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The Effect of Employer Tenure on Wages in Japan*

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【Abstract】We estimate the effects of employer tenure on wages based on the instrumental variable method and by using the Japan Household Panel Survey (JHPS/KHPS) from 2004 to 2014. We cannot reject the hypothesis that employer tenure significantly contributes to the wage growth after correcting for the omitted variable biases due to individuals' unobserved abilities and unobserved matching qualities, while the ordinary least squares estimators imply substantial returns to employer tenure. These results are robust across subsamples and do not depend on the estimation method. We conclude that the return to employer tenure may be less important in Japan than has been specified in previous studies.

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Abstract

We estimate the effects of employer tenure on wages based on the instrumental variable method and by using the Japan Household Panel Survey (JHPS/KHPS) from 2004 to 2014. We cannot reject the hypothesis that employer tenure significantly contributes to the wage growth after correcting for the omitted variable biases due to individuals' unobserved abilities and unobserved matching qualities, while the ordinary least squares estimators imply substantial returns to employer tenure. These results are robust across subsamples and do not depend on the estimation method. We conclude that the return to employer tenure may be less important in Japan than has been specified in previous studies.

1 Introduction

It is important to consider and confirm what effect increasing employer tenure would have on increase in wages for understandng the structure of the labor market and the mechanisms of the determinants of the wages. [*1] For example, if wages increase with tenure, probably because workers accumulate firm-specific human capital through their experience with the employer, they lose that human capital when they switch their employers, and therefore, would expectt their wages to decline. [*2] In this case, it is optimal to remain in a firm. Conversely, if human capital is more general (not employer specific)

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[*1] For example, Becker (1962), Mincer (1974), Mortensen (1978), and Hashimoto (1981) have rationalized the upward-sloping wage-tenure profile.

[*2] See Addison and Portugal (1989a,b); Altonji and Williams (1998); Carrington (1993); Topel (1990); Farber (1999), which have examined the cost of displacement using the data of the United States. Abe et al. (2002) mention about the costs in Japan.

and productivity depends on the match between the firm and the worker, workers could improve their productivity and earn higher wages by switching to an employer with a higher quality match.

Many studies have documented a steep wage profile within Japanese firms. Hashimoto and Raisian (1985) find that wage-tenure profiles are steeper in Japan than in the United States. Mincer and Higuchi (1988) also reveal that productivity growth resulting from greater investment in firm-specific human capital leads to a steeper wage profile, and thus a lower turnover rate, in Japan than in the United States. While some researches have highlighted that the effect of employer tenure on wages has been weaker than conventionally described, they have still found a positive association between tenure and wages.[*3]

However, most of these studies cannot succumb to the omitted variable bias if a correlation between tenure variables and unobservable components exists. For example, the failure to control for unobserved individual abilities would cause the estimated coefficient of employer tenure to be biased upward. Further, if only those workers who are a better match remain with the employer longer, the slope of the wage profile would be steeper than the true slope. In addition, since workers in firms with higher wages have less incentive to move to the other firms, such firm, on average, would have longer employer tenure. Under this condition, since wages affect employer tenure, we cannot obtain, in general, an unbiased estimator using the OLS. Specifically, there is a concern that a wage return to tenure based on OLS would likely be overestimated under this condition.

This paper aims to correct for omitted variable bias when a regression equation is additively separable in the observable variables and time-invariant in unobserved components, such as an unobserved matching component or unobserved ability, using recently accumulated panel data, i.e., the Japan Household Panel Survey (JHPS/KHPS). For this purpose, we adopt the method introduced by Altonji and Shakotko (1987) and Altonji and Williams (2005). Hereafter, we refer to the estimation method introduced by Altonji and Shakotko (1987) and Altonji and Williams (2005) as AS's instrumental variable (IV) method.

First, we regress wages on individuals' employer tenure through OLS and AS's IV method. AS's IV method uses deviation from the mean employer tenure as the instrumental variable representing employer tenure for each individual. An IV can be orthogonal to an individual's time-invariant ability or time-invariant quality of being matched to an employer by construction. Therefore, insofar as unobserved components are time-invariant and additively separable in a regression analysis, this IV estimate can provide a consistent coefficient of employer tenure.

