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Offshoring and working hours adjustments in a within-firm labor market

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ABSTRACT

Although a growing body of literature identifies the within-firm redistribution effects of trade, research on the adjustment processes in within-firm labor markets remains scarce. This study analyzes the within-firm adjustment of working hours and wages by considering workers' educational background and gender in response to a change in offshoring. Matched worker–firm panel data in the Japanese manufacturing sector covering 1998 to 2014 are used. The analysis leads to the following three observations. First, offshoring does not significantly alter the skill premium and gender gap in terms of scheduled monthly salaries and scheduled hourly wages. Second, offshoring decreases skill premium in annual hourly wages, whereas it increases gender gap in annual salaries. Third, this uneven impact on annual variables arises from the different changes in overtime working hours: college graduates work longer with a lower overtime premium, whereas female workers do not increase overtime work.

1. Introduction

The effects of trade shocks experienced by firms are redistributed across groups of workers within the firm. This is considered an important channel through which globalization affects income inequality, based upon two stylized facts: that within-firm wage inequality is the same as or larger than between-firm wage inequality (Skans et al., 2009, for Sweden; Akerman et al., 2013, for Sweden; Hesse, 2015, for Germany; Barth et al., 2016, for nine states in the United States; Helpman et al., 2017, for Brazil), and that firms engaging in international trade have higher levels of productivity, pay higher wages, and employ more skilled workers (Bernard et al., 2007, for the United States; Mayer and Ottaviano, 2008, for European countries; Wakasugi et al., 2014, for Japan). However, while a growing body of literature has identified the within-firm redistribution effects of trade, research concerning the adjustment process in within-firm labor markets through the change of hourly wages, working hours, and total salaries is limited.[1] This aspect is worth considering, especially in terms of the following two facts.

First, it demonstrates how changes in workers' hourly wage and salary are different as a result of working hours. A number of related studies use hourly wage, a key variable associated with factor price, as a dependent variable for estimation. However, what employers and full-time workers ultimately agree on as part of their labor contracts is not hourly wages, but contracted salaries for a certain period of time – such as a week, a half-month, or a month. Therefore, the possible reduction in labor demand for a particular group of workers due to offshoring, for example, would decrease their working hours and consequently, increase their hourly wage, assuming a given amount of contractual salary. Working hours and hourly wages are determined simultaneously in a within-firm labor market and are essential for understanding the impact of trade on workers' welfare.[2]

Second, and related to the first point, is that research on the

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[1] The within-firm, or internal, labor market is defined here as an organization in which the working conditions (e.g., salaries, working hours, and tenure) are determined through the interactions of the firm's labor demand, employees' labor supply, and legal and institutional constraints surrounding them. Although a boundary is drawn between workers inside and outside of the firm concerned, some interactions between the within-firm and external labor markets occur, for example, through the hiring and firing of employees.

[2] Examining working hours explicitly would help us understand the results that are difficult to interpret, such as Table 5 of Hummels et al. (2014). It shows that a 1% increase in offshoring decreases the hourly wages of unskilled workers, including mandatory pension fund payments, by 0.022% (column 3) and decreases their annual labor income, not including pension fund payments, by 0.015% (column 5), in cases of instrumental variable estimation with firm controls in Denmark. This implies that their working hours increase by 0.007% if pension fund payments change commensurably to the hourly wage. It is curious that hourly wages and working hours change in the opposite directions. There are various possible ways to explain this, including that offshoring reduces the number of unskilled workers by a larger number relative to their labor input, resulting in the increase in working hours for unskilled workers, or that the labor market equilibrium is located on the backward-bending section of the labor supply curve.

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adjustment process enables us to distinguish between the impact of trade on the across-the-board wage bill, and the impact on labor demand for each labor group within a particular firm. On the one hand, a trade shock would increase the wage bills of all worker types if it induces a Hicks-neutral technical change in a firm. For example, Bloom et al. (2016) show that import competition from China increased technical change in European firms. On the other hand, trade shocks would reduce the labor demanded for certain types of workers if they are close substitutes for imported inputs. Hummels et al. (2014) provide a theoretical foundation of substitution between imported inputs and labor in each labor group. Examining both working hours and contracted salary in each worker group helps to identify what factor causes the change in its hourly wages.

Given these facts, this study enriches the argument concerning the adjustment process of trade shocks in internal labor markets by estimating the impact of such shocks on salaries, working hours, and hourly wages. This paper specifically deals with offshoring as a type of trade shock. As a type of international shock, offshoring has a distinctive feature in that a large number of firms have engaged in this activity and the extent of offshoring varies greatly from firm to firm, producing different impacts regarding within-firm redistribution. The effects of offshoring on labor markets are well-surveyed by Hummels et al. (2018). In this study, offshoring is defined as the importing of intermediate material inputs from abroad, following the work of Baumgarten et al. (2013), Hummels et al. (2014), Carluccio et al. (2015), Kim and Hwang (2016), Andersson et al. (2016, 2017), and Carluccio et al. (2019), to name just a few. Matched worker–firm data in the Japanese manufacturing sector for 17 years between 1998 and 2014 are employed for the estimations, which is methodologically similar to Hummels et al. (2014) and Vahter and Masso (2019). Workers are categorized by their educational background and gender. These indicators are appropriate for worker classifications in this context because they are characteristics that are exogenous to firms' trade decisions.

The distribution effects of globalization depend on many factors, including country-, time-, and group-specific factors. This case specificity may apply to within-firm redistribution as a result of the offshoring effect. Regarding the skill premium, previous studies uniformly report the enhancing impact of offshoring. Hummels et al. (2014), Kim and Hwang (2016), and Andersson et al. (2016, 2017) show that an increase in imported inputs widens the income gap between skilled and unskilled workers for Denmark, the United States, and Sweden, respectively. Carluccio et al. (2015) consider four occupations in France and show that increases in offshoring improve the hourly wages of white-collar workers and executives more than the other two occupations in the study.[3] This paper provides evidence from Japan that offshoring to Asia actually decreases the skill premium in terms of annual hourly wages, and that it does not change the skill premium in annual salaries.

Although the impact of offshoring on the gender wage gap in within-firm labor markets has not been adequately examined, some closely related studies observe the effect of firms' international activities on male and female workers' wages. Regarding Japanese examples, by using industry-level cost functions, Kiyota and Maruyama (2018) find that offshoring has insignificant effects on female worker demand. Additionally, Kodama et al. (2018) report that Japanese firms acquired by foreign firms increase the number of female employees and the share of females in their workforce. Assuming that higher labor demand causes higher wages, this result suggests that inward foreign direct investment would decrease the gender wage gap in Japan. As for studies using employer-employee panel data in other countries, Bøler et al. (2018) and Vahter and Masso (2019) examine exporter firms in Norway and foreign multinationals in Estonia, respectively, finding that these international factors increase the within-firm gender wage gap. From Japanese employer-employee panel data, this study demonstrates that offshoring to Asia by Japanese firms does not change the gender gap in annual hourly wages but expands it in annual salaries.

The impact of offshoring on working hours by each worker group is a new research topic. This study provides evidence that offshoring decreases scheduled working hours among Japanese workers in a similar fashion across all skill–gender groups – that is, imported material inputs are close substitutes for labor inputs of all types. More than four-fifths of the decrease in scheduled working hours is attributed to a decrease in working days. It is intriguing to see that offshoring increases overtime working hours in workers who are male and college graduates, reflecting the differences in their preferences for consumption and leisure. I demonstrate that the changes in overtime working hours by each worker group is the primary factor inducing the shrinking skill premium with regard to annual hourly wages and the expanding gender gap with regard to annual salary.

The remainder of this paper is structured as follows: Section 2 explains the method of constructing the matched worker–establishment–firm panel data used in the estimation, the characteristics of the Japanese within-firm labor market, and the instrument variable for Japanese firms' offshoring to Asia. Section 3 describes the estimation equation and variables used in this study, and interprets the empirical results. Section 4 explains the role of overtime working hours for the changes in skill premium and gender gap. Section 5 concludes the study.

2. Data

2.1. Construction of the matched worker–firm panel dataset

To construct the Japanese matched worker–firm panel dataset, I utilize *The Basic Survey on Wage Structure* (hereafter, referred to as *The Wage Survey*) conducted by the Ministry of Health, Labour and Welfare for worker–establishment–year data, and *The Basic Survey of Japanese Business Structure and Activities* (hereafter, *The Business Survey*) conducted by the Ministry of Economy, Trade and Industry for firm–year data. The former data are from selected establishments (i.e., the premises of business units among firms such as branches, business offices, and plants), while the latter are from firms. Neither dataset includes information on the establishment–firm connection and, therefore, I employ two censuses to link the datasets. These censuses are *The Establishment and Enterprise Census* and *The Economic Census for Business Frame* (hereafter, *The Censuses*) conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications.[4]

The method to link wage data with firm data is as follows: Each wage observation in *The Wage Survey* contains an identification (ID) number for each establishment at which workers are employed. Establishment ID numbers in *The Wage Survey* were assigned by *The Censuses* conducted several years ago. Since establishment ID numbers change for every census, this number for a particular establishment in *The Wage Survey* also changes every two to four years. However, I could trace back a series of ID numbers for each establishment since *The Censuses* of 1999, 2001, 2004, 2006, and 2009 contain ID numbers for all establishments

[3] Closely related to offshoring, the effect of reducing import tariffs on intermediate inputs is examined by Amiti and Cameron (2012) for Indonesia, Hahn and Choi (2017) for South Korea, and Chen, Yu, and Yu (2017) for China. They propose the opposite results; Amiti and Cameron (2012) report that it reduces the income gap between groups of skilled and unskilled workers, whereas Hahn and Choi (2017) and Chen, Yu, and Yu (2017) show that it widens the income gap.

