUM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,483	5,483	5,483	5,483	5,483	5,483	5,483	5,483
R-squared	0.054	0.22	0.184	0.22	0.077	0.236	0.204	0.236

Table 6 Controls of occupation compositions

	[1] t=1	[2] t=2	[3] t=3	[4] t=4
Exp/Sales	0.000539	0.00188***	0.00117**	0.00118**
	[0.000411]	[0.000459]	[0.000561]	[0.000517]
Imp/Pur	0.00031	0.00159***	0.00129***	0.00185***
	[0.000277]	[0.000298]	[0.000365]	[0.000329]
FDI/(DDI+FDI) (stock value)	-0.0000358	0.000460**	0.000640***	0.000682***
	[0.000129]	[0.000186]	[0.000214]	[0.000200]
FDI/(DDI+FDI) (sub #)	0.000432	0.00192***	0.00260***	0.00195**
	[0.000594]	[0.000681]	[0.000838]	[0.000777]
% Managers	-0.00772**	0.00292	0.00371	0.000913
	[0.00330]	[0.00542]	[0.00555]	[0.00551]
% Engineers	0.00227***	0.00414***	0.00604***	0.00471***
	[0.000468]	[0.000375]	[0.000440]	[0.000387]
% Clerical workers	-0.00164	0.00272**	-0.0000995	0.00161
	[0.00104]	[0.00136]	[0.00145]	[0.00137]
% Sales workers	0.00121**	0.00159**	0.000956	0.000505
	[0.000480]	[0.000620]	[0.000643]	[0.000627]
Observations	5,467	5,467	5,467	5,467
R-squared	0.061	0.203	0.173	0.201

Notes: Firm-specific control variables and prefecture dummies are included in all cases but omitted from the table.

Table 7 Regional concentration of international trade

VARIABLES	[1-1] t=1	[1-2] t=2	[1-3] t=3	[1-4] t=4	[2-1] t=1	[2-2] t=2	[2-3] t=3	[2-4] t=4
Exp/Sales	0.00350***	0.00359***	0.00514***	0.00616***	0.00113**	0.00250***	0.00225***	0.00271***
	[0.00119]	[0.00115]	[0.00140]	[0.00123]	[0.000551]	[0.000606]	[0.000740]	[0.000665]
Imp/Pur	0.00265*	0.00189*	0.00415***	0.00266**	0.000115	0.000870**	0.00118**	0.00107**
	[0.00139]	[0.000973]	[0.00129]	[0.00106]	[0.000398]	[0.000413]	[0.000489]	[0.000455]
FDI/(DDI+FDI) (stock value)	-0.00000658	0.00028	0.000500**	0.000433**	0.0000243	0.000619***	0.000778***	0.000779***
	[0.000141]	[0.000195]	[0.000227]	[0.000211]	[0.000134]	[0.000192]	[0.000222]	[0.000206]
FDI/(DDI+FDI) (sub #)	0.000291	0.00157**	0.00226***	0.00152*	0.000416	0.00165**	0.00249***	0.00163**
	[0.000592]	[0.000705]	[0.000836]	[0.000791]	[0.000599]	[0.000710]	[0.000840]	[0.000793]
XHHI	-4.33E-07	7.53e-06***	4.15e-06**	7.66e-06***				
	[1.28e-06]	[1.90e-06]	[2.11e-06]	[2.03e-06]				
Exp/Sales×XHHI	-4.07e-07***	-3.37e-07**	-6.07e-07***	-8.03e-07***				
	[1.46e-07]	[1.61e-07]	[2.06e-07]	[1.85e-07]				
MHHI	-2.58E-07	9.56e-06***	8.91e-06***	9.99e-06***				
	[1.22e-06]	[1.86e-06]	[2.09e-06]	[2.00e-06]				
Imp/Pur×MHHI	-2.64e-07*	-0.00000019	-4.64e-07***	-2.56e-07**				
	[1.51e-07]	[1.16e-07]	[1.49e-07]	[1.27e-07]				
ShareChinaX					-0.000113	0.000456	0.000372	0.000633**
					[0.000180]	[0.000290]	[0.000316]	[0.000314]
Exp/Sales×ShareChinaX					-0.0000171	-0.0000222	-3.55e-05*	-5.95e-05***
					[1.35e-05]	[1.56e-05]	[1.93e-05]	[1.86e-05]
ShareChinaM					-0.000185	0.000564**	0.000462	0.000729***
					[0.000166]	[0.000261]	[0.000297]	[0.000281]
Imp/Pur×ShareChinaM					0.0000049	0.00000128	-0.0000128	-0.00000141
					[6.89e-06]	[7.52e-06]	[9.72e-06]	[8.57e-06]
Observations	5,483	5,483	5,483	5,483	5,483	5,483	5,483	5,483
R-squared	0.081	0.235	0.204	0.235	0.078	0.228	0.198	0.228

Notes: Firm-specific control variables, industry dummies and prefecture dummies are included in all cases but omitted from the table.