Our results reveal that while wage returns to 2, 5, 10, and 15 years of employer tenure are 9.4%, 13.3%, 19.3%, and 24.6%, respectively, using the OLS estimator, the corresponding returns are approximately 3.2%, 4.2%, 5.7%, and 7.2%, respectively, using AS's instrumental variable method. Using the As's IV method, we cannot reject the

[*3]See, for example, Clark and Ogawa (1992); Hashimoto and Raisian (1992); Tsuru et al. (2003); Ohashi and Nakamura (2004); Yamada and Kawaguchi (2015).

hypothesis that an increase in tenure has no effect on wage growth. These results suggest that employer tenure has little effect on increase in wages after controlling for biases due to unobserved heterogeneity in the quality of employer matching and individual ability. There is a significant difference between the returns to employer tenure by using the OLS versus AS's IV methoed, especially for more than 3 years of employer tenure.

The results are surprisingly robust. We also conduct the two-step first-difference method (hereafter, 2SFD) as suggested by Topel (1991). He highlight the downward bias due to the heterogeneity of the match quality included in the AS's IV estimator of employer tenure. Topel uses the 2SFD method, taking the first difference of wages for workers who remain with the same employer from the previous year. He argues that the true effect of employer tenure on wages is greater than what is presented by Altonji and Shakotko (1987). The returns based on the 2SFD estimator also support our main results, which are based on AS's IV estimator. It indicates the reduced impact of employer tenure on wage growth in our sample[*4] In sum, the matching theory explains our results well, indicating that employer tenure is less important than what has been found in previous studies.

We follow studies that focus on the relative importance of employer and occupation using the AS's IV (e.g., Kambourov and Manovskii, 2009 and Sullivan, 2010),[*5] and find that including occupation tenure in the wage equation does not change the returns to employer tenure in Japan,[*6] which contrasts with the results found in the abovementioned studies.

While this paper attempts to correct for biases included in the series of previous studies which follow Hashimoto and Raisian (1985), it is not the first study endeavoring to correct for such biases. Toda (2008) conducts similar research using the same dataset that we use in this study. Interestingly, he concludes that the human capital theory explains his results well, whereas the matching theory does not, which contrasts sharply with our results. Although Toda's analysis is interesting, his results seem to be influenced by the short time span in which his data is covered. The longer periods now included in the data enables us to obtain more robust results. We discuss the difference between Toda's study and ours in detail in Section 5.

The remaining sections of this paper are organized as follows. We briefly review discussions about returns to employer tenure in Japan in Section 2. In Section 3, we describe the data and explain how we construct our variables. The earnings function equation is defined in Section 4, and estimation results are explained in Section 5, where we examine the importance of employer tenure to wage growth in Japan, compared to

[*4]In the text, we mainly report the result of the 2SFD estimator based on one of the multiple specifications. Results based on other specifications are reported in Appendix E.

[*5]They reveal that the correlation between employer tenure and wages is attributable to the experience gained from an occupation or industry in the United States. Zangelidis (2008) adopts AS's IV to the British employment and wage data and find that while occupational experience significantly contributes to wage growth, industry experience does not.

[*6]Some studies also focus on industry-specific human capital (Neal, 1995; Parent, 2000; Weinberg, 2001). Although it is desirable to compare the effect of firm- and industry-specific human capital on wages using data from Japan, we cannot identify their relative importance because employer and industry tenure are almost the same for individuals in Japan.

previous studies. We also discuss the robustness of the results and conduct the 2SFD estimation as an alternative method. We conclude with a summary of the findings and a brief discussion in Section 6.

2 Literature Review

In this section, we briefly explain the debate about the wage profile in Japan. Many studies have emphasized the importance of the accumulation of firm-specific human capital in Japanese labor market, which is characterized by long-term employment, through the training specific to the firm.[*7] Hashimoto and Raisian (1985) compare wage profiles of Japan and the United States using the Basic Survey of Wage Structure (1980) and find that, for male workers, employer tenure is longer, turnover is less frequent, and the earnings-tenure profile is steeper in Japan. They report that five years of employer tenure is associated with 36.8% of wage growth. Using detailed microdata, Mincer and Higuchi (1988) emphasize that the higher return to employer tenure in Japan is attributable to greater human capital accumulation through on-the-job training.

Later, Clark and Ogawa (1992) extend Hashimoto and Raisian (1985), using the data for the years 1971, 1976, 1981, and 1986. Although they find that wage profile becomes flatter, and that wage growth from employer tenure declines from 1981 to 1986, employer tenure still accounts for one-third to one-half of wage growth[*8] Hashimoto and Raisian (1992) further extend the analysis by Clark and Ogawa (1992) by adding the data for 1985 and 1988. They find that the contribution of employer tenure on wage growth has recovered in the latter part of the 1980s after declining from the early to mid-1980s, while wage profile has flattened through the decade.

