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The Gender Wage Gap across the Wage Distribution in Japan: Within- and Between-Establishment Effects

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Abstract

Although male and female wages have been converging, there still remains a persistent gender wage gap in many countries. To identify what impedes further reductions in this gap, we used Japanese data to conduct a decomposition across the wage distribution, focusing on the *wage structure* effect, which is the portion of the gender wage gap that is unexplained by gendered differences in human capital. We show that the wage structure effect is larger within an establishment than between establishments and at the tails of the wage distribution than in the middle, indicating that both a glass ceiling and a sticky floor exist within establishments and have for more than 25 years. The sticky floor appears to be largely caused by Japan's gendered career track job segregation system and the glass ceiling by a gender promotion gap and a "swimming upstream" phenomenon. Consequently, any further reduction in the gender wage gap will require a resolution of gender job segregation and a shift towards jobs that reward flexibility.

Keywords: gender wage gap; glass ceiling; sticky floor; within- and between-establishments; gendered job segregation; gender promotion gap
JEL classification: J16, J31, J24

1 Introduction

In Japan, as in many countries, the average wages of men and women have been gradually converging, with the female-male ratio of average monthly scheduled wages of full-time workers rising from 59.7% in 1990 to 72.2% in 2014.[1] However, most recently, this trend has stabilized, and Japan's gender wage gap in 2014 remained third highest among OECD countries after Korea and Estonia.[2] What, then, impedes a further reduction? To address this question, in this study we explore the gender wage gap across the wage distribution, focusing on the mechanisms of the gender gap among high-paid workers and low-paid workers, respectively, using Japanese data from 1980–2015.

The gender wage gap has long drawn the attention of labor economists. Recently, however, several studies have focused on the gender gap among highly paid or highly educated workers as a possible explanation of the continuing persistence of the gender wage gap, identifying shorter work hours, career interruption because of family responsibilities[3] and family-friendly government policies[4] as possible factors. However, while we are gaining more insight into the upper tail of the wage distribution, there remains in many countries a gender gap among *low*-paid workers,[5] and the mechanism for the gap at the lower tail is still in question.

Meanwhile, recent advances in decomposition methods that allow for distributional statistics beyond the mean, together with a popular notion that there are "subtle barriers" in the labor market such as *glass ceilings* and *sticky floors* that are not captured

[1] Japanese Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
[2] OECD database.
[3] Bertrand et al. [2010], Goldin [2014], Gicheva [2013], and Cortés and Pan [forthcoming 2018].
[4] Albrecht et al. [2003] and Arulampalam et al. [2007] point out that generous family friendly policies could be a double-edged sword, decreasing the gender wage gap among low-paid workers while increasing the gap among highly paid workers because of the disincentive for women to work intensively, which makes it difficult for them to receive very high wages.
[5] For example, see Arulampalam et al. [2007], Christofides et al. [2013], and Carrillo et al. [2014].

by traditional measures, have led to an effort to build upon the extensive research on the gender gap *at the mean* to explore how and why the gender gap varies *across the wage distribution*.[6] This study draws upon this literature, adopting the recentered influence function (RIF) regression proposed by Firpo et al. [2009], which enables us to separate the gender wage gap observed at each percentile of the wage distribution into two parts: the *compositional* effect, which is due to differences in human capital attributes such as education, tenure or experience in the labor market; and the *wage structure* effect (hereafter, the *WS-e ect*), which cannot be explained by these human capital attributes. This latter effect, which represents gender-based differences in the *returns* to those attributes, is the *unexplained* gender wage gap of interest here.

In estimating the WS-effect across the wage distribution, we examine whether there exists a glass ceiling and/or a sticky floor. A glass ceiling is commonly understood to be a range of presumed barriers that prevent female workers from reaching the upper echelon in business, government and academia, and a sticky floor the presumed barriers that prevent women from escaping low-paying jobs. However, following the labor economics literature cited above, this study examines these phenomena through the observed gender wage gap caused by such barriers. That is, a WS-effect that is larger at the *top* of the wage distribution than at the median is defined as a glass ceiling, and a WS-effect that is larger at the *bottom* than at the median is a sticky floor.

The Japanese dataset we utilize has several advantages for examining the WS-effect across the wage distribution. First and foremost, the *Basic Survey on Wage Structure* (BSWS) conducted by the Japanese Ministry of Health, Labour, and Welfare (MHLW) is a pre-eminent large-sample government statistical database of employee

[6]These include Fortin and Lemieux [1998] and Blau and Kahn [2017] in the U.S.; Javdani [2015] in Canada; Arulampalam et al. [2007] and Christofides et al. [2013] in several European countries; Albrecht et al. [2003] in Sweden; and de la Rica et al. [2008] in Spain.

wages in Japan, with more than one million data samples collected each year. In addition, the BSWS is an employer-employee matched dataset, which allows us to control for establishment fixed effects (FE). In studying the gender wage gap, it is reasonable to assume that characteristics of the workplace may have an effect, and while previous studies have typically accounted for workplace heterogeneity by controlling for specific establishment attributes such as industry, firm size, and private/public sector,[7] our dataset allows us to control for establishment FE more comprehensively, as the researcher is not required to identify specific factors *a priori*.

This study contributes to the field in two main areas. First, it is one of the few that explores the gender wage gap through the wage distribution while also controlling for establishment FE.[8] The BSWS allows us to estimate both the WS-effect "across all establishments" by OLS (*across* WS-effect), and the WS-effect "within an establishment" after controlling for establishment FE (*within* WS-effect). From these, we can calculate the WS-effect "between establishments" (*between* WS-effect = *across* WS-effect – *within* WS-effect), which occurs when women are systematically allocated to low paying establishments. It is crucial to distinguish the within and between WS-effects because the policy prescriptions are quite different. If the between WS-effect is more pronounced,[9] then protection of equal opportunity in hiring could be effective, but if the within WS-effect is more serious, then removal of gender job segregation within a company would be a better remediation policy.

Second, because it examines comprehensively both the upper and lower tails of the wage distribution and finds that a sticky floor and glass ceiling both exist in Japan,

[7] For example, Arulampalam et al. [2007] and Albrecht et al. [2003].

[8] Javdani [2015], who performs a fixed effect estimation, is an exception.

[9] As an example, Card et al. [2016], using Portuguese data, show that a sorting effect whereby women are less likely to work at firms that pay higher premiums to either gender is most important for low- and middle-skilled workers.

this study adds to the literature that has recently focused on the upper tail of the wage distribution by improving our understanding of the mechanism of the gender wage gap for both high-paid and low-paid workers, with implications relevant not only to Japan but also more broadly to any country where the development of firm-specific skills is important. While it is well-known that the gender wage gap can be caused by gendered job segregation,[10] and intuitively we can understand that men and women may receive different wages if they engage in different jobs, our study differs from many other empirical studies because it shows that the effects of gender segregation can vary depending on the location along the wage distribution in ways that are not well represented by earlier studies estimating the gender wage gap only at the mean. For low-paid workers, for example, we hypothesize that the mechanism of the sticky floor in Japan is associated with a systematic gendered form of job segregation known as the *Career-Track Based Employment Management System*.[11]

At the same time, we explain how the aforementioned career-track gender job segregation system should also diminish any glass ceiling, but yet one is still observed. As this suggests that a different mechanism is at work at the upper tail, we examine it as well and find that the glass ceiling in our case is caused by the glass ceiling in our case has historically been caused by a gendered gap in promotion but more recently has been also due to a "swimming upstream" phenomenon advanced by Blau and Kahn [1997], whereby it has become easier for women to get promoted but the promotion premium for female workers is lower than for male workers so that women gain less from any promotion.

It is important to note that while Japanese data and the Japanese labor market

[10] See, for example, Carrington and Troske [1998] and Bayard et al. [2003]

[11] It is called *kousu-betsu-koyou-kanri-seido* in Japanese.

system are used to support the validity of our hypotheses, the findings are not limited to Japan but are broadly applicable to any country in which statistical discrimination in the labor market (explained in detail in Section 4), a gender gap in promotion, or a "swimming upstream" phenomenon is observed, of which there are several.[12]

The main results of this study are as follows. First, the *within* WS-effect is larger than the *between* WS-effect in Japan, implying that the gender wage gap is explained more by differential treatment by gender within a company than between different companies. Second, as larger within WS-effects are observed at the lower and upper tails of the wage distribution than in the middle range, both a glass ceiling and a sticky floor exist within establishments, and have since at least 1990. Third, it is argued that the sticky floor phenomenon in Japan could be largely due to a gendered career-track job segregation system in which female workers tend to be segregated into non-career track positions. However, fourth, this system should work to diminish the glass ceiling because a few women are segregated into career track positions, but yet the glass ceiling is still observed. This suggests that even women in career track positions are likely to encounter difficulties in getting promoted to higher positions, and so some other mechanism is at work. Last, it is suggested that while the glass ceiling may have at one time been due largely to a gender promotion gap, most recently, it is more likely due to a promotion premium gap and a "swimming upstream" phenomenon whereby women are more likely than before to be promoted but gain less from it than men.

[12]See Blau and Kahn [2017], and Fortin et al. [2017].

2 Econometric Framework

2.1 Data

This study utilizes micro data from the *Basic Survey on Wage Structure* (BSWS) conducted by the Japanese Ministry of Health, Labor and Welfare (MHLW). The BSWS is the pre-eminent government statistical database providing the most reliable data on employee wages in the country. Each year in June it collects information on all major industries by surveying both establishments and employees. For this study, we have been permitted by the MHLW to use BSWS data from 1980. To examine the current gender wage gap in Japan, we focus on the most recent 2015 data but also use 1980, 1990, 2000, and 2010 data to check the validity of our hypotheses.

The BSWS adopts a two-stage random sampling procedure, with establishments selected in the first stage and employees[13] of those establishments selected in the second stage.[14] Private establishments with at least five regular employees and public corporations with at least ten regular employees are covered by the survey, which accounts for more than 90% of the Japanese labor force.[15]

The BSWS dataset has the following advantages. First, because it is composed of employer and employee surveys, this provides us with employer-employee matched data that enables us to control for establishment fixed effects (FE). We note, however,

[13]The definition of *employee* in the BSWS is a person hired either 1) permanently, 2) for a period longer than one month, or 3) for less than one month or by the day and who had worked for 18 days or more in the two months (April and May) before the date of the survey. Therefore, regular workers and a subset of non-regular workers who make employment contracts directly with companies and whose employment terms are relatively long are included in the BSWS, but short-term temporary workers or those provided by temporary staffing agencies are not.

[14]In the first stage, establishments are chosen with a probability of proportional representation for prefecture, industry, and establishment size. In the second stage, surveyed employees are chosen randomly, but the target number of respondents is decided by industry and establishment size.