[4] Explanation of the four datasets constructed by the Japanese government can be found in Appendix 1.

for both current and previous censuses. I construct panel data on establishment ID numbers by using the five censuses from 1999 to 2009, making it possible to trace the ID numbers of each establishment in *The Wage Surveys* between 1998 and 2014.[5]

The Censuses of 2001, 2006, and 2009 also include information about the firm associated with each establishment. I assume that the firm–establishment relationship for *The Censuses* in 1996 and 1999 are the same as those in 2001 and that the firm–establishment relationship for the 2004 census is the same as that in 2006. *The Business Survey* includes the permanent ID numbers for all firms, which do not change between survey years. However, *The Censuses* do not contain any firm ID numbers. Therefore, I connect firms in *The Censuses* with those in *The Business Survey* by using two pieces of information: the firms' phone numbers, and their names and zip codes. Following this, I connect establishment ID numbers to any year to the permanent firm ID numbers in *The Business Survey*, and thus connect the wage observations in *The Wage Survey* to any year to the firm data. Approximately 28% of observations in *The Wage Survey* are connected with *The Business Survey* in each survey year. The obtained Japanese worker–establishment–firm–-year data form an unbalanced panel, and the panel variables are the establishment and firm, not the worker, since no worker ID system has been introduced in *The Wage Survey*.

The Wage Survey is carried out in July and, therefore, the data for each item is essentially a reflection of the within-firm labor market conditions in June of the survey year, with the exception of annual special cash earnings, which record the value provided to each employee in the previous year. *The Wage Survey* in Japan is unique in the sense that it includes data not only on workers' background and salaries but also their actual working hours and days. I connect the worker data from *The Wage Survey* conducted in year t with the firm data in fiscal year t-1 from *The Business Survey* conducted in year t, with the assumption that a firm's performance in fiscal year t-1 affects workers' bonuses in year t-1 and their wages and working hours in year t.

I use observations for private manufacturing firms that directly import from foreign countries under their own names, except for firms in the petroleum, the plastic products, the tires and inner tubes, and the smelting and refining non-ferrous metal industries. I delete observations for these industries as their main inputs are petroleum and metal ores, whose production in Japan is not significant and, therefore, are not considered to be substitutes for Japanese workers. Furthermore, these inputs' prices change widely during the analyzed period and, as such, the change in firms' import values do not sufficiently represent the actual change in import volumes correctly. Observations of senior management (*Bucho* in Japanese) and middle management (*Kacho*) positions are excluded from the dataset because they are taken to be on the management side, and more than 96% of those in the manufacturing sector report zero overtime working hours. Since working hours including overtime is the key variable in observing the adjustment process in within-firm labor markets, they are not appropriate for the analysis. Observations considered to be unsuitable for the analysis are also deleted.[6]

The constructed panel data for this analysis cover 1998–2014 for wage and working hours data, and 1997–2013 for firm data. The panel dataset has 785,475 worker–establishment–firm–year observations from 8242 establishments. Each firm is classified into one of 42 industries, based on the earliest recorded observation of that firm in *The Business Survey*. The largest share of worker observations is in the "motor vehicles, parts, and accessories" industry (16.5%) followed by "electronic parts and devices" (6.8%).

2.2. Data on wages, working hours, and trade

Japanese firms' internal labor markets are suitable for this paper's analysis due to the following reasons that make the effect of firms' offshoring on their salaries and working hours more observable.[7] First, the working hours and overtime hours of Japanese workers are longer than those of most other developed countries – hence, there is more room for the adjustment of working hours in response to trade shocks experienced by Japanese workers than by those of other countries. According to Ogura (2009), working hours in Japan are similar to those in the United States and longer than those in developed European countries. Furthermore, the proportion of Japanese people working more than 49 h per week was among the highest in developed countries in the 2000s.[8] Second, worker mobility between internal and external labor markets is still limited in Japan. The longer average job tenure of Japanese employees represents the lower mobility of its labor market compared to other countries.[9] This feature produces two potential benefits, held at

[5] *The Establishment and Enterprise Censuses* for 1996 and earlier do not contain the establishment ID numbers used in previous censuses and, therefore, it is not possible to trace them before 1996 by using this information. I do not use other information such as names, addresses, and telephone numbers to construct the panel data because this was beyond the capacity of the research environment.

[6] A detailed explanation of the selection of the analysis sample is as follows: First, for workers' status, I remove the observations of workers aged 60 years and older because the age–wage profile in Japan is discontinued at 60 years owing to the mandatory retirement system in Japanese firms. The observations of part-time workers are also not used in the analysis because they do not provide workers' academic background information, which is used to define the group of workers later. In addition, I remove the observations of workers whose tenure year is zero because most of these workers would not have received special cash earnings (a component of annual salary) in the previous year. Second, I delete observations that meet the following conditions: workers with fewer than 15 or more than 26 working days in a month, those with fewer than five or more than ten average standard working hours in a day, and those with annual special cash earnings that are more than eight times the next year's monthly wages. This is because the working schedules for these workers are considered to not match their employment contracts, their contracts are rather exceptional, or they take a longer leave of absence for any reason. Therefore, their observations may contain outliers for the dependent variables.

[7] The characteristics of the within-firm labor markets in Japan are summarized by, for example, Ariga, Brunello, and Ohkusa (2000), Flath (2014), and Ito and Hoshi (2020). Waldman (2013) surveys previous research, which explains the differences between the within-firm labor markets in the United States and Japan.

[8] In addition, OECD (1998) shows that overtime hours in Japan were longer than those in Australia, Canada, Finland, Germany, and the United Kingdom in the late 1990s.

[9] The average job tenure of Japanese employees was 11.9 years in 2010 from *The Wage Survey*, which is longer than that of all countries provided in the OECD database (see the variable "employment by job tenure intervals" for a comparison). In particular, the average job tenure of Japanese male workers was 13.3 years, which is remarkably longer than that of Italian male workers (11.7 years), the highest of all countries available in the OECD database, which did not provide this figure in Japan.

Table 1
Mean figures of key variables concerning salary, working hours, and hourly wages by worker group.

	Male non-college graduates	Male college graduates	Female non-college graduates	Female college graduates
Salary (Japanese Yen):				
Monthly salary ($a = b + c$)	372,351	412,531	236,021	308,151
Scheduled monthly salary (b)	318,665	372,527	220,170	283,954
Overtime monthly salary (c)	53,686	40,003	15,851	24,197
Bonuses (d)	1,246,192	1,372,790	797,931	1,093,503
Annual salary ($e = a \times 12 + d$)	5,714,409	6,323,157	3,630,182	4,791,314
Working days and hours:				
Monthly working days (f)	20.7	20.7	20.7	20.5
Monthly working hours ($g = h + i$)	178.2	176.8	169.3	169.9
Scheduled working hours (h)	158.9	160.4	160.4	158.6
Overtime working hours (i)	19.3	16.4	8.9	11.3
Working hours per day ($= g / f$)	8.6	8.6	8.2	8.3
Scheduled hours per day ($= h / f$)	7.7	7.8	7.7	7.7
Overtime per day ($= i / f$)	0.9	0.8	0.4	0.5
Share of obs. with positive overtime (%)	77.8	60.8	60.9	64.4
Hourly wage (Japanese Yen):				
Annual hourly wage ($= e / (g \times 12)$)	2,673	2,981	1,786	2,350
Scheduled hourly wage ($j = b / h$)	2,006	2,322	1,372	1,790
Overtime hourly wage ($k = c / i$)	2,782	2,444	1,779	2,146
Ratio of overtime/ sched. hourly wage ($= k / j$)	1.39	1.05	1.30	1.20
Observations	425,021	201,541	136,657	22,256

Note: Salaries and hourly wages are deflated by the GDP deflators of their corresponding years.
Source: Author.

least in short term, for the analysis: That the effect of firm-specific trade shocks permeates less through other firms, and that the considerable part of labor quantity adjustment occurs through the changes in working hours.[10] Third, the enterprise union is the dominant form of labor union in Japan. Therefore, the working conditions of employees is more closely related to the performance of their firm in Japan than in other countries where craft unions prevail.

This study focuses on two worker attributes among the many candidates: college graduates and female workers. The main reason for using these indicators is that workers' educational background and gender are almost always determined before they are hired by firms and, therefore, it is safe to say that these indicators are exogenous to firms' trade decisions. Some other indicators available in *The Wage Survey* – such as non-production workers and supervisors – are not exogenous due to job rotations driven by internal transfers and promotions in response to firm-specific trade shocks.[11] I categorize workers who list college and graduate school as their highest completed education as college graduates, and use the category to estimate the skill premium. Similarly, the female worker category is to estimate the gender wage gap. As these two definitions are not mutually exclusive, there are four worker groups from the combination of the two indicators: male non-college graduates, male college graduates, female non-college graduates, and female college graduates.

Table 1 shows the mean figures of key variables concerning the salary, working hours, and hourly wages of the four worker groups in the constructed panel dataset.[12] Monthly salary is the sum of scheduled monthly salary and overtime pay, and annual salary is calculated as 12 times the monthly wage in June of that year and the annual bonuses paid in the previous year.[13] These payments are deflated by the GDP deflators of their corresponding years. Male college graduates receive the highest monthly salary, bonuses, and annual salary; followed by male non-college graduates, female college graduates, and female non-college graduates. Monthly working hours are the sum of scheduled working hours and overtime during the survey month of June. All four groups work almost the same number of days and scheduled hours, but male workers work more overtime hours.[14] Around 60% of workers record overtime work, with the exception of male non-college graduates, among whom 78% record overtime.