Yamada and Kawaguchi (2015) believe that a change in the importance of firm-specific human capital due to declining technological progress in the 1990s occur and estimate the returns to employer tenure using the same data as studies listed above for the period of 1991 to 2008. They report that, for the survey period, five years of employer tenure is associated with around 3% of wage growth, and the return declines over time. They find a much smaller return to employer teure than what is reported in previous studies by, for example, Clark and Ogawa (1992) and Hashimoto and Raisian (1992); their returns are still positive at the 1% significance level.

Although much of the literatures emphasize the importance of the contribution of firm-specific human capital to wage increases, the importance seems to have declined

[*7] Hashimoto and Raisian (1985) reveal that workers in Japan have longer employer tenure than those in the United States. An anecdotal feature of Japanese labor market is lifetime employment, but its evidence is mixed. Since this practice applies to only 30% of the male labor force, some literatures, in early as the 1970s, have pointed out that the prevalence of lifetime employment in Japan is exaggerated. For example, Koike (1977) argues that long-term employment is more prevalent in the United States than in Japan. Subsequent papers such as Kato (2001) finds little evidence for any decline in the job retention rates in Japan, whereas Ono (2010) finds that a smaller percentage of workers are employed under lifetime employment.

[*8] They also focus on the heterogeneity of the return across firms of different sizes. They find that the contribution of the employer tenure to the wage growth is the largest in large firms, then in medium-size firms, and, lastly, in small firms.

over time. Moreover, these studies have used cross sectional data. Each study has dealt with the selection problem after understanding the data used, but it is difficult to gage whether previous studies accurately remove biases due to unobservable components such as individual fixed effects and the quality of match between employers and workers. The returns to employer tenure could be even smaller the period between the end of 2000s and mid-2010s if these biases are removed using panel data.

3 Data

In this section, we explain the data used and how we construct variables for our estimation. The data comes from the Japan Household Panel Survey (JHPS/KHPS) for the period 2004–14, which is integrated panel data of the Keio Household Panel Survey (KHPS) and the Japan Household Panel Survey (JHPS).

These household panel surveys reflect the composition of Japanes society as a whole, covering a wide range of topics such as employment behavior, poverty dynamics, and transfer of real property among households. The KHPS is a survey that has been conducted every year since 2004, covering 4,000 households and 7,000 people nationwide. Approximately 1,400 people were added in 2007 and about 1,000 were added in 2012 to compensate for dropouts from the sample. The JHPS has been conducted annually since 2009, covering 4,000 households nationwide, focusing on education, health and medical care in addition to the topics described above. The populations included in these datasets are men and women aged between 20 and 69 for the KHPS and men and women aged 20 old or older in the JHPS. The populations of these samples overlap, but there is no overlap between respondents in KHPS and JHPS. Every year, each survey is conducted in Januar. When the respondent is married, the spouse responds to the same questionnaire.

The respondents are selected by a stratified two-stage random sampling method. In the first stage of the sampling, the entire country is stratified into 24 strata based on region and city. The number of samples is allocated according to the proportion of the resident basic ledger population in each stratum, then if the number of samples per survey area is set to roughly 10 (five for KHPS 2007 and KHPS 2012). The number of survey areas in each stratum is decided, and predetermined number of surveyed areas are randomly selected. The census survey area is used as a sampling unit. In the second stage, approximately 10 people (five for KHPS 2007 and KHPS 2012) are extracted using the resident basic ledger of the selected surveyed area as an extracted ledger, based on the designated calling number and extraction interval for qualified persons to be surveyed. The respondent rate is between 82.3% and 94.2% during the survey period.