Table A1 International trade &FDI in levels

	[1]	[2]	[3]	[4]
VARIABLES	t=1	t=2	t=3	t=4
lnExp	0.00245	0.0138***	0.0116***	0.0137***
	[0.00213]	[0.00256]	[0.00299]	[0.00278]
lnImp	0.00118	0.0146***	0.0115***	0.0155***
	[0.00207]	[0.00238]	[0.00281]	[0.00260]
lnFDI (stock value)	0.00524**	0.00535**	0.0112***	0.00709**
	[0.00238]	[0.00254]	[0.00301]	[0.00276]
lnFDI (sub #)	0.0116	0.0419***	0.0664***	0.0546***
	[0.0188]	[0.0156]	[0.0204]	[0.0174]
lnY/L	0.0145	0.0977***	0.0792***	0.0908***
	[0.00989]	[0.0144]	[0.0158]	[0.0150]
lnIntangible/L	0.0994***	0.0475***	0.0978***	0.0571***
	[0.0202]	[0.0182]	[0.0217]	[0.0197]
ICT/Sales	-0.000188	0.0000158	-0.00111	-0.00206
	[0.00102]	[0.00371]	[0.00288]	[0.00281]
HQ/L	0.000768*	0.000825	0.00123**	0.00131**
	[0.000406]	[0.000534]	[0.000577]	[0.000559]
SGA/Sales	2.01E-04	0.00243***	0.00114**	0.00160***
	[0.000372]	[0.000468]	[0.000516]	[0.000492]
Foreign own	0.00176***	0.000312	0.00204***	0.000816**
	[0.000462]	[0.000350]	[0.000418]	[0.000373]
Loan/Asset	0.00000663	-0.000439***	-0.000429**	-0.000345**
	[9.28e-05]	[0.000163]	[0.000190]	[0.000168]
Regular/L	-0.000273	-0.000891**	-0.000749*	-0.000750*
	[0.000247]	[0.000402]	[0.000427]	[0.000419]
Observations	5,483	5,483	5,483	5,483
R-squared	0.081	0.239	0.211	0.239

Notes: Robust standard errors in brackets

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

Industry dummies and prefecture dummies are included in all cases but omitted from the table.

The same notes apply to all the following tables.