An annual hourly wage is the annual salary divided by 12 times of the monthly working hours. A scheduled hourly wage is the scheduled monthly salary divided by scheduled monthly working hours, and an overtime hourly wage is obtained from the parallel definition. Overtime hourly wages are naturally higher than scheduled hourly wages in all four groups because of an overtime premium. The premium ratio of overtime – that is, the ratio of overtime to scheduled hourly wages – is the highest among male non-college graduates. This may be the result of overtime work with higher premiums – such as late-night work, night-duties, and holiday work – being assigned to them more frequently than other worker groups. In contrast, the premium ratio is the lowest

[10] There are no concrete figures of what ratio of labor quantity adjustment in a firm attributes to the changes in the number of employees in that firm and to the changes in their working hours, because *The Wage Survey* and *The Business Survey* do not contain sufficient information to calculate them.

[11] Previous research defines college graduates, non-production workers, and supervisors as skilled workers and uses them to estimate trade shocks on skill premiums. Some examples of these definitions of skilled workers from the literature on the impact of imported inputs or offshoring on the skill premium in developed countries follow. Baumgarten et al. (2013) and Hummels et al. (2014) use the classification of workers' educational background as a proxy for skill. Feenstra and Hanson (1999) and Yan (2006) consider production and non-production workers to be proxies for unskilled and skilled labor, respectively. Egger and Egger (2003) and Hijzen, Görg, and Hine (2005) consider the characteristics of each job or task and classify workers with jobs or tasks that require high or special qualifications as skilled labor.

[12] Figures in Table 1 are the averages observed over the period 1998–2014; therefore, the table does not provide their changes over the analyzed period. The time-series developments of salaries, working hours, and hourly wages in the four worker groups are depicted in Figure A1 of Appendix 2.

[13] Scheduled monthly salary is the before-tax cash amount paid to employees for their scheduled working hours, based on paying conditions specified in labor contracts for the surveyed month of June. It does not include overtime pay but includes commuting and family allowances. Calculated annual salary in a certain year can be interpreted as the approximate salary of the first half of the corresponding year and the second half of the previous year, as Japanese firms usually pay bonuses twice a year, in July and December.

[14] Monthly working hours are considered to be underreported owing to firms' affecting adherence to the Labor Standards Law and forcing their employees to perform unpaid work. The estimation of actual working hours is beyond the scope of this study. See Kuroda (2010), for example, for the measurement and transition of Japanese working hours. Kuroda and Yamamoto (2013) investigate the determinants of Japanese workers' long working hours, with an emphasis on firms' fixed labor costs.

among male college graduates, possibly because a larger share of them work according to an annual salary scheme.

2.3. IVs for offshoring

It is intuitive to assume that a firm's offshoring is endogenous with respect to its optimization process because trade is a choice variable for firms and, thus, is determined together with each firm's factor prices and inputs. In addition, other unobserved variables might simultaneously affect the level of offshoring, factor prices, and inputs. Recent studies on trade predominantly employ two approaches to tackle the endogeneity problem in this context. The first approach is to use a large-scale policy change which is exogenous to a firm's performance, and the other is to use an instrumental variable (IV) estimation. Since it is difficult to find appropriate international events affecting Japanese offshoring for the former approach, I use the latter approach in this study. Firms' offshoring and their interaction terms are, thus, to be instrumented. I use firms' material imports from Asia, recorded in *The Business Survey*, as a variable of offshoring.[15] Imports from the Middle East, Oceania, and Africa are not considered here because they largely consist of mineral resources and agricultural products, which are not appropriate measures of offshoring for Japanese manufacturing firms. Among imports from the rest of the world, those from Asia constitute the majority of intermediate imports among Japanese firms and are a driving force behind expanding offshoring.[16]

Instruments for offshoring must be correlated with changes in firms' imports from Asia but must be uncorrelated with changes in firms' productivity and wage structures. In this study, I employ the per worker exports of Asian subsidiaries of other Japanese firms (excluding exports to Japan) classified in the same industry as an IV for Japanese firms' offshoring. Data on the overseas subsidiaries of Japanese firms are obtained from *The Survey on Overseas Business Activities* (hereafter, *The Overseas Survey*) conducted by the Ministry of Economy, Trade and Industry.[17] The IV for a particular firm, say firm j, in industry k is calculated by using *The Overseas Survey* as follows: First, Asian subsidiaries of other Japanese firms belonging to industry k are ascertained. Then, their export values to the world are summated, except those to Japan. Finally, the total values is divided by the sum of the number of workers employed by these Asian subsidiaries to obtain the per worker values. This variable affects firm j's offshoring to Asia positively because it reflects the overall tendency of overseas activities and the international transactions of the Japanese industry to which firm j belongs. This further represents various factors, including the system of international transportation, the size of labor intensity, the cost of foreign labor, and the development of global value chain in industry k. The IV is free from endogeneity for two reasons: it uses export values of other firms' Asian subsidiaries, and these export values do not include exports to Japan.

3. Empirical analysis

3.1. Estimation equation

The following equation is used to estimate the effects of offshoring on salaries, hourly wages, or working hours:

$$\ln y_{ijt} = \beta^{off} \ln off_{jt-1} + \boldsymbol{\beta}^{\mathbf{off}}_{\mathbf{dw}} \mathbf{d}_{\mathbf{wit}} \ln off_{jt-1} + \boldsymbol{\beta}_{\mathbf{xw}} \mathbf{x}_{\mathbf{wit}} + \boldsymbol{\beta}_{\boldsymbol{\varphi}} \boldsymbol{\varphi} + \varepsilon_{ijt}, \quad (1)$$

where y_{ijt} is the dependent variable associated with worker i employed by firm j in year t (where bonuses are given in year $t-1$); off_{jt-1} represents firm j's offshoring to Asia in year $t-1$; $\mathbf{d}_{\mathbf{wit}}$ is a vector of two worker dummies used as interaction terms with off_{jt-1}; $\mathbf{x}_{\mathbf{wit}}$ is a vector of the worker-level variables; $\boldsymbol{\varphi}$ is a vector of the dummies that is used to absorb fixed effects for worker groups, years, and establishments; and ε_{ijt} is the error term.

The complete list of variables in three sets of vectors in Eq. (1) is as follows. First, $\mathbf{d}_{\mathbf{wit}}$ represents two worker attributes: college graduates and female workers. A group of male non-college graduates has no dummies and, therefore, is used as the baseline.

Second, $\mathbf{x}_{\mathbf{wit}}$ consists of three variable types: (1) Variables for the wage profile – years of potential work experience and its square, and years of job tenure and its square;[18] (2) dummy variables for workers' characteristics – junior high school graduate, high school graduate, higher-level vocational school or junior college graduate, college or graduate school graduate, lower management level, crew leader or equivalent, other supervisory level, specialist, non-production worker, fixed-term employment, and female; and (3) differences in wage profiles reflecting worker and industry characteristics – interaction terms with each variable in (1) and each variable in (2), and interaction terms with each variable in (1) and each dummy for the 24 aggregated industries of the establishment to which worker i belongs. An establishment's industry is fixed for the industry in which that establishment first appears in *The Wage Survey* conducted after 1998.

Third, $\boldsymbol{\varphi}$ includes four types of fixed effects: age group–gender–year groups, female–prefecture groups, establishment industry–year groups, and establishments. The first set of dummies is used to absorb the fixed effects by age group, gender, and year groups. Here, I categorize workers by their age into the cohorts of 10 s, 20 s, 30 s, 40 s, and 50 s in each year. This set of dummies reflects the flattening of the cohort wage profile in Japan throughout the sample period used for this research (e.g., Bognanno and Kambayashi, 2013; Hamaaki et al., 2012; Yamada and Kawaguchi, 2015) and the closing trend of the wage gap between male and female workers (e.g., Abe, 2010; Kawaguchi, 2015; Hara, 2018). Female–prefecture dummies are used to control for the regional differences in gender wage gaps. Establishment industry–year dummies absorb specific shocks on each of nine comprehensive industry groups to which establishments belong for a particular year.

I use establishment as a panel variable for the fixed effect estimation. *Worker* is preferable to *establishment* as a panel variable for the matched worker–firm panel data; however, this is not viable since no worker ID system has been introduced in *The Wage Survey*, as mentioned in Section 2.1. I do not include firm variables such as output, export, and capital in this equation, as I intend to observe the total results of firms' offshoring, which include a productivity effect. Table 2 summarizes the descriptive statistics of the dependent variables, as well as some of the independent

[15] The definition of offshoring in this study does not include the international trade of service, because of the limitation of data availability.

[16] These observations come from Panels A and B in Figure A2 in Appendix 3, which show firms' average imports of intermediate goods and their average ratio of imports to total intermediate inputs from 1997 to 2013. It conveys the significance of material intermediates from Asia, though it covers only Japanese firms with positive imports from Asia. In addition, Panel C in Figure A2 in Appendix 3 depicts the ratio of import-expanding firms in the same period, suggesting a large variation of the change of offshoring among firms. This is the characteristic required as an explanatory variable.

[17] I connect firms in *The Business Survey* with those in *The Overseas Survey* by using three keys: firm code, firm phone number, and firm name plus zip code.