[15]According to the 2014 *Economic Census* by the Japanese Bureau of Statistics, the total number of employees in Japan was 51,058,767, and the number of those working at establishments with 1–4 employees was 4,555,108, or 8.9%.

that the BSWS is a survey only of employee wages, so compensations for employers are not included. Second, because employees do not self-report wages and working hours, the dataset avoids a common concern about potential response error for these important varaibles. For the BSWS, employers both respond to the employer survey directly and then also complete the employee survey by referring to employee payroll records. Third, variables such as monthly wages, overtime payments, bonuses, monetary benefits, working hours, and overtime hours are surveyed nominally, not by categories or ranges. This allows us to obtain the exact amounts, avoiding any "top-coding" problem recognized as a concern when estimating the top of the wage distribution. Lastly, the dataset represents well the labor market in Japan. The BSWS is a large-sample dataset with more than one million samples every year (e.g. 1,280,180 in 2015), and we use the sample weights to weight back the data used in our estimation to create an analysis sample representative of the target population.[16]

Notwithstanding the benefits of the BSWS dataset, there are two potential limitations to also consider. First, because the information about employees comes from payroll records and not employees directly, some employee characteristic variables such as marital status and the number of children are not available. If we were able to control for those variables, it is possible that the estimated WS-effect would become smaller. Second, this study controls for establishment FE, not firm FE, because the survey unit for employers is the establishment, not the firm to which that establishment belongs. This is not thought to be a serious concern, however, because human resource management systems are determined at the level of the firm, not the establishment. Because

[16]For the establishment survey, the probability of sampling a given observation j, $1/\omega_j$, depends on prefecture, industry, and establishment size. This probability is the inverse of the sample weight (ω_j). For the employee survey, the probability of sampling a given observation i, $1/\omega_i$, depends on both the industry and establishment size for those working at an establishment with 500 or more employees, and only on establishment size for those at establishments with 499 employees or fewer.

all establishments within a firm adhere to the rules determined by the company, the heterogeneity between establishments is similar to that between companies, and so it is plausible to consider that controlling for establishment FE is essentially the same as controlling for firm FE.

2.2 Wage Variable and Analysis Sample

We describe how the analysis sample of this study was constructed. First, the sample was restricted to full-time workers because the BSWS surveys the academic background of full-time but not part-time workers. In Japan, full-time workers include both workers in permanent positions and workers on longer-term contracts but not short-term temporary workers such as day laborers or staff provided by a temp agency. Additionally, the sample was restricted to those under 60 years old because many Japanese companies have introduced a mandatory retirement system that could make the wage determination system different for those who are younger than 60 and those who are older. Finally, the analysis sample was further restricted to employees working at least one year at that location because bonuses were included in the hourly wage calculations (explained below) but bonus details are surveyed only for workers whose length of service is at least one year.

Next, the main variable of this study is an hourly wage calculated as (*monthly scheduled wage* + *bonus per month*) ÷ *monthly scheduled hours*. The monthly scheduled wage consists of a basic wage and various allowances.[17] There has been a relatively unique system of labor compensation in Japan and most Japanese full-time workers receive bonuses in magnitude.[18] As the bonus in Japan is systematic and is usually

[17]These include such items as an allowance attached to a position, perfect attendance allowance, commuting allowance, and dependent family allowance.

[18]The ratio of workers who received a bonus in the analysis sample (2015 data) was 88.5%, with male workers 90.1% and female workers 85.1%, and the ratio of monthly bonus to monthly scheduled

considered to be part of one's wage, we have also included it in our measure of hourly wage in this study.[19] Japanese bonuses are ***not*** necessarily individual-performance based (as might be common in the U.S., for example), but are instead considered to be a form of profit sharing (Freeman and Weitzman [1987]) and/or a return to job-specific tenure (Hashimoto [1979], Hart and Kawasaki [1995]).

2.3 Descriptive Overview

In this section, we provide the descriptive statistics illustrating the differences between male and female employees in Japan, but first we begin with a brief overview of the ***raw*** gender wage gap salient in our dataset. Figure 1 shows the raw gender wage gap (defined as the difference in the log of wages between men and women) from the 10th percentile (P10) to the 90th percentile (P90) in 2015 and, for reference in our later discussion, each decade between 1980–2010. We immediately notice that the raw gap at each percentile in 2015 is the smallest, and so it appears that the gender wage gap has been decreasing over time (Appendix 2 discusses these changes across time in more detail).

Focusing now on 2015, our main analysis year, we see that: (1) The raw gender wage gap increases toward the top of the distribution, and the difference between P90 and P10 is 14 percentage points, which means that the raw gender wage gap is substantially larger at the top of the distribution than at the bottom; (2) The difference between P50 and P90 (10 points) is larger than that between P10 and P50 (4 points), implying that the raw gender wage gap is more prevalent in the upper half of the wage distribution

wage is 25.1% for male workers and 21.5% for female workers.

[19]Bonus is usually paid twice a year, in June and December, but the BSWS surveys the amount of bonus paid in the last year. Therefore, we converted this annual data to an amount per month. See Hashimoto [1979] about the Japanese bonus system for more detail.

than at the bottom.[20]

Now turning to the descriptive statistics, Table 1 shows the human capital and workplace differences between male and female workers.[21] The definitions of variables in this study are summarized in Appendix 1. Age, potential experience, and schooling are slightly larger for males than for females, and while the gender difference in tenure is fairly large, the differences in the former three variables, especially years of schooling, are quite small. Additionally, we see that the average ratio of those in higher employment positions such as chief, section manager or director is larger for males than for females. Further, we see that the ratio of employees who work at medium-size companies is slightly larger for females and at large companies greater for males.[22] We also observe gender differences by industry, with the proportion of male workers relatively higher in the manufacturing, construction, and transport and communications industries and higher for women in the service industry.

2.4 The FFL Decomposition

Next, we describe how the *across* and *within* WS-effects are estimated along the wage distribution. We made use of a recentered influence function (RIF) regression method proposed by Firpo et al. [2009] (FFL) to decompose the gender wage gap observed at each percentile into two parts: one that results from *compositional* effects that are

[20]Additionally, we decomposed the variance of log hourly wage into variance between establishments and variance within an establishment using a sample including both male and female workers, and found that the ratio of the between variance to total variance is 0.58, showing that wage dispersion (but not the gender wage gap) is generally larger between establishments than within establishments in Japan. This suggests that it might be useful to examine the gender wage gap after removing the between-establishment difference.

[21]These workplace variables are presented for descriptive purposes only. They are not included directly in our estimation equation because we instead control for establishment fixed effects.

[22]The BSWS surveys both the size of the establishment in which an employee works and the size of the firm to which the establishment belongs. Here, we report gender differences by firm size, not establishment size.

explained by gender differences in human capital and so are not the focus of this study, and another that results from ***wage structure*** (WS) effects that are ***not*** explained by differences in human capital and are thus due to differences in the returns to that human capital. It is these unexplained WS-effects that are of interest to us.

The FFL decomposition is essentially the same as the usual Oaxaca-Blinder (OB) technique except that instead of only identifying the sources of differences between the means of two distributions, FFL decomposition allows us to perform a quantile by quantile investigation of the differences between the distributions of female and male log wages. The FFL decomposition technique rests on using the RIF as the dependent variable in a linear regression framework. With w_i being the hourly wage, the RIF for observation w_i at the τth quantile Q_τ is given by

$$RIF(w_i; Q_\tau) = Q_\tau + \frac{\tau - \mathbb{1}[w_i \leq Q_\tau]}{f_w(Q_\tau)}, \tag{1}$$

where $f_w(\cdot)$ is the density and $\mathbb{1}(\cdot)$ is the indicator as to whether the wage observation is at or below quantile Q_τ. The idea behind recentering the RIF by adding Q_τ is simply that since $E(\tau - \mathbb{1}[w_i \leq Q_\tau]) = 0$, the expected value of the recentered RIF will be Q_τ itself. Firpo et al. [2009] show that this property also extends to the conditional-on-X RIF.

In implementing the FFL decomposition, the RIF regression is first run at each quantile and then the usual OB decomposition is performed. The procedure for the FFL decomposition is as follows:

(1) Compute the RIF for each quantile τ of interest by gender ($R\hat{I}F(w_{i,g}; Q_{\tau,g})$, where $g = f : female, m : male$);

(2) Run an OLS regression of the RIF on the vector of covariates (X_{ig}) by gender, estimating the following regression equation:

$$R\hat{I}F(ln(w_{i,g});Q_{\tau,g}) = \alpha_{\tau,ig} + X_{ig}\beta_{\tau,ig} + u_{\tau,ig}, \tag{2}$$

where lnw_i is the log hourly wage; α is a constant; and u is an error term;
(3) Perform the usual OB decomposition.

The coefficients of the RIF regressions for each gender, $\hat{\beta}_{\tau,ig}$, are expressed as

$$\hat{\beta}_{\tau,ig} = (\sum_{i \ g} X_i X_i)^{-1} \sum_{i \ g} R\hat{I}F(ln(w_{i,g});Q_{\tau,g})X_{ig}, \tag{3}$$

and the gender log wage gap at each quantile is $\Delta_\tau = Q_\tau[ln(w_m)] - Q_\tau[ln(w_f)]$. Using $\hat{\beta}_{\tau,ig}$, which is equivalent to the OB decomposition for any unconditional quantile, we can write the estimated gender wage gap[23] [24] as

$$\begin{aligned} \hat{\Delta}_\tau &= E[RIF_\tau[ln(w_m)]] - E[RIF_\tau[ln(w_f)]] \\ &= \bar{X}_m\hat{\beta}_{\tau,im} - \bar{X}_f\hat{\beta}_{\tau,if} \\ &= \underbrace{(\bar{X}_m - \bar{X}_f)\hat{\beta}_{\tau,if}}_{compositional\ effect} + \underbrace{\bar{X}_m(\hat{\beta}_{\tau,im} - \hat{\beta}_{\tau,if})}_{WS-effect}. \end{aligned} \tag{4}$$

In estimating the *across* WS-effect, this study applies Mincer's well-known human capital earnings function (Mincer [1974]) for Eq. (2), meaning that X is a vector of human capital variables including 1) schooling, 2) job tenure, 3) tenure squared, 4) potential labor market experience and 5) potential experience squared.[25] We can

[23]The FFL decomposition procedure is based on providing a linear approximation of a nonlinear function of the distribution and thus provides only a first-order approximation of the true effects irrespective of whether or not one uses a linear probability model. Therefore, the extent to which the approximation is imperfect, including the choice of a linear probability model, will be reflected in the estimation error.

[24]The OB decomposition is known to be sensitive to how male and female coefficients and characteristics are specified. However, in order to produce results compatible with the seminal paper by Albrecht et al. [2003] which constructs counterfactuals using the male characteristics and female coefficients, here we also use the Eq. (4) specification.