Table A2 Ordered logit

	[1-1]	[1-2]	[1-3]	[1-4]	[2-1]	[2-2]	[2-3]	[2-4]	[3-1]	[3-2]	[3-3]	[3-4]
Variables for globalization	Ratio				Dummy				Log			
Dep. var.= RW_extent	t=1	t=2	t=3	t=4	t=1	t=2	t=3	t=4	t=1	t=2	t=3	t=4
Export	0.00761*	0.0104***	0.00645***	0.00543**	0.0977	0.362***	0.231***	0.318***	0.0428	0.0699***	0.0533***	0.0626***
	[0.00403]	[0.00233]	[0.00245]	[0.00246]	[0.165]	[0.0765]	[0.0814]	[0.0788]	[0.0274]	[0.0126]	[0.0135]	[0.0131]
Import	0.00171	0.00653***	0.00525***	0.00752***	0.131	0.421***	0.371***	0.477***	0.0215	0.0805***	0.0678***	0.0918***
	[0.00299]	[0.00161]	[0.00174]	[0.00162]	[0.163]	[0.0747]	[0.0808]	[0.0780]	[0.0262]	[0.0120]	[0.0130]	[0.0126]
FDI (stock)	0.002	0.00417***	0.00458***	0.00503***	0.274*	0.340***	0.411***	0.400***	0.0691***	0.0419***	0.0603***	0.0492***
	[0.00166]	[0.000904]	[0.000967]	[0.000924]	[0.152]	[0.0782]	[0.0833]	[0.0802]	[0.0254]	[0.0132]	[0.0138]	[0.0134]
FDI (sub #)	0.00354	0.00912**	0.00938**	0.0105***					0.0226	0.152	0.168*	0.188**
	[0.00633]	[0.00361]	[0.00368]	[0.00367]					[0.153]	[0.0979]	[0.101]	[0.0906]
/cut1	2.376***	-2.223***	-0.854*	-1.630**	2.393***	-2.331***	-0.911*	-1.745***	2.152***	-2.404***	-1.022**	-1.837***
	[0.755]	[0.491]	[0.490]	[0.647]	[0.750]	[0.498]	[0.490]	[0.644]	[0.746]	[0.510]	[0.487]	[0.644]
/cut2	4.191***	-0.0626	0.794	0.222	4.208***	-0.142	0.751	0.137	3.978***	-0.198	0.663	0.0641
	[0.751]	[0.491]	[0.490]	[0.646]	[0.746]	[0.498]	[0.490]	[0.643]	[0.744]	[0.510]	[0.486]	[0.642]
/cut3	4.949***	1.898***	2.553***	2.220***	4.966***	1.827***	2.512***	2.147***	4.740***	1.798***	2.451***	2.110***
	[0.760]	[0.492]	[0.491]	[0.647]	[0.756]	[0.499]	[0.491]	[0.644]	[0.753]	[0.511]	[0.488]	[0.643]
Observations	5,483	5,483	5,483	5,483	5,483	5,483	5,483	5,483	5,483	5,483	5,483	5,483
Pseudo R-squared	0.111	0.176	0.147	0.175	0.111	0.182	0.152	0.182	0.119	0.186	0.158	0.187

Notes: Firm-specific control variables, industry dummies and prefecture dummies are included in all cases but omitted from the table.

Included globalization variables are Exp/Sales, Imp/Pur, FDI/(DDI+FDI) in Columns [1-1] to [1-4], Exporter, Importer, FDI DUM in Columns [2-1] to [2-4], and lnExp, lnImp, lnFDI in Columns [3-1] to [3-4].

Table A3 Firm-level controls of occupation compositions

	[1]	[2]	[3]	[4]
	t=1	t=2	t=3	t=4
Exp/Sales	0.000663	0.00171***	0.00117**	0.00102*
	[0.000431]	[0.000476]	[0.000590]	[0.000552]
Imp/Pur	0.000253	0.00127***	0.000878**	0.00140***
	[0.000288]	[0.000306]	[0.000374]	[0.000339]
FDI/(DDI+FDI) (stock value)	-0.0000457	0.000580***	0.000727***	0.000780***
	[0.000132]	[0.000185]	[0.000215]	[0.000200]
FDI/(DDI+FDI) (sub #)	0.000393	0.00196***	0.00255***	0.00187**
	[0.000592]	[0.000681]	[0.000827]	[0.000768]
Planning dept./HQ	0.00144***	0.00065	0.00171**	0.000812
	[0.000509]	[0.000673]	[0.000725]	[0.000676]
ICT dept./HQ	0.000544	0.00179	0.00464***	0.00335**
	[0.000986]	[0.00139]	[0.00151]	[0.00147]
R&D dept./HQ	0.00132**	0.00369***	0.00259***	0.00444***
	[0.000514]	[0.000606]	[0.000709]	[0.000639]
International dept./HQ	-0.00119	0.00279**	0.00445**	0.00405***
	[0.00131]	[0.00117]	[0.00177]	[0.00142]
Other corporate dept./HQ	0.0000554	-0.00000699	0.000116	0.000221
	[0.000209]	[0.000315]	[0.000343]	[0.000335]
Info service/HQ	-0.000188	0.00175***	0.00173***	0.00203***
	[0.000409]	[0.000448]	[0.000540]	[0.000503]
ICT workers/total workers (outside of HQ)	0.000932***	-0.0000609	0.000335	0.000409
	[0.000318]	[0.000309]	[0.000350]	[0.000320]
R&D lab workers/total workers (outside of HQ)	0.00178*	0.00128**	0.00274***	0.00228***
	[0.000932]	[0.000580]	[0.000860]	[0.000686]
Observations	5,483	5,483	5,483	5,483
R-squared	0.085	0.242	0.208	0.241

Notes: Firm-specific control variables, industry dummies and prefecture dummies are included in all cases but omitted from the table.