Following the related research of Altonji and Shakotko (1987) and Kambourov and Manovskii (2009), the sample is restricted to employed male heads of household, aged between 20 and 64.[*9][*10][*11] We eliminate observations who, at that time of the interview, worked for the government or received real hourly wages of less than 250 yen in constant 2010 Japanese yen terms. Those who worked fewer than 500 hours or more than 3,120 hours per year,[*12] had total earnings of zero in a given year, or reported being self-employed are also excluded. Since the representativeness of the data is lost by including responses from spouses, we do not use them for estimation. Earning functions defined in Section 4 are estimated from the data sample between 2004 and 2014.[*13] The estimation uses 7,648 observations of 2,068 individuals, out of a total of 27,186 observations, 5,112 individual male respondents.[*14]

Next, we define some variables and explain their constructions. We define occupations and industries using the classifications provided by JHPS/KHPS for 2004–2014. Appendix A contains the description of occupation and industry codes. We identify employer changes when the respondents report they changed employers, left their employer, or had been on loan[*15] within the last year. Transfers[*16] are not defined as changing employers.

Since JHPS/KHPS does not record the length of employer tenure or the total experience each year except in KHPS 2004 and JHPS 2009, we compute the tenure in each year based on the tenure in 2004 and 2009 using the following procedure.[*17][*18] (1) Employer

[*9]In fact, they restricted the data from 18 to 64 years old, the data we use here do not contain samples of 18 and 19 years old.

[*10]Here, the head of household refers to the main livelihood maintainer.

[*11]Since, in Japan, many firms adopt a system that terminates regular employment when workers turn 60 years old, their wage tend to decline sharply even if they make contract for to be rehired. We also estimate wage returns to employer tenure for the sample of under 60 year old as a robustness check.

[*12]In fact, in the literatures we have followed, the criteria of sample selection do not restrict the upper bound of working hours. However, 3,120 hours of working per year is equivalent to 60 hours of working per week. The Ministry of Health, Labor and Welfare of Japan has recommended that working hours be less than 60 per week in an effort to eliminate death from overwork (so-called *karoshi*). Since our variable of wages used for estimation, whose construction is described below in detail, decreases as working hours increase, we eliminate observations for those who appear to work too much to prevent the hourly wage from being underestimated. We elimintated 1,630 observations because of this restriction.

[*13]The sample used in the estimation contains non-regular worker. Since we believe there is a wage difference between regular and non-regular worker, we control this by adding regular worker dummy variable in the estimation.

[*14]We eliminate 10,880 observations because of age limit, 4,122 because they are not household heads, 4,533 because of unemployment, and 1,694 because they work for the government.

[*15]Being on loan is defined as moving to the subsidiary or affiliate company that belongs to the same employer.

[*16]Transfer is defined as moving to another office of the same employer.

[*17]This procedure follows Kambourov and Manovskii (2009). They explain the procedure in more detail in their paper.

[*18]A supplemental estimates includes occupation tenure. We construct occupation tenure by a procedure similar to the one used for employer tenure. However, since JHPS/KHPS does not directly ask the length of occupation tenure, we do not know the occupation tenure when an individual initially enters the sample. Hence, it is assumed that occupation tenure is the same as his tenure at a particular firm. This method provides measurement error of occupation, especially for respondents who are relatively old when entering the sample, and it may estimate return on occupation tenure downward. However, because there is no alternative, following previous literatures, we decided to apply this method in this

tenure is set equal to reported tenure the first year an individual enters the sample; (2) employer tenure increases by one year if the individual does not report an employer switch in that year and works more than 800 hours in the same year; (3) if the individual works no more than 800 hours during the year, his tenure is not incremented.[*19]

JHPS/KHPS asks for more details about the working experience of individuals in surveys conducted in 2004 (KHPS) and 2010 (JHPS). The respondents are required to specify their experiences of schooling, regular employment, non-regular employment, self-employment, and other employment status from the ages 18 to 70. We regard working experience to have been increased by a year when the respondent report at least one of the above employment experiences. We initially identify years of working experience when an individual enters the survey. The subsequent years of experience are calculated based on the process described above.

In addition to the employer tenure, which is a continuous variable, we define an "old job dummy", as taking the value of one if the individual is not in his first year with the current employer and zero otherwise. Following Altonji and Shakotko (1987) and Kambourov and Manovskii (2009), we introduce this indicator to capture a discontinuity in the employer tenure effect after the first year on a new job.

The dependent variable is the logarithm of real hourly wages. The respondents first select frequency with which their wages are paid as either annually, monthly, daily, or hourly. Next, respondents specify their wages according to the payment method they chose. For example, a respondent who chooses monthly will specify wages earned per month. For each respondent, we first obtain annual working hours by multiplying weekly working hours by 52. Next, we obtain the hourly wage as the sum of annual income and annual bonus devided by annual working hours.[*20] and annual bonus amount by annual working hours. The nominal hourly wage obtained in this way is converted into a real hourly wage, using the consumer index price as deflator with 2010 as the base year. Table 1 contains the summary statistics of the sample used in the estimation.