[18] Workers' years of potential work experience is calculated by subtracting the assumed age when workers graduated from school with their highest educational level from the present age. Assumed age of graduation is 15 years for a junior high school graduate, 18 years for a senior high school graduate, 20 years for a higher-level vocational school or junior college graduate, and 22 years for a college graduate. *The Wage Survey* does not distinguish between workers who have graduated from graduate schools versus colleges in the questionnaire and, thus, graduate school graduates are considered to be college graduates in this calculation.

Table 2
Descriptive statistics.

	# obs.	Mean	Std. Dev.	P5	P50	P95
Worker-level dependent variables						
Salary variables						
Log annual salary	785,475	15.448	0.381	14.775	15.482	16.010
Log annual hourly wages	785,475	7.802	0.397	7.118	7.823	8.414
Log scheduled monthly salary	785,475	12.595	0.354	12.025	12.599	13.171
Log scheduled hourly wages	785,475	7.528	0.377	6.911	7.531	8.137
Working hours variables						
Log annual working hours	785,475	7.646	0.138	7.427	7.644	7.883
Log scheduled monthly working hours	785,475	5.067	0.099	4.905	5.075	5.215
Log monthly working days	785,475	3.024	0.095	2.890	3.045	3.178
Log scheduled working hours per day	785,475	2.043	0.053	1.946	2.051	2.079
Worker-level independent variables						
Years of job tenure	785,475	15.923	10.855	2.000	14.000	36.000
Years of potential work experience	785,475	19.805	11.255	3.000	18.000	39.000
Firm-level independent variable						
Log offshoring from Asia	13,783	19.605	2.402	15.500	19.653	23.573
Firm-level instrument variable						
Log exports of Asian subsidiaries of other firms	13,783	14.416	1.119	12.519	14.581	15.837

Notes: The worker-level data present worker-year observations and the firm-level data present firm-year observations. Salaries, hourly wages, and trade values are deflated by GDP deflators. See the main text for the definition of variables.
Source: Author.

variables and the IV.

3.2. Analysis for annual variables

The first set of estimations utilizes three annual values as dependent variables: annual salary, annual hourly wages, and annual working hours. These variables include the effects of offshoring on bonuses, overtime payments, and overtime working hours, as well as on monthly scheduled salaries and working hours. An annual hourly wage is obtained by dividing annual salary by annual working hours. The annual hourly wage is used as a key dependent variable in studies by Hummels et al. (2014), Carluccio et al. (2015), and Bøler et al. (2018) on international shocks and wages. I consider, however, that salary and working hours are primary variables determined in within-firm labor markets while being influenced by offshoring, and that the hourly wage is then calculated secondarily from observed salary and working hours. This viewpoint is derived from the observation that, in labor–management negotiations in Japanese firms, employers and employees discuss terms relating to salary and working conditions, including working hours and number of days leave allocated and taken, but do not directly negotiate an hourly wage. Additionally, it is worth noting that, to a certain degree, employees can change working hours themselves by taking more or less paid and sick leave.[19]

Table 3 summarizes fixed effects (FE) and FE-IV estimates. FE estimation uses offshoring and its interaction terms with college graduates and female workers as independent variables – these results are reported in columns 1–3 of Panel A. There are two sets of FE-IV estimations: The first only uses offshoring, while the second adds interaction terms – these second-stage results are shown in columns 4–6 and 7–9 of Panel A, respectively. FE estimates in columns 1–3 of Panel A are generally smaller than their correspondences in the second-stage FE-IV estimates, as indicated in columns 7–9 in the same panel. The first-stage estimate for columns 4–6 in Panel A is reported in column 1 of Panel B, which shows that my IV significantly explains firms' offshoring with the expected positive causality. The F statistic for IV is 37.22, which is sufficiently high. In columns 7–9 of Panel A, where the interaction terms are used, the Kleibergen–Paap F statistic is 12.46. Although this figure is barely more than 10, second-stage estimates for offshoring are not notably different from those in columns 4–6; as such, I posit that possible weak identification does not produce biased results. Their first-stage estimates are reported in columns 2–4 of Panel B, which proves that the IVs have appropriate characteristics.

Columns 4–6 in Panel A in Table 3, show that a 1% increase in offshoring to Asia leads to increases in annual salary and annual hourly wages by 0.034% and 0.049%, respectively, and a decrease in annual working hours by 0.015% – though the latter is not sufficiently significant. The increase in annual salary possibly represents the growth of firms' productivity by introducing new production technology, altering production processes, and reassigning employees to new posts – all accompanied by offshoring. It is beyond the scope of this study, however, to examine what amount and through what channels material offshoring to Asia enhances firms' productivity. The decrease in annual working hours is partly explained by considering imported inputs and labor inputs as being close substitutes; however, the offshoring effect on decreasing labor demand is supposedly blurred in column 6 due to the endogenous change in employees' working hours of their own will. Though offshoring decreases the demand for labor, it is beneficial for workers who are still employed by the offshoring firms due to the resulting increase in annual salary and hourly wages.

Columns 7–9 in Panel A exhibit the results of interaction terms concerning offshoring when college graduates and female workers are used. The characteristic of the results on the base group (male non-college graduates) are the same as those in columns 4–6. It is interesting to see that offshoring has additional, distinctive effects for college graduates and female workers. For college graduates, offshoring does not change their skill premium in terms of annual salary (column 7), whereas it causes a reduced impact with regard to their working hours (column 9). Consequently, offshoring results in a lesser increase in their annual hourly wages (column 8). For female workers, offshoring causes a greater decrease in working hours (column 9) and a lesser increase in annual salary (column 7). To summarize, offshoring decreases skill premium in annual hourly wages, whereas it increases the prevailing gender gap in annual salaries. There are some reasons that clarify these outcomes: the shrinking skill premium or the widening gender gap with regard to schedules monthly salaries, bonuses, or overtime payments; the change of scheduled or overtime working hours; and the vulnerability to the downward pressure from offshoring being utilized as a threat to employees (Jeon and Kwon, 2018). I examine which factors explain the change of skill premium or gender gap in the next section.

[19] *The General Survey on Working Conditions*, conducted annually by the Ministry of Health, Labour and Welfare, reports that the ratio of paid leave employees availed to the paid leave they are entitled fluctuates below 50% during most of the analyzed period. This implies that Japanese employees have some scope to adjust their working hours by availing or not availing paid leave.

Table 3
Estimates for annual variables.

Panel A. FE and second-stage FE-IV estimates

	FE			Second-stage FE-IV					
Dep. variable:	Log annual salary (1)	Log annual hourly wages (2)	Log annual working hours (3)	Log annual salary (4)	Log annual hourly wages (5)	Log annual working hours (6)	Log annual salary (7)	Log annual hourly wages (8)	Log annual working hours (9)
Log offshoring to Asia (a)	−0.0002	−0.0007	0.0005	0.0342***	0.0491***	−0.0149*	0.0374***	0.0524***	−0.0149*
	(0.0008)	(0.0009)	(0.0007)	(0.0099)	(0.0124)	(0.0082)	(0.0099)	(0.0124)	(0.0082)
× college graduates (b)	0.0084***	0.0077***	0.0007**				−0.0037	−0.0110**	0.0073***
	(0.0005)	(0.0005)	(0.0003)				(0.0040)	(0.0047)	(0.0025)
× female workers (c)	−0.0034***	−0.0033***	−0.0001				−0.0195***	−0.0063	−0.0131***
	(0.0006)	(0.0006)	(0.0003)				(0.0055)	(0.0049)	(0.0029)
(a) + (b)	0.0082***	0.0070***	0.0012*				0.0337***	0.0414***	−0.0077
	(0.0009)	(0.0010)	(0.0007)				(0.0099)	(0.0127)	(0.0084)
(a) + (c)	−0.0036***	−0.0040***	0.0004				0.0180	0.0460***	−0.0281***
	(0.0010)	(0.0010)	(0.0007)				(0.0110)	(0.0133)	(0.0088)
(a) + (b) + (c)	0.0048***	0.0037***	0.0011				0.0142	0.0350***	−0.0208**
	(0.0011)	(0.0011)	(0.0008)				(0.0113)	(0.0137)	(0.0091)
Adjusted R^2	0.724	0.732	0.087						
F statistic	403.34	282.17	6.82						

Panel B. First-stage FE-IV estimates

Dep. variable:	Log offshoring to Asia (1)	Log offshoring to Asia (2)	× college graduates (3)	× female workers (4)
Log exports of Asian subsidiaries of other firms	0.1569***	0.1579***	−0.0526***	−0.0307***
	(0.0257)	(0.0259)	(0.0140)	(0.0080)
× college graduates		0.0021	0.2784***	−0.0031
		(0.0073)	(0.0343)	(0.0051)
× female workers		−0.0080*	0.0033	0.2551***
		(0.0045)	(0.0067)	(0.0282)
Adjusted R^2	0.232	0.232	0.983	0.984
F statistic	37.22	40.84	72.34	84.55

Notes: All specifications include establishment, establishment industry-year, age group-female-year, female-prefecture dummies, and other worker controls – such as years of job tenure and potential work experience; the table does not report their coefficients. See the main text for description of all variables used. Standard errors in parentheses are clustered at the establishment level. The number of observations is 785,475 and the number of establishments is 8,242 across all columns. The *F* statistic for Panel B, column 1 is used to test whether the estimate for IV is zero, and the *F* statistics for Panel A, columns 1–3, and for Panel B, columns 2–4, are to test whether the estimates for three trade variables are zero in each column. The Kleibergen-Paap *F* statistic for Panel A, columns 7–9 is 12.46. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Author.