[25]The squared term of schooling is not included according to the theoretical discussion in Card [1999]. The non-squared items are measured in years. See Appendix 1 for a complete definition of these variables.

rewrite Eq. (2) as Eq. (5), using x_i for the human capital variables:

$$R\hat{I}F(ln(w_{i,g}); Q_{\tau,g}) = \alpha_{\tau,ig} + \sum_{k=1}^{5} \beta_{\tau,ig,k} x_{ig,k} + u_{\tau,ig}, \quad (5)$$

and we used Eq. (5) in Step 2 of the FFL decomposition.

Next, when estimating the ***within*** WS-effect, to control for any establishment fixed effect, we applied the method proposed by Mundlak [1978], which amounts to including the establishment means, $\bar{x}_j$, where j indicates an establishment, of the same human capital variables as in Eq. (5) above into X in Eq. (2). We can rewrite Eq. (2) as Eq. (6) :

$$R\hat{I}F(ln(w_{i,g}); Q_{\tau,g}) = \alpha_{\tau,ig} + \sum_{k=1}^{5} \beta_{\tau,ig,k} x_{ig,k} + \sum_{l=1}^{5} \beta_{\tau,ig,l} \bar{x}_{ig,l} + u_{\tau,ig}, \quad (6)$$

and we used Eq. (6) in Step 2 of the FFL decomposition.

3 Literature Review

The strong interest in the gender wage gap by labor economists has led to an extensive literature on this gap at the mean of the wage distribution but while this has been informative, it provides only a general indication of the wage outcomes of the "average" worker of each gender.[26] Since the Albrecht et al. [2003] seminal paper, however, there has been a growing interest in the gender wage gap throughout the wage distribution as this provides a more comprehensive view of the gender gap and insights into such tail end phenomena as the sticky floor and glass ceiling.

Much of this latter research has been conducted outside Japan in other East Asian, European and Latin American countries. Studies of Europe have found glass ceilings

[26]In Japan, there is also an extensive body of research on the gender wage gap, but it too is focused mainly on using decomposition methods to identify gender differences in conditional mean wages (Kawaguchi [2005], Miyoshi [2008]).

in many countries and sticky floors in some. Albrecht et al. [2003] find that the gender gap in Sweden has been sharply increasing at the top of the distribution and conclude that a glass ceiling might exist. Among studies of the EU, Arulampalam et al. [2007] show that female workers face a glass ceiling in most countries[27] while only Italy and Spain have a sticky floor.[28]

Regarding East Asian and Latin American countries, Chi and Li [2008] find strong evidence of a sticky floor in urban China and Cho et al. [2014] find a glass ceiling in Korea. Carrillo et al. [2014] study twelve Latin American countries and find glass ceilings in some, sticky floors in others, and both phenomena in still others.[29] Generally speaking, glass ceilings are widely observed in the literature in both developed and developing countries, but sticky floors are observed in far fewer countries and typically only in developing countries. However, the research reported in this paper shows that both a glass ceiling and a sticky floor are observed in Japan.

Turning to the U.S., Blau and Kahn [2017] show that the gender wage gap for highly paid workers is larger in 2010 than it was in 1980 and convergence in the wages of male and female workers at the upper tail has been slower. Recent interest in examining the gender wage gap among highly paid and highly educated workers is due to the potential it holds for identifying the source of a persistent gender wage gap in the U.S., and some studies have pointed out that the labor market system which disproportionately rewards *job inflexibilities* such as long work hours could be a possible cause.[30] This

[27]Arulampalam et al. [2007] show that glass ceilings are observed in Austria, Belgium, Great Britain, Denmark, Finland, France and Germany, Ireland, and the Netherlands.

[28]de la Rica et al. [2008] show that in Spain a glass ceiling is observed for highly educated workers but for less-educated workers, the gender gap is largest at the lower range of the wage distribution and decreases at the upper range in what they call a '*floor* pattern.'

[29]A glass ceiling is observed in Argentina, Brazil, Paraguay, and Uruguay; a sticky floor in Bolivia, Chile and Peru; and both a glass ceiling and a sticky floor in Colombia, Costa Rica, Honduras, Mexico, and Venezuela.

[30]Goldin [2014] provides micro-foundations for the notion of a disproportionate increase in wages

recent U.S. literature has been especially fruitful in identifying a mechanism for the gender wage gap among highly paid workers and building a consensus around the need to overhaul a labor market system that rewards job inflexibility in order to further reduce this gap. However, despite these recent advances, it is still necessary to identify the mechanism associated with the gender wage gap among ***low-paid*** workers, which continues to exist in many countries around the world. To explore this further, we investigate the gendered career track job segregation system in Japan. While it has already been shown that gender job segregation can create a gender wage gap (e.g. Carrington and Troske [1998], and Bayard et al. [2003]), the research reported in this paper differs from earlier studies in that it shows that the effect of gender segregation can vary along the wage distribution, producing a greater gender wage gap among low-paid workers while simultaneously reducing the gap among high-paid workers, as we see in the next section.

Lastly, while previous empirical studies of the gender wage gap in Japan have also shown that it is associated with the Japanese labor market system,[31] methodological improvements of the current study[32] which draws upon a large-sample dataset and

with respect to longer working hours within a hierarchy of employment positions. Underlying the analysis is a compensation differentials model of wages with respect to the *amenity of "job flexibilities"*, which includes shorter working hours, flexible timing of work hours, schedule predictability and the ability to schedule one's own hours. Bertrand et al. [2010] show that short work hours and career interruption because of family responsibilities have created a gender wage gap even among highly educated workers, and Gicheva [2013] and Cortés and Pan [forthcoming 2018] show a causal effect of the returns to overwork on the gender wage gap, implying that the wages of highly educated women could be lower than that of men under this compensation system because women are likely to work fewer hours than men because of family responsibilities.

[31]For example, Kawaguchi [2015] shows that establishments operating a lifetime employment system, seniority wage system, or internal promotion system are likely to have large gender wage gaps, and Chiang and Ohtake [2014] find that a glass ceiling exists for employees working under a non-performance-based pay system, both suggesting that the Japanese HRM system is likely to impede gender pay equity. Yamaguchi [2009] and Osawa [2015] also discuss this issue.

[32]Kawaguchi [2015] uses the same BSWS dataset as this study but examines the gender gap only at the mean, while Chiang and Ohtake [2014] employ wage distributional analysis but use a unique small-sample dataset that does not represent the overall work environment in Japan.

estimates the gender wage gap across the wage distribution means that it is the first to provide a comprehensive and representative view of the topic in Japan.

4 Japan's Labor Market and Theoretical Discussion

4.1 Gendered Job Segregation

First, we look at Japan's gendered job segregation system to discuss the gender wage gap among low-paid workers. To allow workers to efficiently accumulate firm-specific skills within a firm and enhance productivity, Japanese companies (and large companies in particular) have developed innovative high-performance human resource management (HRM) practices known collectively as the Japanese HRM system[33] and which includes lifetime employment, wages based on seniority, and allocation mechanisms that help to "get the right people in the right seats." These practices have evolved over time, but even the current *Career Track-Based Employment Management System* (CTB-EMS) allocates workers to jobs that are either career track or non-career track.[34] While under the CTB-EMS a company does not explicitly allocate workers based on gender, female workers have been more likely to be assigned to non-career track jobs within a firm while male workers and a very few highly skilled female workers have been more likely to be assigned to career track jobs. In practice, therefore, even the current CTB-EMS is substantially a gendered job segregation system.

In Japan, this gendered job segregation system is long-standing and has been resistant to change in spite of the enactment of the *Equal Employment Opportunities Law*

[33] See Moriguchi [2014] for a detailed description. An extensive literature on the Japanese HRM system includes numerous theoretical models showing the effectiveness and economic rationality of HRM practices (Lazear [1979], Itoh [1994], Aoki [1988], and Kandel and Lazear [1992]) as well as empirical evidence (Ichniowski et al. [1997], and MacDuffie [1995]).

[34] Mincer and Higuchi [1988] show that intensive training within Japanese companies, much of it specific to the firm, results in steeper wage profiles compared with US companies.

for Men and Women (EEOL) in 1986. Prior to the EEOL, the typical Japanese firm had a *literal* gendered employment management system whereby male workers were assigned to career track jobs while female workers were assigned to non-career track jobs.[35] However, with the enactment of the EEOL, such an explicitly gendered management system became illegal, so Japanese firms instead began to introduce a new employment management system with two kinds of positions: career track (a *career-oriented* management track position) and non-career track (a *non-career-oriented* management track position), and this has coalesced into the current CTB-EMS. However, in practice, this current system is virtually the same as the earlier explicitly gendered employment management system[36] because, while each job is ostensibly open to either gender, men are overwhelmingly assigned to career track jobs and women overwhelmingly to non-career track jobs. Only a very few women are assigned to career track jobs.[37] Moreover, as this kind of job segregation is due in part to worker self-selection, it has taken root in Japan as a sociocultural system.

Next, we consider a theoretical mechanism that explains why Japaneses companies have adopted the gendered job segregation system and which predicts the observed relationship between the HRM system and the gender wage gap. The *statistical discrimination* model proposed by Lazear and Rosen [1990] assumes that a given firm has two jobs, A and B. Job A requires firm-specific training and so an initial period of low

[35] See Osawa [2015] and also "Points of Concern about the Career Track-based Employment Management System" by the Japanese Ministry of Health, Labour, and Welfare (http://www.mhlw.go.jp/general/seido/koyou/danjokintou/dl/koyoukanri-a01.pdf).

[36] Among companies that have introduced the Career Track-Based EMS, 66.4% have also introduced a system allowing a worker to convert from a job without a career track to a job with a career track, according to the MHLW *Basic Survey of Gender Equality in Employment Management*), but the number of workers who actually convert is thought to be quite small.

[37] Among new employees in 2014, the ratio of females in the career-oriented management track and non-career-oriented track were 22.2% and 82.1%, respectively (MHLW, http://www.mhlw.go.jp/stf/houdou/0000089473.html).

worker productivity is followed by one of high productivity, with the worker in job A receiving a low wage initially, followed by a very high wage. Job B, on the other hand, does not require training, so a worker's productivity remains constant and the worker accordingly earns a modest wage in both the initial and later periods. As the initial wage in job A is lower than that in job B, the two wage profiles intersect. In this model, job A is a career track job and job B a non-career track job.

Continuing with our description of the model, the firm allocates a worker to either job A or B based on his/her ability (δ_g; $g = m : male, f : female$) and propensity to remain on the job. It is assumed that female workers have the same ability distribution as male workers, but the firm also knows that a female worker has better outside opportunities (in household production, for example) than a male worker, and therefore expects that a female worker will be more likely to leave the firm before it can reap any return from training. Consequently, the firm will set a higher ability threshold (δ) for allocating a female worker to job A than a male worker (i.e. $\delta_m < \delta_f$). This requirement that a woman have a higher ability than a man in order to be allocated to job A can produce a gender wage gap through the subsequent allocation of jobs, as a larger proportion of female workers are allocated to job B which has a low firm-specific job value than to job A which has a high value. Therefore, if the model is an accurate representation of the real labor market, there will be a substantial proportion of female workers who are allocated to non-career track job B.