4 The Model

In this section, we define an earning function used for estimation and explain the variables and instrumental variables employed here. First, we define the earning function. To assess the relationship between wages and employer tenure, we estimate various versions

paper. In the following, estimation, including occupation tenure, will be discussed as an auxiliary result only.

[*19]Total experience is similarly calculated; if the individual works more than 800 hours during that year, then experience increases by one, and it is not incremented otherwise.

[*20]The annual income is defined as (the wage the worker earns per month)×12 for monthly wage, (the wage the worker earns per day)×(the number of working days per month)×12 for daily wage, and (the wage the worker earns per hour)×(the number of working hours per week)×52 for hourly wage.

Table 1: Descriptive statistics using JHPS/KHPS, 2004–2014

	Mean	SD	Min	Max
Age	45.7276	10.3303	20	64
Educational background				
Junior high school	.0366	.1878	0	1
High school	.4397	.4964	0	1
2-year college or vocational	.1117	.3150	0	1
College or more	.4120	.4922	0	1
Married	.8372	.3692	0	1
Union member	.2922	.4548	0	1
Firm size				
size < 100	.3715	.4832	0	1
$100 \leq$ size < 500	.2316	.4219	0	1
size ≥ 500	.3970	.4893	0	1
Regular employee	.8874	.3161	0	1
Log of real hourly wage	7.6036	.5538	6	11
Total experience	25.7539	10.7858	0	50
Employer tenure	14.5000	11.3053	0	47

Notes: The data come from the JHPS/KHPS for 2004–2014. The sample includes employed male household heads, aged 20–64. Respondents who are government workers at that time of the interview, or who receive real hourly wages of less than 250 yen in constant 2010 Japanese yen, are eliminated. Those who work less than 500 hours or more than 3120 hours per year, have total earnings of zero in a given year, or report being self-employed are also excluded from the sample. Since the representativeness of the data is lost when reponses from spouses are included, we do not use them for estimation. 7,648 observations of 2,068 individuals are used for the estimation.

of the following econometric model:[*21]

$$\ln w_{ijt} = \beta_1 T_{ijt} + \beta_2 W_{it} + \beta_3 OJ_{ijt} + e_{ijt} \tag{1}$$

where $\ln w_{ijt}$ is the log of real hourly wage of individual i working in firm j at period t, T_{ijt} is employer tenure, and W_{it} is total labor market experience. OJ is the old job dummy explained in Section 3. In practice, this equation includes a matrix of characteristics that contain year dummies and an individual's observable characteristics such as occupation and industry code. Other dummy variables represent marital status, union membership, education,[*22] size of the firm,[*23] and a dummy for regular employees. The education dummies are a proxy for ability to capture differences in accumulation of employer-specific human capital among workers who have different abilities. If employer-specific human capital exists, the coefficients of employer tenure in the wage equation should be determined so that the return to employer tenure is positive.

The error term is decomposed as follows.

$$e_{ijt} = \mu_i + \lambda_{ij} + \varepsilon_{ijt} \tag{2}$$

μ_i is interpreted as a time-invariant individual-specific component, λ_{ij} is a time-invariant employer-match component, and ε_{it} is the error term. In addition to the observed variables, such as employer tenure, working experience, and individual characteristics, these unobserved individual-specific characteristics and matching quality may affect wages as well. For example, an individual who has higher ability may receive higher wages than one who has low ability, despite having the same level of overall work experience. Similarly, individuals with the same observable characteristics might receive different wages because some of them are better matched to their employer.

These unobserved factors may cause potentially serious biases because unobserved match components are likely to correlate with tenure. One would expect that individuals with a better employer match tend to stay employed to the same employer and receive higher wages. Also, the correlation between total labor market experience and the employer-match component is important. We might expect that a worker with more years of labor market experience would switch employers to obtain a better match ("job shopping") than one who has just entered the labor market. Certainly, total experience correlates with the probability of participation in the labor market, and thus, it might be endogenous as employer tenure. These correlations are likely to cause a bias in an OLS regression.