3.3. *Analyses for scheduled monthly variables*

Three annual, dependent variables employed in the previous subsection are composed of three parts: scheduled monthly variables (scheduled monthly salaries, hourly wages, and working hours), overtime working variables (overtime payments and overtime working hours), and bonuses. These three parts are expected to react to exogenous shocks in different ways. The part concerning scheduled monthly variables is considered less elastic to exogenous shock, as these variables are key contractual items in labor–management negotiations, and employees prefer sound and stable working conditions. Overtime working variables and bonuses are more elastic: employees have some autonomy in setting their preferable overtime working hours, and bonuses correlate more closely with the performance of each firm. The aim of this subsection is to examine the differences in impacts of offshoring to Asia on these variables by comparing the estimates for annual variables in Table 3 and the estimates for scheduled monthly variables.

I employ five monthly variables regarding working conditions during standard business hours as dependent variables: scheduled monthly salary, scheduled hourly wages, scheduled working hours, working days, and scheduled working hours per day.[20] Table 4 summarizes the second-stage results of FE-IV estimations on the impact of offshoring on these five variables (first-stage results are the same as those in columns 2–4 of Panel B in Table 3). These variables have nesting relationships: Scheduled monthly salary is the product of scheduled hourly wages and scheduled working hours, whereas scheduled working hours is the product of working days and scheduled working hours per day. This relationship can be confirmed, for example, by taking the impact of a 1% increase in offshoring to Asia on the base group workers and observing that the increase in scheduled monthly salary by 0.019% (column 1) is the sum of the increase in scheduled hourly wages by 0.052% (column 2) and the decrease in scheduled working hours by 0.034% (column 3) – and the latter is then the sum of a 0.027% decrease in working days (column 4) and a 0.007% decrease in scheduled working hours per day (column 5).

Among the five monthly variables, scheduled working hours are a good representation of how offshoring to Asia is substituted for employees in firms' production process. This interpretation is based on the supposition that the change in scheduled working hours is determined mainly through labor–management negotiations from both employers'

[20] Scheduled working hours is the number of hours employees actually worked from a start time to an end time in a working day determined by working rules in June of the survey year. It does not include the time employees are not working because of sick leave, paid leave, or leaving the office early.

Table 4
Estimates for scheduled monthly variables.

Dep. variable:	Log scheduled monthly salary (1)	Log scheduled hourly wages (2)	Log scheduled working hours (3)	Log working days (4)	Log scheduled working hours per day (5)
Log offshoring to Asia (a)	0.0186**	0.0522***	−0.0336***	−0.0270***	−0.0066*
	(0.0075)	(0.0129)	(0.0091)	(0.0082)	(0.0035)
x college graduates (b)	−0.0033	−0.0076	0.0043**	0.0002	0.0041***
	(0.0043)	(0.0047)	(0.0018)	(0.0017)	(0.0011)
x female workers (c)	0.0054	0.0013	0.0041**	0.0017	0.0024**
	(0.0047)	(0.0047)	(0.0016)	(0.0015)	(0.0010)
(a) + (b)	0.0153*	0.0446***	−0.0293***	−0.0268***	−0.0025
	(0.0081)	(0.0132)	(0.0092)	(0.0082)	(0.0035)
(a) + (c)	0.0240***	0.0535***	−0.0295***	−0.0253***	−0.0042
	(0.0089)	(0.0139)	(0.0095)	(0.0084)	(0.0036)
(a) + (b) + (c)	0.0207**	0.0459***	−0.0252***	−0.0251***	−0.0001
	(0.0093)	(0.0142)	(0.0096)	(0.0085)	(0.0038)

Notes: This table summarizes second-stage FE-IV estimates. See the notes in Table 3 for other independent variables used in the estimation, the number of observations, the number of establishments, and the Kleibergen-Paap *F* statistic. The first-stage FE-IV estimates are the same as those in Table 3, Panel B, columns 2–4. The standard errors in parentheses are clustered at the establishment level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Author.

and employees' perceptions of how importing inputs decrease labor demand. It is true that estimates for scheduled working hours are partly affected by employees' own decisions concerning the number of days and hours of leave they take. The impact on estimates is, however, smaller than that on annual working hours (see Table 3), because the latter includes overtime working hours.

Column 3 in Table 4 indicates that the scheduled working hours for all labor types decrease due to offshoring, implying that they are all close substitute for imported material inputs. In addition, column 4 indicates that the decrease in working days amounts to more than four-fifths of the decrease in scheduled working hours for all groups of workers. There are several possible causalities from offshoring to working days. One is the increase in off days: firms that substitute offshoring for in-house production would then be able to afford the implementation of a five-day workweek system or increase firm holidays for their employees. Another casualty is employees voluntarily electing to take more paid and sick leave: A reduced workload would create an atmosphere that accommodates such actions in their workplace.

The degree of substitutability appears to differ across labor types, though. Column 3 reports additional, though relatively small, positive effects of offshoring on scheduled working hours for college graduates (0.0043) and female workers (0.0041), implying that they are less substitutable to imported inputs than the base group. This possibly reflects the fact that different substitute effects for each worker group are diminished by, for example, enhancing job rotation and on-the-job training within offshoring firms, or that there is little difference with regard to substitutability, to begin with. The additional effects on college graduates and female workers mainly arise from the change in scheduled working hours per day, as reported in column 5.

There are two other notable points in Table 4 regarding the observed changes of skill premium and gender gap in Table 3. First, estimates for the interaction terms in columns 1 and 2 in Table 4 are not significant; this implies that offshoring does not significantly change skill premium or gender gap with regard to scheduled monthly salary and scheduled hourly wages. Offshoring to Asia increases both scheduled monthly salary and scheduled hourly wages across-the-board, which may reflect

Table 5
Estimates of other specifications.

Panel A. Use of gender-educational background dummies Dep. variable:	Log annual salary (1)	Log annual hourly wages (2)	Log annual working hours (3)	Log scheduled monthly salary (4)	Log scheduled hourly wages (5)	Log scheduled working hours (6)	Log working days (7)	Log scheduled working hours per day (8)
Log offshoring to Asia	0.0370***	0.0521***	−0.0151*	0.0185**	0.0521***	−0.0336***	−0.0270***	−0.0066*
	(0.0099)	(0.0125)	(0.0082)	(0.0075)	(0.0129)	(0.0092)	(0.0082)	(0.0035)
x male, college graduates	−0.0008	−0.0091*	0.0083***	−0.0026	−0.0067	0.0041**	0.0002	0.0039***
	(0.0040)	(0.0046)	(0.0026)	(0.0042)	(0.0047)	(0.0017)	(0.0017)	(0.0011)
x female, non-college graduates	−0.0184***	−0.0056	−0.0127***	0.0056	0.0016	0.0040**	0.0017	0.0023**
	(0.0053)	(0.0048)	(0.0029)	(0.0047)	(0.0046)	(0.0016)	(0.0015)	(0.0010)
x female, college graduates	−0.0164**	−0.0130*	−0.0034	0.0037	−0.0043	0.0080***	0.0021	0.0059***
	(0.0068)	(0.0067)	(0.0039)	(0.0060)	(0.0064)	(0.0027)	(0.0026)	(0.0019)

Panel B. Add lower-level managers dummy	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log offshoring to Asia	0.0361***	0.0509***	−0.0148*	0.0180**	0.0514***	−0.0334***	−0.0269***	−0.0065*
	(0.0099)	(0.0125)	(0.0082)	(0.0075)	(0.0129)	(0.0091)	(0.0082)	(0.0035)
× college graduates	−0.0054	−0.0129***	0.0074***	−0.0040	−0.0085*	0.0045**	0.0003	0.0042***
	(0.0041)	(0.0049)	(0.0026)	(0.0043)	(0.0048)	(0.0018)	(0.0017)	(0.0012)
× female workers	−0.0179***	−0.0046	−0.0133***	0.0061	0.0022	0.0039**	0.0016	0.0023**
	(0.0055)	(0.0049)	(0.0030)	(0.0047)	(0.0047)	(0.0016)	(0.0015)	(0.0010)
× lower-level managers	0.0123***	0.0136***	−0.0012	0.0053*	0.0069*	−0.0016	−0.0011	−0.0005
	(0.0037)	(0.0040)	(0.0021)	(0.0032)	(0.0037)	(0.0016)	(0.0015)	(0.0008)

Notes: This table summarizes second-stage FE-IV estimates. See the notes in Table 3 for other independent variables used in the estimation, the number of observations, and the number of establishments. The Kleibergen-Paap *F* statistic is 9.35 for Panel A and 9.41 for Panel B. The first-stage FE-IV estimates are not reported. The standard errors in parentheses are clustered at the establishment level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Author.

the mode of Japanese firms' labor–management negotiations, by which the salary effect of exogenous shocks on a firm is distributed evenly to its employees as a result of the enterprise union system.

Second, the negative impact of offshoring on the scheduled working hours of each worker group in column 3 is larger than that on annual working hours (shown in column 9 of Table 3). Differences vary across worker groups, however. The estimate for female non-college graduates in column 3 in Table 4 (−0.0295) is almost the same as that in column 9 in Table 3 (−0.0281), whereas the estimates for male college graduates in these columns are largely different (−0.0293 and −0.0077). This suggests that male workers and college graduates increase their amount of overtime working hours due to offshoring, which is explained in the next section.