Drawing upon this theoretical model, we can expect that different estimation results of the WS-effect ($\bar{X}_m(\hat{\beta}_{m,\tau} - \hat{\beta}_{f,\tau})$) might be obtained throughout the wage distribution. At the bottom tail, the majority of female workers will be those engaging in non-career track jobs, while most male workers at this low wage range will be in the initial years of a career track job, so large positive WS-effects might be observed. Moving toward the middle range, the proportion of female workers in a career track job will be larger and, consequently, the WS-effects will become smaller in the middle than at the lower range. At the upper tail of the wage distribution, however, the proportion of female workers in a career track job should be much larger than those in a non-career track job, and the female workers in these higher-paying career track jobs will be those with higher ability than men because $\delta_m < \delta_f$. Consequently, in theory, the WS-effect should disappear or even become negative at the upper tail.

4.2 Gender Promotion Gap

In this section, we discuss a gender gap in promotion and how that might cause a gender wage gap to arise, particularly among highly paid workers, because a worker receives a higher wage if s/he is in a higher employment position. If we look at the published data, the percentage of female workers who hold managerial posts has been increasing in Japan from 3.0% in 1990 to 10.1% in 2012, according to the BSWS. However, in Japan as in many countries, it remains more difficult for women than men to get promoted to manager, with Japan (0.65%) the second lowest among OECD countries after Korea (0.34%).[38]

The published data, however, does not account for any gender differences in human capital so in what follows we examine the gender gap in promotion after controlling for this. First, we estimated the probability of a female working in a medium-sized and a large company, respectively,[39] in each of six possible positions. Because this employment position variable does not fit in perfect sequence from the highest to lowest position

[38]According to the OECD database (http://www.oecd.org/gender/data/employed-who-are-managers-by-sex.htm), this compares to 14.6% in the US (in 2013), 4.6% in France, 4.6% in Sweden, 34.5% in the UK, 8.1% in Germany, and 2.4% in Italy in 2015. It should be noted, however, that the OECD definition of managers differs from that of the BSWS.

[39]As the BSWS includes data on employment position only for workers in firms with more than 100 employees, we cannot perform this calculation for small firms.

(although director, section manager, chief and ordinary workers are clearly ordered),[40] we created a multinomial logit model using the following equation:

$$employment\ \ position_i = \alpha + \delta female_i + \beta(\sum_{k=1}^{5} x_{ik} + \sum_{l=1}^{5} \bar{x}_{jl} + \bar{female}_j) + u_i, \quad (7)$$

and estimated the average marginal effect of being in each employment position for female workers within an establishment. To control for establishment FE, we applied the method proposed by Mundlak [1978], with definitions of x_i and $\bar{x_j}$ the same as in subsection 2.4. As $\bar{female}_j$ is the ratio of females at the establishment where employee i works and $female_i$ is a female dummy variable, our interest here is $\hat{\delta}$.

The results for 2015 are summarized in Panel A of Table 2. Director, section manager, foreman, and others are statistically significantly negative for both medium-sized and large companies. This means that after controlling for any gender differences in human capital, it is more difficult for female workers than male workers employed in the same establishment to be promoted to higher positions. As wages are related to one's employment position (i.e. there is a promotion premium), this gender difference in promotion could cause a gender wage gap among highly paid workers.

5 Results

5.1 Gender Wage Gap across Establishments

In this section, we present our main results, first looking at estimates of the gender wage gap ***across establishments*** using the most recent available data from 2015. Figure 2 shows the estimated raw gender wage gap ($E[RIF_\tau[lnw_m]] - E[RIF_\tau[lnw_f]]$) and the

[40] Complicating the analysis is that foreman and others do not fit into this framework as neatly. Specifically, "foreman" is a job title only for production laborers and not for office workers and so it is surveyed only in the mining, construction, and manufacturing industries, with foremen in other industries coded to "other," a category that also includes many kinds of employment positions specific to each establishment.

WS-effect ($\bar{X}_m(\hat{\beta}_{m,\tau} - \hat{\beta}_{f,\tau})$) at every fifth percentile between P5 and P95 (the point estimates and standard errors are reported in Table A3_1 in Appendix 3 which shows that all have 1% statistical significance). The estimated raw gap in Figure 2 is broadly similar to the raw gap shown in Figure 1, so approximation error appears to be quite small.[41]

We also see in Figure 2 that the WS-effect is smaller toward the middle of the wage distribution but becomes larger toward the upper tail. In particular, we notice a sharp acceleration in the upper range (above P75), with the WS-effect at P90 exceeding that of P50 by more than 12 points. Though not to the extent that Albrecht et al. [2003] report in Sweden,[42] this shows that in high-paying jobs in Japan too, the gender gap caused by gendered differences in the wage structure becomes increasingly large as the wage increases in the upper range of the wage distribution, which we have defined as a glass ceiling.

Additionally, we see that the WS-effect is also larger in the lower range of the distribution (between P10 and P45) than at the median, and while this difference is less than at the upper range of the distribution, this unexplained gender gap among low-paid workers is considered to be the sign of a sticky floor. Previous studies commonly define a sticky floor as the situation in which the P10 wage gap exceeds the reference gap (at P25 or P50, for example) by at least two percentage points.[43] While we cannot observe a difference of more than two points between P10 and P25 or P50, the gender gap at P20 (18.9 points) exceeds that of P50 (16.9 points) by two points with 1% statistical significance,[44] so we might therefore conclude that there exists a "weak"

[41] See footnote 23.

[42] From Figure 1 in Albrecht et al. [2003], it was around 20 points in 1998.

[43] See Arulampalam et al. [2007] and Christofides et al. [2013].

[44] The bootstrapped standard error for the gap between P20 and P50 is 0.005 (with the number of repetitions = 100).

sticky floor. In any case, there appears to be a stickiness experienced by women in the bottom fifth but not at the very bottom of the wage distribution. Taken together, our results show that both a glass ceiling and a weak sticky floor exist across establishments in the Japanese labor market.

Figure 2 also shows the across WS-effect after controlling for industry and we can see that it is larger at each percentile than that without controlling for industry. This suggests that Japanese female workers are more likely to work in an industry with a higher wage.

5.2 Gender Wage Gap within an Establishment

In Section 5.1, we found a glass ceiling and a weak sticky floor across establishments, but it is not yet clear whether this is caused by the segregation of women into low-paying establishments through the market (*between* WS-effect) or by the segregation of women into low-paying jobs within an establishment (*within* WS-effect). We examine these effects in this section.

Hence, we next examined the *within* WS-effect to see whether a glass ceiling or sticky floor is observed among workers at the same establishment by controlling for establishment FE using Eq. (6) as explained in Section 2.4.[45] The analysis sample was restricted to full-time workers at only those establishments that employed both men and women.[46]

Figure 3 presents the results. In addition to the within WS-effect, the estimated raw

[45]To confirm whether controlling for establishment means brings new information to the results of the FFL decomposition, F tests were also performed at each fifth percentile to test the null hypothesis that each coefficient $\bar{x}_{ig,l}, l = 1, \cdots, 5$ of the decomposition = 0, and they were all rejected for both the composition effects and the WS-effects at the 1% significance level, which means that statistically significant establishment FEs were found.

[46]In this restricted sample, the average number of workers per establishment was 18.9, with the minimum 2 and maximum 318, and the average proportion of female workers per establishment was 36.0%.

gender gap and the across WS-effect discussed in the previous section are also included for comparison.[47] First, we notice that the shapes of the within and across WS-effects are quite similar, which means that both the glass ceiling and sticky floor are observed within an establishment as well as across establishments. Second, the within WS-effect is smaller than the across WS-effect at every data point, and this difference represents a non-negative between WS-effect. This result thus supports the findings of previous studies that have shown that the gender wage gap can be attributed at least in part to the allocation of female workers into low-paying establishments.[48] However, as the difference in the across and within WS-effects (which represents the size of the between WS-effect) is less than 30%, this means that the between WS-effect is smaller than the within WS-effect, and so we can say that both the sticky floor and glass ceiling are more apparent within an establishment than between establishments in Japan.[49]

Having found that both a sticky floor and glass ceiling exist in Japan, we next consider why they might arise. One of the factors could be the CTB-EMS, the job segregation system that has become *de facto* gendered due to the difference in expected value employers receive from the development of firm-specific skills. As explained in Section 4, under this system, many female workers are assigned to non-career track jobs and so they become stuck in low-paying jobs. Also, because firm-specific skills are

[47]As this analysis sample is different from that of Figure 2, to permit a strict comparison, the raw gender gap and across WS-effect are not simply reproduced from Figure 2 but are recalculated for the new analysis sample. We can see, however, that there is little difference between these new estimates and the earlier estimates based on the full analysis sample.

[48]See Bayard et al. [2003] and Carrington and Troske [1998] for studies of the gender wage gap at the mean. For studies across the wage distribution, Javdani [2015] applies a method developed by Pendakur and Woodcock [2010] to explore the cause of this phenomenon through the wage distribution using Canadian data, finding clear evidence that women experience a glass ceiling that is driven not primarily by their experiences within a firm but by their disproportionate sorting across firms.

[49]To confirm whether the results change if we do not include bonus in the wage variable, we see from Panel C in Figure A3_1 that bonus increases both in the across and the within WS-effects both at the lower and at the upper tails, suggesting that it plays an important role in the gender wage gap in Japan.

important in career track jobs but are neither required nor rewarded in non-career track jobs, this explains how it is possible that a large WS-effect could be observed among low-paid workers. At the same time, under this system, a relatively few highly skilled female workers do get assigned to career track jobs and receive high wages. One would thus expect this to lead to the ***absence*** of a glass ceiling and yet we found that one exists. This argues for the possibility that the glass ceiling in Japan is caused by a different mechanism, which we hypothesize to be gendered differences in the opportunities for job promotion and an associated gender differential in wages, because even female workers in career track jobs face difficulties in getting promoted to higher positions and are possibly rewarded less when it does occur. In the next section, we test whether these conclusions are valid by conducting an analysis by firm size.