To deal with this problem, we employ the instrumental variable method, which is devised by AS and also employed by Kambourov and Manovskii (2009) and Parent (2000),

[*21] There are studies arguing the existence of industry specific human capital such as Abe (1996). It is desirable to estimate industry specific human capital at the same time. Our data, however, do not contain enough variations to endure the estimation since many workers have the same industry tenure as employer tenure. So, industry tenure is omitted from the estimation.

[*22] The dummies of years of education are divided into five: middle school graduates (base), high school graduates, junior college or vocational school graduates, college degree or higher.

[*23] The size of the firm is defined by the number of employees, which is divided into three degrees: less than 100 people (base), 100 to 499 people, and 500 people or more.

in subsequent studies. As an example, we explain how to construct an instrumental variable for the employer tenure. Let T_{ijt} denote the employer tenure of individual i with employer j in period t, and let $\overline{T}_{ij}$ denote the average tenure of individual i during the current spell of working in employer j. We construct an instrumental variable for the employer tenure as follows: $\widetilde{T}_{ijt} \equiv T_{ijt} - \overline{T}_{ij}$. We instrument the squared and cubed employer tenure in a similar way: $(\widetilde{T}_{ijt})^2 \equiv T^2_{ijt} - \overline{T^2}_{ij}$. By contruction, this instrumental variable is orthogonal to employer-match component.[*24] In the same way, we create an instrumental variable for old job dummy, and total experience with their deviations from the spell- and individual- specific means, respectively. In the following section, we present the estimation results of earnings function (1) based on OLS and AS's IV.

5 The Estimation Results

In this section, we describe the estimation results. First, we explain the main results, that is, employer tenure brings less wage growth in the Japanese labor market than previous literatures have argued when we remove the bias from unobserved individual's ability and match quality between a worker and an employer. Second, we show that these main results are robust. We can find the same results in several subsamples based on various specifications. As a part of robustness check, we employ another estimation method by Topel (1991). The details of the estimation method are also described in this section.

5.1 Main Results

In this section, we describe the main estimated results using the econometric model described in the previous section. Table 2 reports the coefficients of earnings function (1), which is estimated by the OLS and AS's IV method. This table shows the results of the estimation. Table 3 reports the calculated wage returns on employer tenure based on the coefficients in Table 2. Each number in parentheses, in both tables, represent the robust standard error.

[*24]These are systematically valid instrumental variable as long as the match component is time-invariant. As mentioned by AS, $\widetilde{T}_{im}$ sums to zero over the sample years in which the worker is in employer j. Let N denote the ultimate employer tenure of an individual with employer j, the covariance of $\widetilde{T}_{ijt}$ and λ_{ij} is

$$\begin{aligned} E[\widetilde{T}_{ijt}\lambda_{ij}] &= E[(T_{ijt} - \overline{T}_{ij})\lambda_{ij}] \\ \sum_{t=1}^{N} E[\widetilde{T}_{ijt}\lambda_{ij}] &= \sum_{t=1}^{N} E[(T_{ijt} - \overline{T}_{ij})\lambda_{ij}] \\ &= E\left[\lambda_{ij}\sum_{t=1}^{N}(T_{ijt} - \overline{T}_{ij})\right] \\ &= E[\lambda_{ij} \cdot 0]. \end{aligned}$$

Thus, $\widetilde{T}_{ijt}$ is uncorrelated with employer-match component. Also, this instrumental variable is definitely correlated with T_{ijt}.

Table 2: Earnings function estimates, using the AS's IV method

	OLS		AS's IV	
	(1)	(2)	(3)	(4)
Employer tenure	.0140***	.0134***	.0032	.0043
	(.0020)	(.0022)	(.0058)	(.0062)
Emp.ten.^{2} $\times$ 100	-.0132***	-.0125**	-.0006	-.0060
	(.0051)	(.0058)	(.0150)	(.0165)
Old job	.0661**	.0733**	.0260	.0265
	(.0283)	(.0295)	(.0460)	(.0473)
Total experience	.0203***	.0212***	.0398***	.0417***
	(.0027)	(.0028)	(.0080)	(.0083)
Experience^2	-.0004***	-.0004***	-.0007***	-.0008***
	(.0001)	(.0001)	(.0001)	(.0002)
Occupation tenure	No	Yes	No	Yes
Observations	7648	7519	7648	7519

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
The dependent variable is the log of real hourly wages. Other covariates include an intercept, year dummies, education dummies, occupation and industry dummies, a union membership dummy, a marital status dummy, dummies of firm size, and a regular employee dummy. In addition to those variables, Columns (2) and (4) also include occupation tenure. Columns (1) and (2) denote the coefficients of earnings function (1) which is estimated by OLS, and columns (3) and (4) denote those computed using AS's IV method.