3.4. Other specifications

This subsection runs the regression of two other specifications to examine the robustness of the results in Tables 3 and 4. Table 5 reports second-stage FE-IV estimates (first-stage FE-IV estimates are not reported). The definition of eight dependent variables are the same as those used in Tables 3 and 4. Based on the findings explained below, it can be said that the results in Tables 3 and 4 are robust in other specifications.

Panel A employs three interaction terms with education–gender group dummies: male college graduates; female non-college graduates; and female college graduates. The regression aims to examine whether the effect of offshoring is specific to each of the four education–gender groups. Results indicate that estimates for the interaction terms with male college graduates and with female non-college graduates in Panel A are similar to those for the interaction terms with college graduates and with female workers, respectively, in Tables 3 and 4. In addition, estimates for the interaction term with female college graduates are close to the sum of those for the interaction terms with college graduates and with female workers in Tables 3 and 4. This implies that the offshoring effect on each education–gender group can be isolated well along education and gender factors. Since the Kleibergen–Paap F statistic for weak identification test becomes lower than 10 in Panel A, I use the estimates in Tables 3 and 4 as baseline results.

Panel B adds an interaction term with a lower-level manager dummy. Lower-level managers include lower-level management (*Kakaricho* in Japanese), crew leaders or equivalent (*Shokucho*), and other supervisory levels. I do not use employees' positions in a firm as a worker attribute in Eq. (1) as they are considered to be affected by firms' performance and are, therefore, endogenous with offshoring. Some readers may presume, however, that a promotion in a within-firm labor market follows routine job rotation in many Japanese firms and is, thus, little affected by offshoring. From this point of view, excluding the interaction term of offshoring with employees' positions could possibly produce biased results, since employees in supervisory positions earn higher salaries, which seem susceptible to firms' performance. Panel B shows that, although offshoring has an additional, positive and statistically significant effect on lower-level managers with regard to annual salary and annual hourly wages, estimates for the interaction terms with both college graduates and female workers are still quite similar to those displayed in Tables 3 and 4.

Table 6
Implied working hour changes induced by 10% increase in offshoring.

	Male non-college graduates	Male college graduates	Female non-college graduates	Female college graduates
Changes in monthly working hours	−0.265 [−15.9]	−0.136 [−8.2]	−0.476 [−28.6]	−0.353 [−21.2]
Changes in scheduled working hours	−0.534 [−32.0]	−0.470 [−28.2]	−0.473 [−28.4]	−0.400 [−24.0]
Changes in overtime working hours	0.268 [16.1]	0.334 [20.0]	−0.003 [−0.2]	0.046 [2.8]

Note: Minutes are in brackets.
Source: Author.

4. Changes in skill premium, gender gap, and overtime working hours

By interpreting and comparing the results presented above, I examine what factors among candidates would result in the shrinking skill premium in annual hourly wages and the widening gender gap in annual salaries, which are shown in Table 3.

With regard to bonuses, it is safe to say that they are the driving force of neither shrinking skill premium in annual hourly wages nor the widening gender gap in annual salaries. Bonuses in Japanese firms are generally calculated by scheduled monthly income being multiplied by a factor determined by each firm. This factor depends on the performance of each firm, is determined during the labor contract negotiations, and is generally applied to all employees. Since offshoring increases scheduled monthly salary evenly among all labor groups – as shown in column 1 of Table 4 – bonuses are, per se, not able to change relative salaries and hourly wages. Relating to this point, the hypothesis of offshoring as a threat to employees does not hold; offshoring actually increases scheduled monthly salary and hourly wages.

The substitutability between intermediate inputs from Asia and each worker group can explain uneven offshoring results to some extent. Data in column 3 of Table 4 indicate that college graduates decrease their working hours to a lesser extent during on-duty hours than non-college graduates. This leads to the increase in scheduled hourly wages of college graduates being to a lesser extent, as their scheduled monthly salary increases are also lower than those of non-college graduates. This mechanism partly explains the shrinking skill premium with regard to annual hourly wages.

There is an additional factor for shrinking skill premium: Increasing overtime work with a low overtime premium for college graduates. The estimate for the interaction term with college graduates in column 9 of Table 3 (0.0073), is larger than that in column 3 of Table 4 (0.0043), implying that they increase their overtime working hours relatively more than non-college graduates. The annual salaries of college graduates, including overtime salary, are not statistically different from non-college graduates (column 7 in Table 3), however, since their overtime premium is lower – as shown in Table 1.

The change in overtime working hours differs saliently across worker groups. Take male non-college graduates as an example: on the one hand, a 1% increase in offshoring reduces their scheduled working hours by 0.034% (column 3 in Table 4) and annual working hours, including overtime, by 0.015% (column 9 in Table 3), whereas their overtime working hours account for only one tenth of their total working hours (Table 1). These figures indicate that male non-college graduates actually increase their overtime work through offshoring. For female non-college graduates, on the other hand, the impacts of offshoring on scheduled working hours (−0.0295 in column 4 in Table 4) and annual working hours (−0.0281 in column 9 in Table 3) are almost the same, implying that they change overtime working hours by a small amount. The widening gender gap with regard to annual salaries (−0.0195 in column 7 in Table 3) is explained by the fact that female workers reduce their annual working hours to a greater extent than male workers.

These arguments are summarized as follows: Offshoring decreases skill premium in annual hourly wages due to the reduction in scheduled working hours to a lesser extent and the increase in overtime working hours with less overtime premium to a greater extent for college graduates, while it increases the gender gap in annual salaries as female

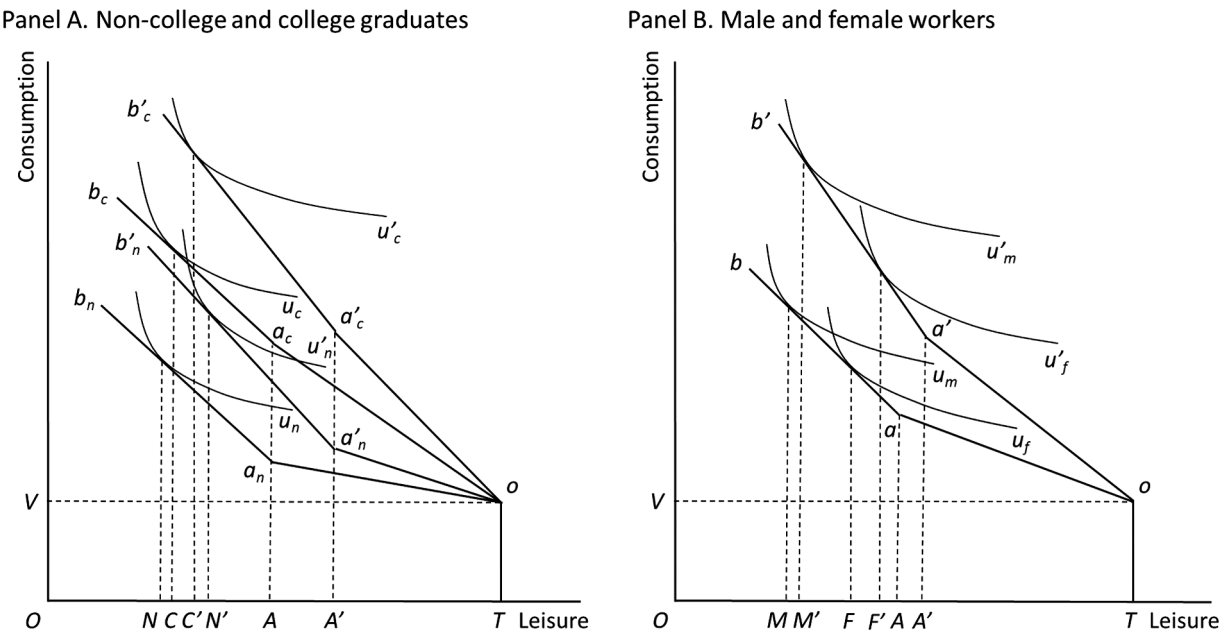

Fig. 1. Determination of overtime working hours.

workers do not work additional overtime. They demonstrate how the change in overtime working hours plays a critical role in the salary and hourly wage effects of offshoring in Japan.

Table 6 displays the implied working hour changes induced by a 10% increase in offshoring to Asia by worker group. Each figure is calculated using figures in Tables 1, 3, and 4. For example, the average monthly working hours, including overtime, of male non-college graduates during the analyzed period is 178.2 (Table 1), and the estimate for their annual working hours is −0.0149 (column 9 in Table 3) – therefore, their monthly working hours decrease by 0.265 h, or 15.9 min, when offshoring to Asia increased by one-tenth (178.185 × 0.0149 × 0.1). Similarly, their scheduled working hours are calculated to decrease by 0.534 h, or 32.0 min (158.885 × 0.0336 × 0.1). The difference between the two figures indicates an increase of overtime by 0.268 h, or 16.1 min. These results should be interpreted with caution, however, as these implied changes are mitigated by a firm's adjustments to their workforce in the long term, even in Japan.

Changes in scheduled working hours are similar across the four groups, whereas changes in monthly working hours – and the resulting changes in overtime – exhibit more variances. College graduates extend their overtime working hours more than non-college graduates, and female workers do not change their overtime work amount. I illustrate the differences in working hour changes in worker groups from a labor supply schedule and explain it from their preference for consumption and leisure, as depicted in Fig. 1.

Panel A depicts the changes in monthly scheduled and overtime working hours for hypothetical non-college and college graduate workers as a result of increasing offshoring in a leisure–consumption space. The total amount of time available is *OT* on a horizontal line, and the amount of consumption at zero working hours is *OV* on a vertical line, for each hypothetical worker in a particular month. Bonuses are not considered.