5.3 Analysis by Firm Size: Validity Check

To examine the possibility that a gendered job segregation might lead to a sticky floor and a gender gap in promotion to a glass ceiling in Japan, we performed an analysis by firm size. First, the rate at which companies adopt the CTB-EMS is proportionate to company size. In Japan, 46.8% of companies with more than 5,000 employees and 44.5 % of those with 1,000–4,999 have instituted this system, while only 7.5% of those with 30–99 employees have done so.[50]

Next, turning to the gender promotion gap by firm size, Panel A of Table 2 presents the average marginal effects of female workers on each employment position, and shows that for director and section manager, the highest and the second highest ranks, the effect is greater for medium-size firms than for large firms. This means that it is relatively more difficult for women to get promoted to higher positions in medium-size

[50]See the 2012 MHLW *Basic Survey of Gender Equality in Employment Management*. The rates for companies with 300-999 employees and 100–299 employees are 31.7% and 17.5%, respectively.

firms than in large firms.

Having confirmed that both the CTB-EMS is more pervasive and promotion is easier for female workers at large companies, if our hypothesis is correct, the sticky floor phenomenon should be observed more clearly among large companies, while the glass ceiling should be more clearly evident among smaller companies. To confirm this, we conducted an analysis by firm size[51] by dividing firms into three groups: large, medium, and small.

Figure 4 shows the *within* WS-effect, and we are interested in the third line from the top in each panel. If we look at the lower tail of these panels, the sticky floor is observed most clearly in large companies, to a lesser extent in medium-size companies, and is not observed in small companies. Thus, as expected, sticky floors are most prevalent in large companies. Next, if we look at the upper tails, the glass ceiling is observed in large companies, but it is more apparent in medium-size and small companies, also as predicted. These results thus support the suggestion that while gender job segregation could be one of the causes of the sticky floor, another mechanism such as a gender gap in promotion must be the cause of the glass ceiling in Japan.

To further explore this, we conducted a mediation analysis of within WS-effects while controlling for employment position. While the BSWS includes information on the employment positions of workers only in large and medium-size companies, we can confirm whether the above interpretation is true at least for this reduced sample. For this estimation, we added employment position dummy variables and establishment mean of each employment position in Eq. (6). The results are shown in Panels A and B of Figure 4 (the fourth lines from the top). Focusing on the upper tail of the wage

[51] While the BSWS directly surveys establishments, or the various operating units within a firm, it also provides data on the size of the firm each establishment belongs to, and so we used the firm size data rather than establishment data for this calculation.

distribution, we notice that the WS-effect differs greatly by firm size. In large firms, the WS-effects after controlling for employment position have fallen close to zero at the higher wages[52] but remain large in medium-sized firms. This supports our theoretical prediction in Section 4.1 that the CTB-EMS diminishes the WS-effect among high-paid workers if we control for any gender difference in job promotion.

Looking further into the potential causes of the glass ceiling, even female workers in career track positions may be less likely than men to get promoted to higher positions or, for male and female workers in the same position, female workers might be stuck at the bottom of the wage scale for that position. This situation has been observed in the U.K. (Booth et al. [2003]), and as the wage range for each position might be larger in medium-size companies than in large companies in Japan, this could explain why a glass ceiling might be more salient in smaller companies.

To gain additional insight, an another validity check was conducted using time series data for each decade from 1980 to 2010 in addition to the 2015 data from our main analysis. The details are presented in Appendix 2, but we found that the sticky floor has become weaker but the glass ceiling has become more apparent at an accelerating rate since 1990 (Figure A2_3). This result provides additional confirmation of our hypothesis about the sticky floor, but not the glass ceiling. To explore why this might be, one final analysis was conducted, and the result shows that a "swimming upstream" phenomenon (Blau and Kahn [1997]) might also exist among highly paid female workers in Japan, for while it has become less difficult for female workers to get promoted to higher positions in 2015 as compared to 1990, the return to these higher positions has become smaller (Table A2_1). This phenomenon among highly paid female workers is

[52] Regarding those above P55, the null hypotheses are not rejected statistically significantly. See Table A3_2 in Appendix 2.

not specific to Japan but is also observed in the U.S., the U.K. and Canada.[53]

6 Conclusion

This study examines the gender wage gap across the wage distribution using a large-scale Japanese employer-employee matched establishment-level dataset. We found that the gender wage gap unexplained by gender differences in human capital (namely, the WS-effect) is more prevalent within an establishment than between establishments, suggesting that differing treatment by gender within an establishment does indeed matter when discussing the gender wage gap in Japan. In addition, as the within WS-effect remains large even recently at both the lower and the upper tails of the wage distribution, Japanese female workers face both a glass ceiling and a (weak) sticky floor, with the sticky floor likely brought about by a gendered job segregation system and the glass ceiling by a gender gap in promotion.[54]

Further, as the sticky floor has become weaker since 1990, this might indicate that the gendered job segregation system has been weakening in Japan. The glass ceiling, however, has been becoming more pronounced over time, and this may be due to an increasing gender gap in the returns to promotion. Specifically, it seems that a "swimming upstream" phenomenon has appeared whereby it has become easier for female workers to get promoted to higher positions than before but the returns they gain from that promotion are less than for male workers.

As to how best to remedy this situation, we recall that Japan's gendered job segregation system emerged because of the role that firm-specific skill plays in enhancing

[53] See Blau and Kahn [2017] and Fortin et al. [2017].

[54] Note that Japan has introduced some family-friendly policies and policies to help women to participate in labor force, such as the *Childcare Leave Law* that was put into effect in 1992 to allow working parents to take a one-year leave of absence from work after the birth of a child.

productivity and the desire for companies to help employees accumulate firm-specific skills within the company in order to enhance their own productivity under the lifetime employment system. The gender promotion gap can be considered similarly. Kato et al. [2016] suggest that because working long hours can be a device for revealing to employers private information about employees' commitment to the firm and their ability to accumulate firm-specific human capital via in-firm training, those who work long hours (in Japan, usually men who have fewer family responsibilities than women) are more likely to get promoted to higher positions. Taking this into consideration, while the importance of firm-specific skills in productivity enhancement will not change, the results of this study suggest that a system that rewards jobs with flexibility, not inflexibility (the same hourly wage for both full-time and part-time workers, for example), is needed to further reduce the gender wage gap.

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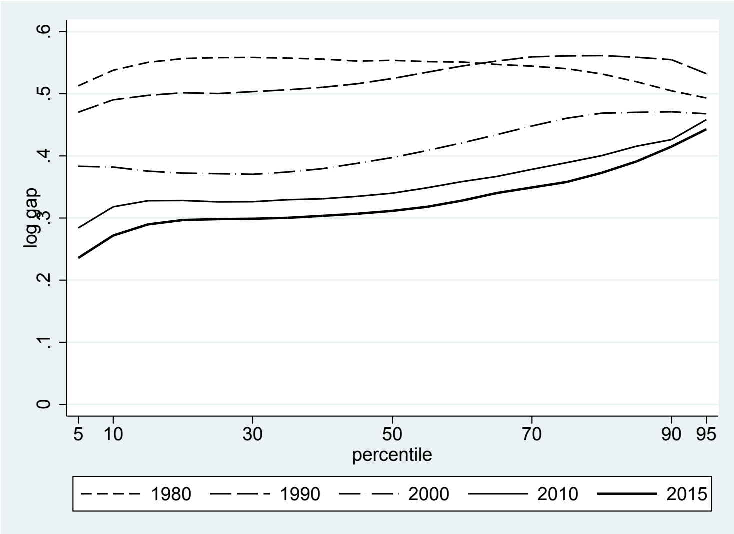
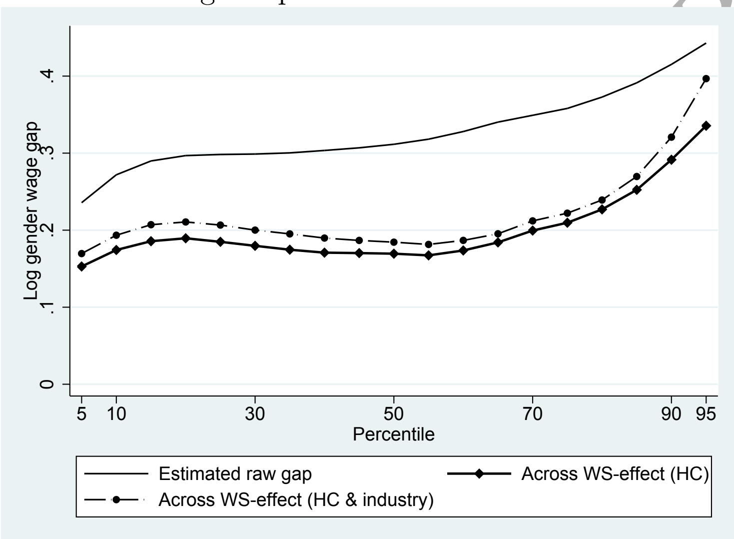
Figure 1: Raw gender wage gap (1980–2015)



Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Note: Raw gender wage gap at each τ percentile is calculated by $Q_\tau[lnw_m] - Q_\tau[lnw_f]$, where $Q_\tau[\cdot]$ indicates the τth quantile.

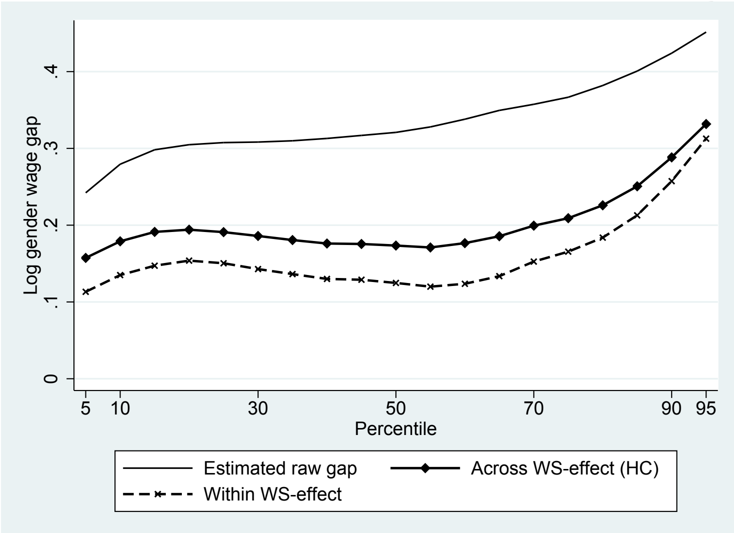
Figure 2: Raw Gender Wage Gap and WS-Effect across Establishments, 2015



Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Notes:

1. Estimated raw gender gap = $E[RIF_\tau[lnw_m]] - E[RIF_\tau[lnw_f]]$.
2. "Across WS-effect" is estimated using Eq. (5) and indicates the gender gap across establishments. HC indicates controlling for human capital variables, and HC & industry controls for both human capital and industry dummy variables.
3. All of the point estimates are 1% statistically significant. The point estimates and bootstrapped standard errors (calculated with number of reps = 100) at each fifth percentile are reported in Table A3_1 in Appendix 3.