Table 3: Estimated returns to employer tenure.

	AS's IV				2SFD
	OLS		IV		
	(1)	(2)	(3)	(4)	(5)
2 years	.0935***	.0995***	.0323	.0348	-.0130
	(.0271)	(.0283)	(.0430)	(.0443)	(.0307)
5 years	.1327***	.1370***	.0417	.0463	-.0323
	(.0264)	(.0276)	(.0434)	(.0449)	(.0760)
10 years	.1926***	.1945***	.0570	.0632	-.0637
	(.0268)	(.0283)	(.0515)	(.0537)	(.1503)
15 years	.2460***	.2457***	.0720	.0770	-.0941
	(.0277)	(.0296)	(.0622)	(.0646)	(.2244)
20 years	.2927***	.2907***	.0867	.0879	-.1235
	(.0285)	(.0304)	(.0731)	(.0749)	(.3000)
25 years	.3329***	.3295***	.1011	.0957	-.1520
	(.0289)	(.0309)	(.0848)	(.0858)	(.3786)
Occupation tenure	No	Yes	No	Yes	No
Observations	7519	7519	7519	7519	7824

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
This table reports the calculated wage returns to 2, 5, 10, 15, 20, and 25 years of employer tenure based on the coefficients of the corresponding columns of Table 2. Columns (1) and (2) denote the calculated returns estimated using OLS, and columns (3) and (4) denote those obtained using AS's IV method. The corresponding returns based on the 2SFD method are represented in column (5).

Column (1) of Table 2 shows the coefficients in the earnings fuction (1) estimated by OLS. The coefficients for all the variables—the employer tenure, old job dummy, and total experience—are statistically different from zero. The coefficient for employer tenure and its quadratic term, and for total experience and its quadratic term, suggest that the earnings function is concave in employer tenure and total labor market experience, respectively. The coefficient of the old job dummy variable is approximately 0.07, which suggests there is a substantial wage jump between the first and the second year of employer tenure. The results are quite simlar when occupation tenure is included in the earnings function (1), as shown in column (2) of Table 2.

Columns 1 to 3 of Tables A1 and A2 (in the Appendix) show the results obtained by adding cubic and quartic terms of employer and occupation tenure, and total experience to the covariates shown in Table 2. Kambourov and Manovskii (2008, 2009) reveal that returns to employer tenure disappear after controlling the occupation tenure in the United States. Other literatures, such as Shaw (1984, 1987) and Zangelidis (2008), have also showed that occupation tenure is more important than employer tenure. After obtaining these results, we check to see whether including occupation tenure changes the coefficients of employer tenure. Our results contrast with those studies, as we found that neither employer nor occupation tenure have significant effect on wages in Japan. Including the higher-order terms of employer tenure,occupation tenure, and total experience do not change these results.

Column (3) of Table 2 shows the coefficients in the earnings fuction (1) estimated using AS's IV. Unlike the results obtained using OLS, the coefficients of employer tenure and its quadratic term and old job dummy are not statistically different from zero even at the 10% level of confidence. Only the coefficients of total labor market experience are still significantly different from zero at the 1% level. As shown in column (4) of Table 2, the same result is obtained even when occupation tenure is included in the estimation. Columns 4 to 6 of Table A1 and A2 (in the Appendix) show the results obtained by adding cubic and quartic terms of employer tenure, occupation tenure, and total experience to this estimation. Similar to the previous instance, including these higher-order terms of tenure variables do not change the results described above, consistent with the results of the OLS estimator.

The same can be said from the estimated wage returns based on these coefficients. The estimated returns to employer tenure based on the coefficients of the column (1) in Table 2 are 9.4%, 13.3%, 19.3%, and 24.6% for 2, 5, 10, and 15 years, respectively. All of the returns to employer tenure are significantly positive. In particular, magnitude of the coefficient of the old job dummy of 0.07 contributes approximately one-third of the return to 10 years of employer tenure; thus, the old job dummy explains a large part of this positive return. This implies that employer tenure after the second year has only a modest effect on wage growth relative to the effect of transitioning from the first to the second year of employer tenure. The positive returns to employer tenure based on the coefficient obtained from OLS are robust even after controlling for occupation tenure.