Before the increase in offshoring, scheduled working hours are *AT* for both non-college and college graduates. The line T-o-a_n-b_n is the budget constraint of non-college graduates, where the slopes of o-a_n and a_n-b_n are their scheduled hourly wage and overtime hourly wage, respectively. An indifference curve in a leisure–consumption space represents the combination that would provide the same satisfaction to a worker. Two out of a set of indifference curves for non-college graduates are depicted in Panel A as u_n and u'_n. The optimal combination of consumption and leisure under the given budget constraint occurs at a point of tangency between an indifference curve and the line T-o-a_n-b_n. The figure shows that u_n is the indifference curve representing the highest attainable utility for non-graduate students and *NT* is their optimal total working hours, within which *NA* is their optimal overtime working hours. Similarly, the line T-o-a_c-b_c is the budget constraint of college graduates. The slopes of o-a_c and a_c-b_c do not differ much, because an overtime premium for college graduates is not high (as shown in Table 1). The optimal total working hours for college graduates is *CT*, within which *CA* is their optimal overtime working hours, and u_c is the indifference curve of their highest attainable utility.

After the increase in offshoring, scheduled working hours become shorter to *AT'* for both types of workers, and the scheduled hourly wages for non-college and college graduates increase to the slopes of o-a'_n and o-a'_c, respectively. These shifts correspond with the findings in Table 4. For non-college graduates, the highest attainable indifference curve under the new budget line is u'_n and optimal overtime working hours become longer, from *NA* to *N'A'*. Similarly, for college graduates, the highest attainable indifference curve is u'_c and optimal overtime working hours becomes longer, from *CA* to *C'A'*. Panel A shows that college graduates extend overtime working more than non-college graduates by *NN'*−*CC'*. This is since the slope of indifference curve, or the marginal rate of substitution of leisure for consumption, for college graduates does not differ much over a set of their indifference curves at a given leisure level. This is likely since college graduates decrease the marginal utility of consumption to a lesser extent than non-college graduates as consumption increases.

Panel B explains the changes in overtime working hours for hypothetical male and female workers in a situation where both types of workers face the same budget constraint. Before the increase in offshoring, the budget constraint is T-o-a-b, and the highest attainable indifference curves for male and female workers are u_m and u_f, respectively. Optimal overtime working hours for male workers *MA* are longer than those for female workers *FA*. This is because the marginal utility of leisure is higher for female workers, indicating that females bear the burden of household work more than males. After the increase in offshoring, the budget constraint shifts up to T-o-a'-b', and the highest attainable indifference curves for male and female workers are now u'_m and u'_f, respectively. Optimal overtime working hours for male workers *M'A'* are larger than *MA*, whereas those for female workers *F'A'* are the

same as *FA*. This implies that male workers decrease the marginal utility of consumption to a lesser extent than female workers as consumption increases.

5. Conclusion

This study is the first attempt to analyze the impact of trade shocks on working hours in the within-firm labor market, a possible but underexamined channel through which salary inequality changes. Because the within-firm labor market in Japanese firms is less connected to other labor markets outside the firm, its data are suitable for observing the within-firm redistribution effects of trade shocks. Methodologically, I used data on the Japanese manufacturing sector and constructed a matched worker–establishment–firm dataset. Among various trade shocks, this study employed firms' offshoring to Asia, defined as their intermediate material inputs imported from Asia. Since each firm determines offshoring, factor prices, and inputs collectively, its offshoring was instrumented by the per worker exports of Asian subsidiaries of other Japanese firms classified in the same industry.

The study results show that an increase in offshoring raised workers' scheduled monthly salary and scheduled hourly wages while it reduced working hours in a similar manner for all types of employees. This suggests that imported inputs are close substitutes for any labor inputs, and that the substitutability, per se, does not produce different redistribution effects of offshoring among labor types. When annual variables as dependent variables were used for estimation, however, it was found that offshoring shrank the skill premium with regard to annual hourly wages, whereas it widened the gender gap with regard to annual salaries. These two redistribution effects arose from employees' adjustment of their overtime working hours. College graduates increased their overtime work to a greater extent with low overtime premium, which led to the relative decrease of their annual hourly wages. Female workers neither worked more overtime nor obtained more overtime payment as male workers did, which was the reason for the relative decrease in female workers' annual salaries.

Two policy implications are derived from the findings presented in this study. First, even if people are worried about the uneven redistribution effects on their employees of the possible increase in firms' trade activities in the future, introducing new regulations to prevent it is ineffective. This is because the changes in skill premium and gender gap are the result of employees' spontaneous overtime adjustment, reflecting their preference for consumption and leisure. Second, how and to what extent globalization affects income distribution depends on many factors, some being characteristic to particular countries. The study results and their background are likely specific to Japan, since prior research based on other countries does not provide similar findings. This specificity arises from the adjustment processes found in within-firm labor markets in Japan.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jjie.2021.101132.

Appendix 1. The explanation of the four datasets used for the panel data

The Basic Survey on Wage Structure (*The Wage Survey*) aims to provide insight into the wage structure for employees in Japan. The Ministry of Health, Labour and Welfare conducts this survey annually, targeting private establishments with five or more regular employees, as well as public establishments with 10 or more regular employees. The population for this survey comprises roughly 1.4 million establishments and approximately 37 million employees, nationwide. The survey uses two-stage sampling, with establishments as the primary sampling unit and employees as the secondary sampling unit. Among sampled establishments and employees, about 55,000 establishments with 1.2 million employees submit valid responses every year. The survey items include each employee's monthly contractual cash earnings, annual special cash earnings, years of job tenure, age, gender, school career, and workplace information. In January 2019, it was made public that the data gathering for *The Wage Survey* had been conducted inappropriately in some respects by the Ministry of Health, Labour and Welfare for more than 10 years. However, this study uses the original data the Ministry provided to the author, as the Committee of Statistics, the Ministry of Internal Affairs and Communications concluded after its examination that there seemed to be little bias in the resulting data.

The Basic Survey of Japanese Business Structure and Activities (*The Business Survey*), conducted annually by the Ministry of Economy, Trade and Industry, acquires basic data on the business activities of private Japanese companies. The survey targets companies engaged in business with both a minimum capital of 30 million JPY, and 50 or more employees. The survey covers multiple industries; although it excludes industries involved in agriculture, fishing, construction, transportation, healthcare, and welfare. There are approximately 37,000 companies targeted, of which roughly 30,000 submit valid responses every year. The survey covers items such as the number of regular workers, sales, operating profit, the number of subsidiaries, fixed assets, exports, and imports for the previous fiscal year.

The Establishment and Enterprise Census and *The Economic Census for Business Frame* (*The Censuses*), conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications, cover all establishments and firms in Japan. They record basic information on each establishment – such as name, address, telephone number, and the number of workers – and serve as the master sampling framework for statistical surveys (including *The Wage Survey*). Until 2006, *The Establishment and Enterprise Census* was conducted every two to three years. It has since been incorporated into *The Economic Census for Business Frame* launched in 2009 and *The Economic Census for Business Activity* launched in 2012, the latter being conducted jointly by the Statistics Bureau, Ministry of Internal Affairs and Communications and the Ministry of Economy, Trade and Industry.

Appendix 2. Time-series data of salaries, working hours, and hourly wages

Fig. A1 shows the time-series data on salaries, working hours, and hourly wages in the constructed panel dataset. Panel A depicts the average scheduled monthly salary, monthly salary including overtime payment, and annual salary of Japanese manufacturing workers from 1998 to 2014. Monthly and annual salaries had increased modestly until 2008, fell by around 10% in 2009, and then recovered to their pre-shock