Figure 3: Across- and Within-Establishment Raw Wage Gap and WS-effect, 2015



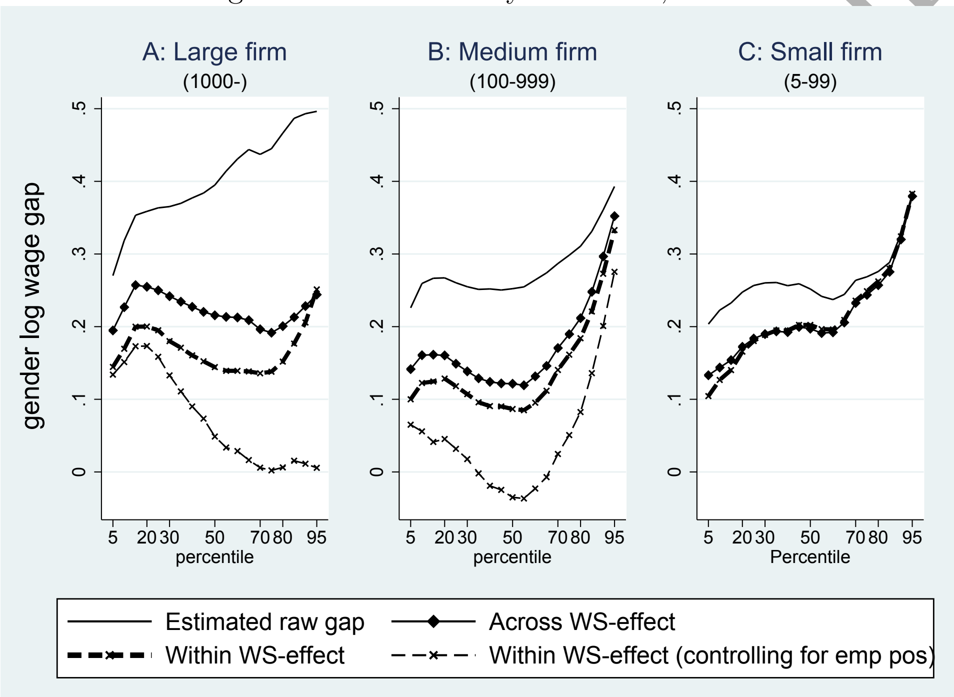
Source: Ministry of Health, Labour, and Welfare, *Basic Survey on Wage Structure*.
Notes:

1. "Estimated raw gap" $= E[RIF_\tau[lnw_m]] - E[RIF_\tau[lnw_f]]$ and "WS-effect" $= \bar{X}_m(\hat{\beta}_{m,\tau} - \hat{\beta}_{f,\tau})$. "Across WS-effect" is estimated using Eq. (5) and indicates the gender gap across establishments. "Within WS-effect" is estimated using Eq. (6) and indicates the gender gap within an establishment.

2. All of the point estimates are 1% statistically significant. The point estimates and bootstrapped standard errors (which are calculated with the number of reps = 100) at each fifth percentile are reported in Table A3_1 in Appendix 3.

3. The analysis sample is full-time workers at establishments employing both men and women in 2015.

Figure 4: WS-Effects by Firm Size, 2015



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Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Notes:

1. "Across" indicates that establishment fixed effects are not controlled for, "within" indicates that establishment fixed effects are controlled for, and "emp pos" indicates that employment position is controlled for.
2. Point estimates and bootstrapped standard errors at each fifth percentile (with number of repetitions = 100) are reported in Table A3_2 in Appendix 3.

Table 1: Summary Statistics by Gender, 2015

	Male		Female	
	Mean	S.D.	Mean	S.D.
ln hourlywage	3.19	(0.00)	2.87	(0.00)
Age	41.00	(0.03)	39.28	(0.04)
Tenure	13.43	(0.03)	9.48	(0.03)
Potential experience	22.19	(0.03)	20.61	(0.04)
Years of schooling	13.81	(0.01)	13.67	(0.01)
Employment position				
Ordinary worker	0.60	(0.00)	0.88	(0.00)
Foreman	0.03	(0.00)	0.00	(0.00)
Chief	0.10	(0.00)	0.04	(0.00)
Section manager	0.12	(0.00)	0.03	(0.00)
Director	0.05	(0.00)	0.01	(0.00)
Others	0.09	(0.00)	0.04	(0.00)
Firm size				
10–29	0.11	(0.00)	0.11	(0.00)
30–99	0.17	(0.00)	0.17	(0.00)
100–299	0.18	(0.00)	0.20	(0.00)
300–499	0.08	(0.00)	0.09	(0.00)
500–999	0.10	(0.00)	0.11	(0.00)
1000-4999	0.18	(0.00)	0.16	(0.00)
5000–	0.19	(0.00)	0.16	(0.00)
Industry				
Mining	0.00	(0.00)	0.00	(0.00)
Construction	0.08	(0.00)	0.03	(0.00)
Manufacturing	0.30	(0.00)	0.17	(0.00)
Wholesale and retail trade	0.15	(0.00)	0.14	(0.00)
Finance and insurance	0.03	(0.00)	0.07	(0.00)
Real estate	0.01	(0.00)	0.01	(0.00)
Transport and communications	0.16	(0.00)	0.06	(0.00)
Electricity, gas, heat supply and water	0.01	(0.00)	0.00	(0.00)
Service	0.25	(0.00)	0.53	(0.00)

Source: Ministry of Health, Labour, and Welfare, *Basic Survey on Wage Structure*.

Table 2: Probability of a female worker being employed in a given position within an establishment (Marginal effects)

	(1) director	(2) section manager	(3) chief	(4) foreman	(5) ordinary workers	(6) others
Panel A. by firm size in 2015						
medium size firms (100-999)	-0.071***	-0.070***	-0.006	-0.010***	0.183***	-0.027***
	(0.005)	(0.006)	(0.005)	(0.003)	(0.006)	(0.006)
large firms (1,000-)	-0.041***	-0.065***	0.004	-0.014***	0.165***	-0.050***
	(0.009)	(0.009)	(0.008)	(0.005)	(0.009)	(0.009)
Panel B. by year						
1990	-0.057***	-0.098***	-0.060***	-0.020***	0.235***	0.000
	(0.004)	(0.005)	(0.005)	(0.003)	(0.009)	(0.012)
2015	-0.047***	-0.059***	-0.006*	-0.012***	0.158***	-0.034***
	(0.003)	(0.004)	(0.003)	(0.002)	(0.006)	(0.004)

Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Notes:

1. Marginal effects are reported. Standard error is in brackets and is clustered by establishment.
2. Analysis sample is restricted to workers at firms employing more than 100 workers and employing both male and female workers.
3. Sampling weights are used to make analysis sample represent the population.

Appendix 1: Variables

1. **Industry**
   Sixteen industries based on the Japan Standard Industry Classification are covered: 1) mining and quarrying of stone and gravel; 2) construction; 3) manufacturing; 4) electricity, gas, heating, and water; 5) information and communications; 6) transportation and postal services; 7) wholesale and retail trade; 8) finance and insurance; 9) real estate and goods rental and leasing; 13) scientific research, professional and technical services; 11) accommodations, eating and drinking services; 12) living-related and personal services and amusement services; 13) education and learning support; 14) medical, health care, and welfare; 15) compound services; and 16) services (not classified elsewhere).

2. **Potential experience (in years)**
   It is calculated as [age – years of schooling – 6 + 1] because the enrollment age for elementary school is six in Japan.

3. **Schooling (in years)**
   1) Junior high school: 9 years; 2) high school: 12 years; 3) two-year college/specialized vocational high school: 14 years; and 4) university/graduate school: 16 years.

4. **Firm size (size of the firm each establishment belongs to)**
   1) Small: 99 or fewer employees; 2) medium: 100–999 employees; and 3) large: 1,000 or more employees.

5. **Employment position**
   1) Director (*bucho*); 2) section manager (*kacho*); 3) chief (*kakaricho*); 4) foreman (*syokucho*); 5) ordinary worker; and 6) other.

Appendix 2: Time Series Validity Check

Here we report the results of another validity check based on a time-series comparison using data for each decade from 1980 to 2010 and the 2015 data from the main analysis. Briefly returning to Figure 1 to observe the changes in the ***raw*** gender wage gap, we notice that from 1990 on, the line graphs are all upward-sloping, with the slopes getting steeper every decade toward 2015. Another trend to note is that the raw gender wage gap at each percentile has decreased every decade since 1990, though this convergence in male and female wages has been slowing down over time. It also should be mentioned that as we are interested in the gender wage gap among workers, ***not*** all people, this analysis might face a sample selection problem. The labor force participation rate of women increased by more than 15 points between 1980 and 2015 (Figure A2_1), but this has been accompanied by a change in the composition of the female workforce such that gender differentials in human capital have decreased (Figure A2_2).[55] This indicates that while the raw gender wage gap has indeed decreased over time, much of this decline has been caused by a convergence in the formerly large differences between men and women in human resource attributes. Thus we focus again on the WS-effect that is unexplained by such attributes.

Viewing the ***within*** WS-effect in 1980 in Figure A2_3, before the Equal Employment Opportunities Law (EEOL), neither a glass ceiling nor a sticky floor are observed. It is suggested that while the overall gender gap was larger at this time, a few female workers might have earned high wages, and these relatively well-rewarded women would

[55] Panels A–C in Figure A2_2 show that tenure, potential experience and years of schooling have increased for both male and female workers toward 2015, but the difference between men and women with respect to these variables has decreased. We also notice that the gender difference in tenure is large in 2015 compared to the other variables. In addition, Abe [2010] shows that educational composition changes played a larger role in closing the pay gap for younger cohorts than it did for older cohorts.

represent the decline in the gender gap at the upper tail above P70.

As for the sticky floor, our hypothesis is that the sticky floor has been weakening over time because the EEOL has undergone several revisions since 1985, each of which has introduced more stringent provisions against differential treatment between male and female workers.[56] It is also expected that the glass ceiling has been weakening because it has become relatively easier in 2015 for women to get promoted compared with men than it was in 1990 (Panel B of Table 2). Turning to after 1990, on the lower tail of the wage distribution, we see that a sticky floor has been observed since 1990, but the difference between those at the bottom and those in the middle of the distribution has become smaller since 2010, suggesting that it has been weakening.[57] This result supports our hypothesis. However, at the upper tail, we can see that the glass ceiling has become increasingly apparent more recently, suggesting that it has been accelerating over time.[58] As this does not support our hypothesis, what might be happening?

One possible explanation is the "swimming upstream" phenomenon proposed by Blau and Kahn [1997]. In the 2000s, while promotion has become easier for women, the returns to managerial positions might have increased for men but not for women so that women are relatively less rewarded for this increase in upward mobility. To explore this interpretation, we conducted an additional analysis estimating the returns

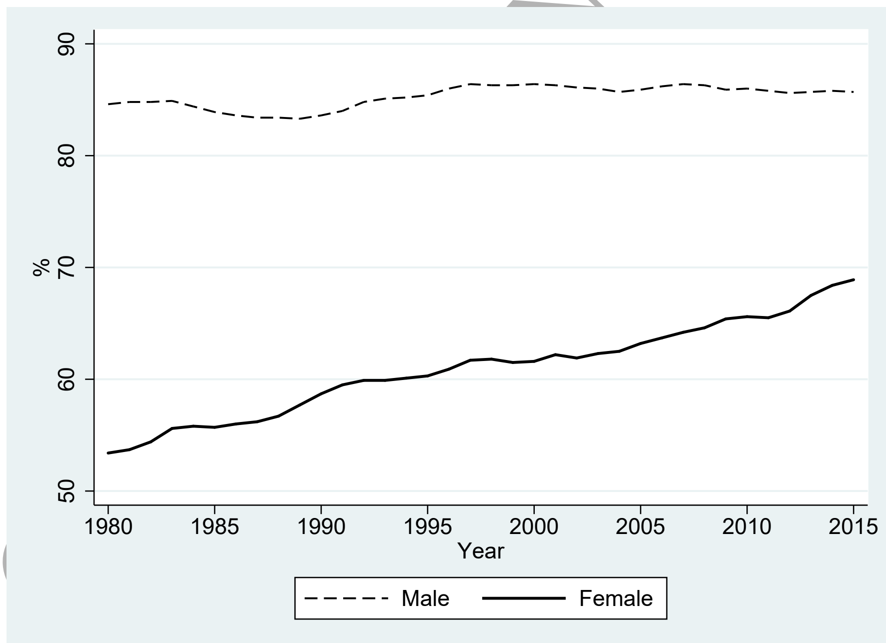
[56] For example, when the law was enacted in 1985, different treatments in major training, retirement and dismissal were banned, but as for recruitment/hiring and job assignment/promotion, the law only required companies to "make efforts" to ensure equal treatment. However, this differential treatment was also prohibited in the 1999 revision.

[57] A difference between P10 and P50 in 1990 is larger than that in 2015 with 1% statistical significance (the difference-in-differences is 0.057). The bootstrapped standard error for the gap in 1990 and in 2015 is 0.010 for between P10 and P50 and 0.007 for between P20 and P50 (with the number of repetitions = 100).

[58] A difference between P50 and P90 in 1990 is larger than that in 2015 with 1% statistical significance (the difference-in-differences is 0.107). The bootstrapped standard error for the gap in 1990 and in 2015 is 0.013 for between P50 and P90 (with the number of repetitions = 100).

to employment position by gender for 1990 and 2015.[59] Table A2_1 shows that the employment position premium for male workers is larger in 2015 than in 1990 for all positions, but this is not the case for female workers. Assuming that the internal labor markets for male and female workers are segregated, one interpretation is that the supply of female workers in managerial positions has increased, so the return to managerial positions has decreased while, on the other hand, the supply of core male workers (that is, those in high positions), has decreased because of the erosion of the lifetime employment system,[60] and so the premium for male workers has increased.

Figure A2_1: Changes in Labor Force Participation Rate by Gender (15 to 60 years old), 1980–2015

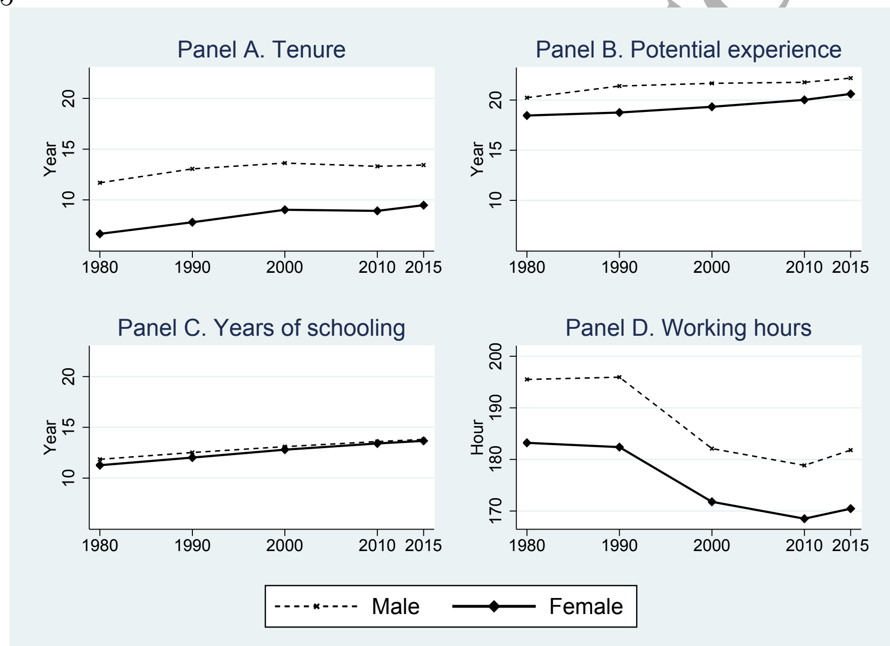


Source: Japanese Bureau of Statistics *Labour Force Survey*.

[59]See the footnote of Table A2_1 for the estimation equation.

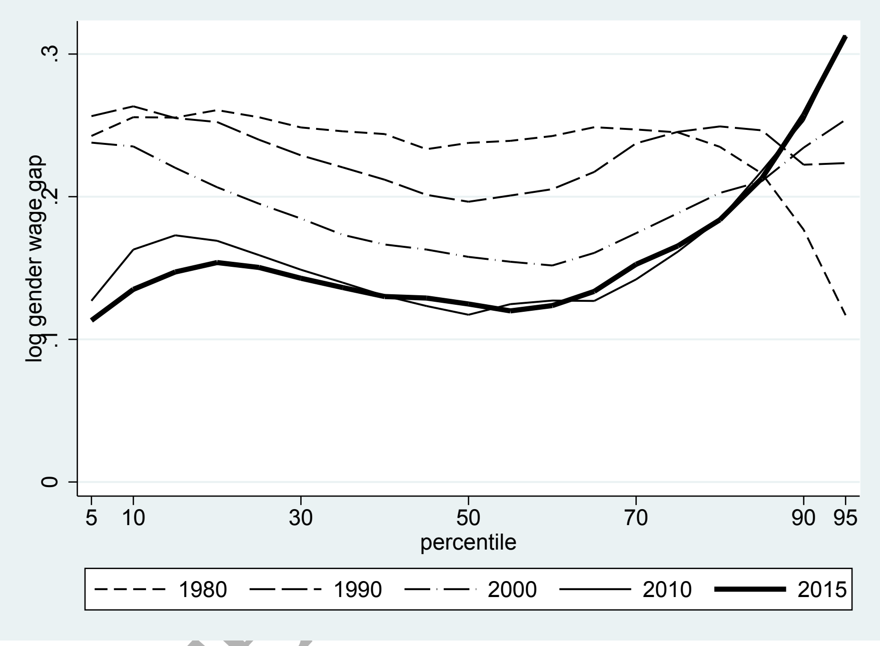
[60]Hamaaki et al. [2012] find a discernible downward trend in the share of lifetime employees among university educated younger workers from the early 2000s, and their job retention rate also declined noticeably in the first decade of the 2000s.

Figure A2_2: Changes in Human Capital Variables and Working Hours by Gender, 1980–2015



Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.

Figure A2_3: Within-WS effect, 1980–2015



Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Notes:

1. The "within-WS effect" indicates that establishment fixed effects are controlled for. The analysis sample is full-time workers at establishments employing both female and male workers.
2. All of the point estimates are within 1% statistical significance. Point estimates from P5 to P95 each year, and bootstrapped standard errors at each fifth percentile (number of reps = 100) are reported in Table A3_3 in Appendix 3.
3. The results for 2015 are the same as in Figure 3.

Table A2_1: Employment position premium within an establishment

	male		female	
	(1)	(2)	(3)	(4)
	1990	2015	1990	2015
director	0.457***	0.489***	0.577***	0.491***
	(0.007)	(0.011)	(0.066)	(0.045)
section manager	0.297***	0.315***	0.279***	0.278***
	(0.005)	(0.007)	(0.026)	(0.017)
chief	0.121***	0.130***	0.143***	0.125***
	(0.004)	(0.007)	(0.017)	(0.013)
foreman	0.061***	0.080***	0.107***	0.111**
	(0.004)	(0.010)	(0.023)	(0.050)
others	0.216***	0.258***	0.164***	0.167***
(ref: ordinary workers)	(0.005)	(0.010)	(0.020)	(0.016)
R-squared	0.683	0.616	0.318	0.464

Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Notes:

1. The estimation equation is $lnw_i = \alpha_i + \eta \times employment\ position_i + \sum_{k=1} \beta_i x_{i,k} + \sum_{l=1} \beta_i \bar{x}_{i,l} + u_i$, where $x_{i,k}$ includes years of education, tenure and its square, potential experience and its square, and $\bar{x}_{i,l}$ is the establishment mean of $x_{i,k}$ and employment position.
2. The clustered standard error by establishment is in ( ).

Appendix 3

Figure A3_1: Comparison between Results with and without Bonus, 2015

Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Note: "W/ bonus" is the same as Figure 2, meaning that the hourly wage variable is calculated including bonus. "W/o bonus" means that the hourly wage variable is calculated excluding bonus.