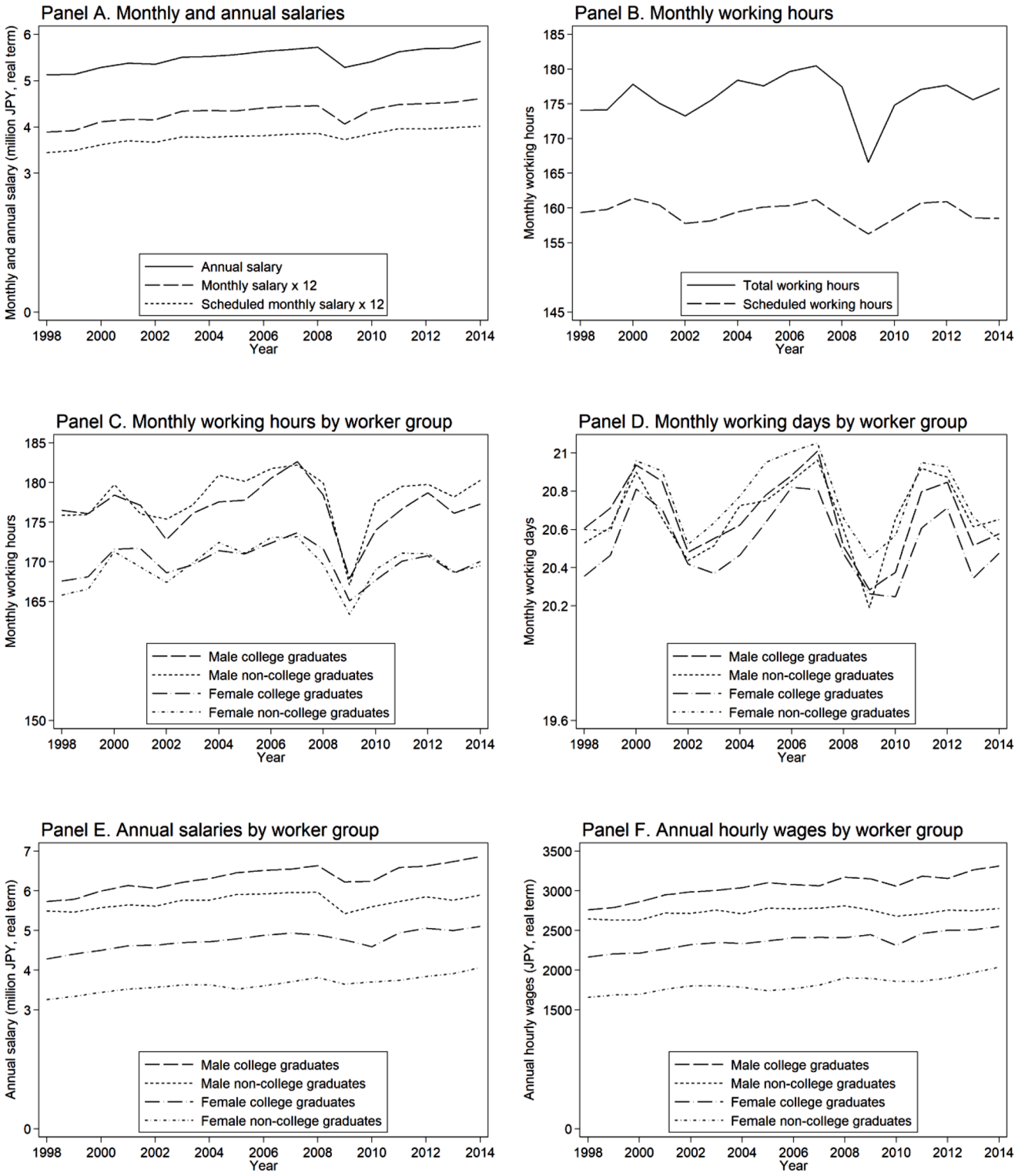

Fig. A1. Time-series data of salaries, working hours, and hourly wage.

levels by 2014. The negative shock of the global financial crisis in 2009 mainly reduced overtime payments (the difference between monthly salary and scheduled monthly salary) and bonuses (the difference between annual and monthly salaries). Panel B reports the scheduled and total working hours each year in the month of June between 1998 and 2014. Working hours show a periodic change, partly representing the change in the number of weekdays in June. In addition, the global financial crisis caused a drop in scheduled working hours and overtime (the difference between total and scheduled working hours) in 2009. Panels C, D, E, and F show the monthly working hours, monthly working days, annual salaries, and annual hourly wages of four worker groups, respectively. Panel D shows little sign of a decreasing trend in monthly working days on average, which suggests that the five-day workweek system had already been implemented in many sample firms before the analyzed period. Annual hourly wage in Panel F is obtained by dividing annual salary in Panel E by 12 times of the monthly working hours on display in Panel C. Annual salaries and hourly wages vary among the four groups. The growth of annual salary and hourly wages for the group of male non-college graduates is stagnant compared to the other three groups, partly because the workforce of this group becomes younger and their tenure years become shorter during the period. The trend is the opposite for the other three groups.

Appendix 3. The transition of import variables in the dataset

Fig. A2 shows the transition of import variables in the panel dataset, constructed using Japanese firms with positive imports from Asia, originally from *The Business Survey*. Panel A shows the average import values of firms during the analysis period with regard to the total imports except from the Middle East, Oceania, and Africa, and the imports from Asia. Values of total imports and imports from Asia, per firm, exhibit an increasing trend – although there are decreases in 2009 and 2011 due to the global financial crisis, as well as the Great East Japan Earthquake and subsequent tsunami. The majority of total imports are from Asia, and the difference between total imports and imports from Asia is stable at around 2 billion JPY per firm. This indicates that the driving force behind increasing trends of offshoring is imports from Asia. Panel B depicts the ratio of import value to total intermediate purchases with respect to the same two import values as Panel A. Panel B also clearly shows the increasing trend of the two ratios, implying that Japanese manufacturing firms have strengthened their relationship with foreign markets as a source of intermediate inputs. This result does not mean, of course, that all Japanese firms in the dataset experience an increase in offshoring. Panel C reports the ratio of firms that increase their real imports compared to those in the previous year, again with respect to both total imports and imports from Asian countries. Around 60–70% of firms, on average, increase their real transactions with regard to imports in each year before 2007. Taken from the opposite perspective, as many as a third of the firms experienced a decrease in imports each year during this period. In this regard, my estimation result includes the effects of both the expansion and the contraction of offshoring.

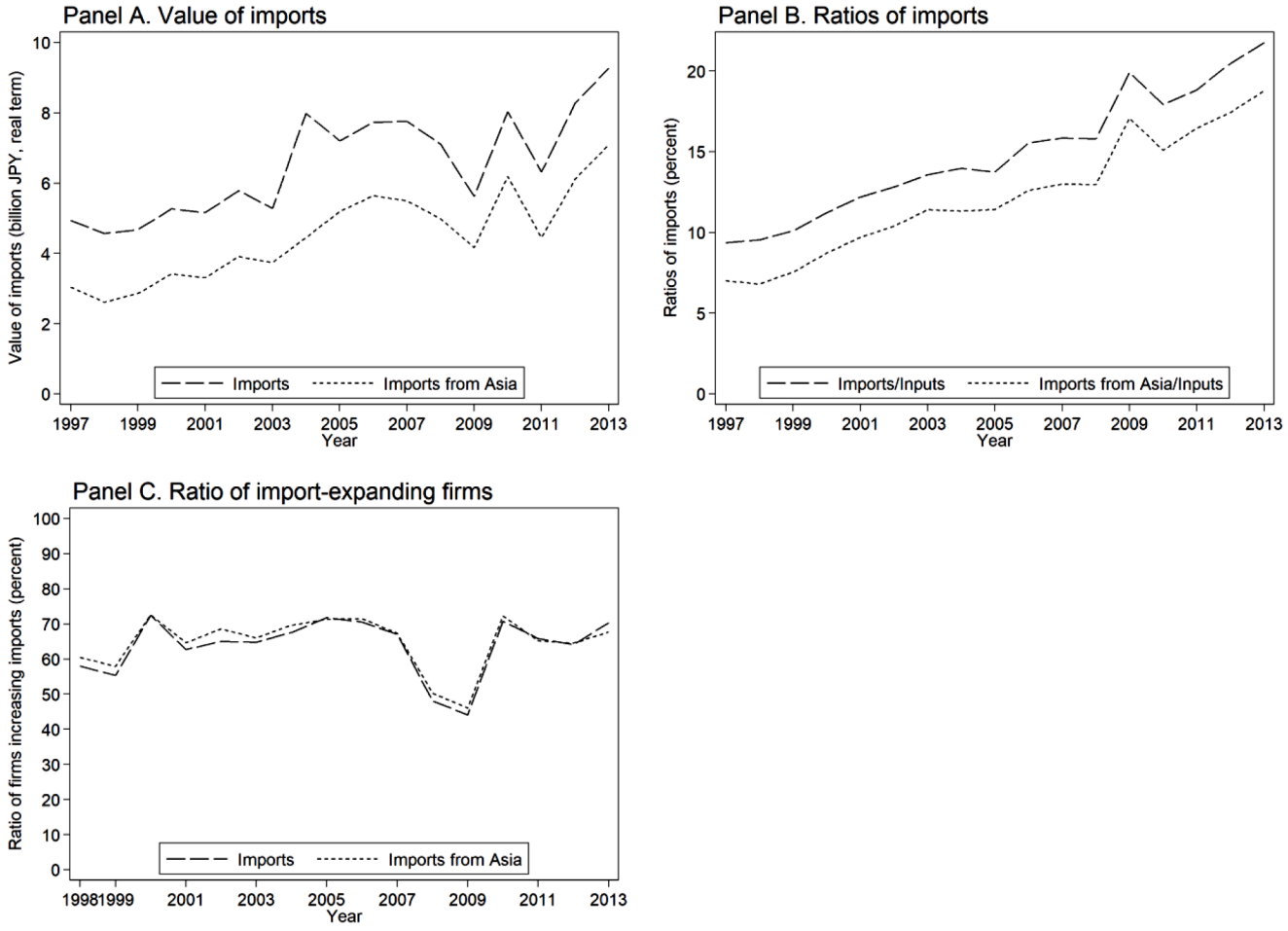

Fig. A2. The transition of firm-level import variables.

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（Abstract 翻訳文）

多くの論文が貿易の企業内再分配効果を同定してきたが、企業内労働市場における調整過程に関する研究はまだ少ない。この分析では、オフショアリングの変化に伴う労働時間と賃金の企業内調整を、労働者の学歴や性別を考慮して分析した。1998 年から 2014 年までの日本の製造業部門の労働者・企業接合パネルデータを用いた。分析の結果、以下の 3 点が明らかになった。第一に、所定時間内月間給与と所定時間における時給については、オフショアリングによってスキルプレミアムやジェンダーギャップはあまり変化しない。第二に、オフショアリングは年収で計算した時給でスキルプレミアムを低下させるが、年間給与のジェンダーギャップを拡大させる。第三に、年間変数への不均等な影響は、残業時間の変化が異なることから生じる。大卒労働者は低い残業プレミアムで長く働き、女性労働者は残業時間を増やさない。