Table A3_1: Coefficients and Bootstrapped Standard Errors in Figures 2 and 3

	Panel A. Figure 2									**Panel B. Figure 3**								
	raw gap			across WS-effect (HC)			across WS-effect (HC and industry)			raw gap			across WS-effect			within WS-effect		
percentile	coef.	s.e.		coef.	s.e.		coef.	s.e.		coef.	s.e.		coef.	s.e.		coef.	s.e.	
5	0.236	0.004	*	0.153	0.005	*	0.170	0.006	*	0.242	0.005	*	0.157	0.006	*	0.113	0.009	*
10	0.272	0.004	*	0.174	0.005	*	0.193	0.006	*	0.279	0.005	*	0.179	0.005	*	0.135	0.006	*
15	0.290	0.005	*	0.186	0.005	*	0.207	0.006	*	0.298	0.006	*	0.191	0.005	*	0.147	0.006	*
20	0.297	0.005	*	0.189	0.005	*	0.211	0.005	*	0.305	0.006	*	0.194	0.005	*	0.154	0.005	*
25	0.298	0.005	*	0.185	0.004	*	0.207	0.005	*	0.308	0.007	*	0.191	0.006	*	0.150	0.005	*
30	0.299	0.005	*	0.180	0.005	*	0.200	0.005	*	0.308	0.007	*	0.186	0.006	*	0.143	0.005	*
35	0.300	0.006	*	0.175	0.005	*	0.195	0.005	*	0.310	0.007	*	0.181	0.006	*	0.136	0.005	*
40	0.303	0.006	*	0.171	0.005	*	0.190	0.005	*	0.313	0.008	*	0.176	0.006	*	0.130	0.005	*
45	0.307	0.007	*	0.170	0.005	*	0.187	0.005	*	0.317	0.008	*	0.176	0.006	*	0.129	0.005	*
50	0.312	0.007	*	0.169	0.006	*	0.184	0.005	*	0.321	0.008	*	0.173	0.007	*	0.125	0.005	*
55	0.318	0.008	*	0.167	0.006	*	0.181	0.005	*	0.328	0.009	*	0.171	0.007	*	0.120	0.005	*
60	0.328	0.008	*	0.174	0.006	*	0.187	0.005	*	0.338	0.010	*	0.177	0.007	*	0.124	0.005	*
65	0.340	0.008	*	0.184	0.006	*	0.195	0.006	*	0.350	0.010	*	0.186	0.007	*	0.134	0.006	*
70	0.349	0.008	*	0.200	0.006	*	0.212	0.006	*	0.357	0.010	*	0.199	0.007	*	0.153	0.006	*
75	0.358	0.010	*	0.210	0.007	*	0.222	0.006	*	0.367	0.011	*	0.209	0.008	*	0.166	0.006	*
80	0.373	0.011	*	0.227	0.008	*	0.239	0.007	*	0.382	0.011	*	0.226	0.007	*	0.184	0.007	*
85	0.391	0.011	*	0.252	0.008	*	0.270	0.008	*	0.401	0.012	*	0.251	0.008	*	0.213	0.008	*
90	0.415	0.011	*	0.291	0.009	*	0.321	0.009	*	0.424	0.012	*	0.288	0.008	*	0.257	0.009	*
95	0.443	0.013	*	0.336	0.011	*	0.397	0.013	*	0.451	0.014	*	0.332	0.010	*	0.313	0.013	*

Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Notes:

1. * indicates 1% statistical significance.
2. Bootstrapped standard errors (with number of repetitions = 100) are reported.

Table A3_2: Coefficients and Bootstrapped Standard Errors in Figure 4

Panel A. Large firm

	raw gap			across WS-effect			within WS-effect			within WS-effect (cont. for position)		
percentile	coef.	s.e.		coef.	s.e.		coef.	s.e.		coef.	s.e.	
5	0.270	0.006	*	0.195	0.010	*	0.145	0.015	*	0.134	0.023	*
10	0.319	0.008	*	0.227	0.010	*	0.170	0.013	*	0.151	0.021	*
15	0.353	0.007	*	0.257	0.009	*	0.200	0.012	*	0.173	0.020	*
20	0.359	0.008	*	0.255	0.009	*	0.200	0.010	*	0.173	0.017	*
25	0.364	0.009	*	0.250	0.009	*	0.195	0.010	*	0.159	0.016	*
30	0.365	0.010	*	0.242	0.010	*	0.180	0.011	*	0.133	0.017	*
35	0.370	0.011	*	0.234	0.010	*	0.171	0.011	*	0.111	0.017	*
40	0.377	0.012	*	0.227	0.011	*	0.160	0.012	*	0.090	0.017	*
45	0.384	0.012	*	0.220	0.011	*	0.152	0.011	*	0.073	0.016	*
50	0.395	0.012	*	0.216	0.012	*	0.144	0.012	*	0.049	0.017	*
55	0.414	0.013	*	0.213	0.012	*	0.139	0.012	*	0.034	0.017	
60	0.431	0.014	*	0.213	0.012	*	0.139	0.012	*	0.029	0.018	
65	0.444	0.015	*	0.209	0.013	*	0.138	0.013	*	0.016	0.018	
70	0.437	0.015	*	0.196	0.013	*	0.136	0.013	*	0.006	0.018	
75	0.445	0.017	*	0.192	0.014	*	0.138	0.014	*	0.002	0.020	
80	0.466	0.019	*	0.201	0.016	*	0.152	0.016	*	0.006	0.022	
85	0.487	0.021	*	0.213	0.018	*	0.177	0.016	*	0.015	0.024	
90	0.493	0.023	*	0.228	0.019	*	0.206	0.018	*	0.011	0.027	
95	0.496	0.029	*	0.244	0.025	*	0.251	0.023	*	0.006	0.039	

Panel B. Medium-size firm

	raw gap			across WS-effect			within WS-effect			within WS-effect (cont. for position)		
percentile	coef.	s.e.		coef.	s.e.		coef.	s.e.		coef.	s.e.	
5	0.226	0.008	*	0.142	0.011	*	0.100	0.014	*	0.065	0.021	*
10	0.259	0.008	*	0.161	0.009	*	0.122	0.013	*	0.056	0.019	*
15	0.267	0.007	*	0.161	0.008	*	0.124	0.011	*	0.041	0.018	*
20	0.267	0.007	*	0.160	0.008	*	0.129	0.010	*	0.045	0.016	*
25	0.260	0.007	*	0.149	0.008	*	0.118	0.010	*	0.032	0.015	*
30	0.255	0.007	*	0.138	0.007	*	0.107	0.010	*	0.018	0.014	
35	0.251	0.008	*	0.129	0.008	*	0.096	0.008	*	-0.002	0.011	
40	0.252	0.008	*	0.124	0.008	*	0.091	0.009	*	-0.019	0.011	
45	0.250	0.009	*	0.122	0.009	*	0.090	0.009	*	-0.025	0.011	*
50	0.252	0.009	*	0.121	0.009	*	0.087	0.009	*	-0.035	0.012	*
55	0.255	0.008	*	0.119	0.008	*	0.085	0.009	*	-0.036	0.012	*
60	0.264	0.009	*	0.132	0.008	*	0.095	0.009	*	-0.023	0.014	
65	0.274	0.009	*	0.146	0.008	*	0.112	0.010	*	-0.007	0.015	
70	0.287	0.009	*	0.171	0.008	*	0.140	0.009	*	0.025	0.014	
75	0.298	0.010	*	0.190	0.009	*	0.161	0.011	*	0.051	0.016	*
80	0.311	0.009	*	0.212	0.009	*	0.184	0.011	*	0.082	0.016	*
85	0.331	0.009	*	0.248	0.009	*	0.221	0.010	*	0.136	0.015	*
90	0.361	0.009	*	0.297	0.008	*	0.273	0.011	*	0.201	0.016	*
95	0.393	0.011	*	0.352	0.011	*	0.333	0.017	*	0.275	0.022	*

Panel C. Small firm

	raw gap			across WS-effect			within WS-effect		
percentile	coef.	s.e.		coef.	s.e.		coef.	s.e.	
5	0.204	0.007	*	0.133	0.011	*	0.104	0.014	*
10	0.223	0.007	*	0.144	0.010	*	0.127	0.012	*
15	0.233	0.007	*	0.154	0.009	*	0.140	0.011	*
20	0.248	0.008	*	0.172	0.009	*	0.166	0.010	*
25	0.257	0.008	*	0.184	0.009	*	0.180	0.009	*
30	0.260	0.009	*	0.190	0.009	*	0.189	0.009	*
35	0.261	0.010	*	0.194	0.010	*	0.195	0.008	*
40	0.256	0.011	*	0.192	0.011	*	0.195	0.008	*
45	0.259	0.011	*	0.200	0.011	*	0.202	0.007	*
50	0.252	0.012	*	0.197	0.012	*	0.202	0.007	*
55	0.242	0.014	*	0.191	0.012	*	0.197	0.007	*
60	0.237	0.014	*	0.192	0.012	*	0.196	0.006	*
65	0.244	0.016	*	0.206	0.013	*	0.209	0.006	*
70	0.264	0.016	*	0.233	0.013	*	0.236	0.005	*
75	0.269	0.018	*	0.244	0.014	*	0.249	0.004	*
80	0.276	0.021	*	0.257	0.015	*	0.262	0.004	*
85	0.288	0.022	*	0.275	0.015	*	0.280	0.005	*
90	0.328	0.023	*	0.320	0.016	*	0.324	0.005	*
95	0.383	0.031	*	0.379	0.019	*	0.383	0.006	*

Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Notes: 1. * indicates 1% statistical significance.
2. Bootstrapped standard errors (with number of repetitions = 100) are reported.

Table A3_3: Coefficients and Bootstrapped Standard Errors in Figure A2_3

	1980 WS-effect (within)			1990 WS-effect (within)			2000 WS-effect (within)			2010 WS-effect (within)		
percentile	coef.	s.e.		coef.	s.e.		coef.	s.e.		coef.	s.e.	
5	0.243	0.004	*	0.256	0.007	*	0.238	0.008	*	0.127	0.009	*
10	0.256	0.003	*	0.263	0.007	*	0.235	0.006	*	0.163	0.007	*
15	0.255	0.003	*	0.255	0.006	*	0.220	0.006	*	0.173	0.007	*
20	0.261	0.002	*	0.252	0.005	*	0.207	0.005	*	0.169	0.007	*
25	0.256	0.002	*	0.240	0.005	*	0.195	0.005	*	0.159	0.007	*
30	0.249	0.002	*	0.229	0.005	*	0.185	0.005	*	0.149	0.007	*
35	0.246	0.002	*	0.221	0.005	*	0.173	0.005	*	0.140	0.007	*
40	0.244	0.002	*	0.212	0.006	*	0.166	0.005	*	0.131	0.007	*
45	0.233	0.002	*	0.201	0.007	*	0.163	0.005	*	0.123	0.007	*
50	0.238	0.002	*	0.196	0.005	*	0.158	0.005	*	0.117	0.007	*
55	0.239	0.002	*	0.201	0.007	*	0.154	0.005	*	0.125	0.007	*
60	0.243	0.002	*	0.205	0.005	*	0.152	0.005	*	0.127	0.007	*
65	0.249	0.002	*	0.217	0.005	*	0.161	0.004	*	0.127	0.007	*
70	0.247	0.002	*	0.237	0.005	*	0.174	0.005	*	0.142	0.007	*
75	0.245	0.003	*	0.245	0.007	*	0.188	0.005	*	0.162	0.007	*
80	0.235	0.003	*	0.249	0.007	*	0.203	0.005	*	0.184	0.007	*
85	0.216	0.003	*	0.247	0.007	*	0.211	0.006	*	0.218	0.008	*
90	0.177	0.004	*	0.222	0.010	*	0.234	0.006	*	0.253	0.007	*
95	0.117	0.005	*	0.224	0.010	*	0.254	0.008	*	0.313	0.008	*

Source: Ministry of Health, Labour, and Welfare *Basic Survey on Wage Structure*.
Notes:

1. * indicates 1% statistical significance.
2. Bootstrapped standard errors (with number of repetitions = 100) are reported.