The corresponding returns using the AS's instrbbumental variable method are approximately 3.2%, 4.2%, 5.7%, and 7.2%, as showed in column (3) of the same table. It

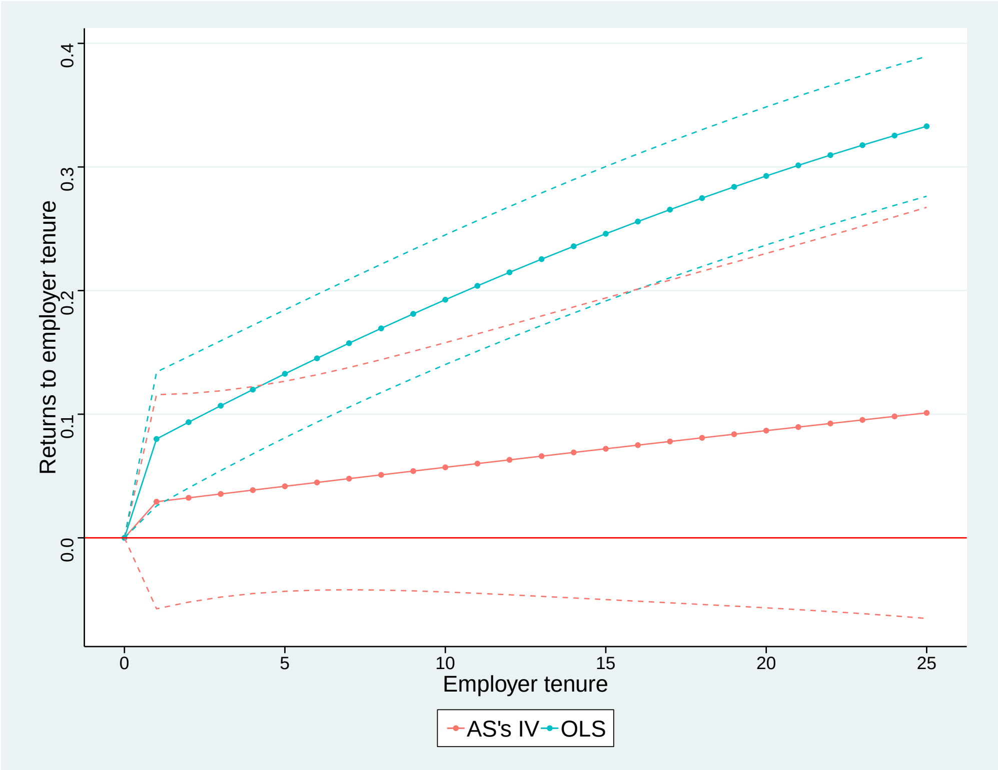

Figure 1: Plot of returns to employer tenure.

can be observed that the wage returns to 10 years of employer tenure based on AS's IV estimator are around one-third compared to the returns based on the OLS estimator. In addition to this decrease in the amount of returns, these returns are not statistically different from zero. This result does not change when we include occupation tenure into the earnings function (1).

Figure 1 represents the plot of the estimated returns to each year of employer tenure based on OLS and AS's IV method. Comparing the returns based on OLS and AS's IV estimators represented in the columns (1) and (3) of Table 2, respectively, the returns based on AS's IV estimators point to significantly different amount compared to the returns based on the OLS estimators where the employer tenure is over two years, although there is almost no significant difference until the second year of employer tenure. Therefore, we find that the bias from the selection matters not immediately after employment but rather after some employment period has been accumulated.

The previous literatures, such as Hashimoto and Raisian (1985), Clark and Ogawa (1992), and Hashimoto and Raisian (1992), report almost the same coefficients of employer tenure as the one estimated here based on the OLS estimator. They insist on the importance of firm-specific human capital based on these coefficients.[*25] Our results,

[*25]Clark and Ogawa (1992) and Hashimoto and Raisian (1992) show that the importance of employer tenure on the wage growth declines in 1980s, and they report smaller returns to employer tenure than

contrary to previous studies, suggest that employer tenure has only a modest effect on wages.

In sum, our main results are that the OLS estimators include a substantial amount of selection bias, and employer tenure may not be as important for wage growth as suggested by previous research when biases from unobserved heterogeneity in ability and employer matching quality are considered. Further, the magnitude of these biases become problematic as employer tenure increases.

5.2 Robustness Checks

In this section, we show that the main results described in the previous section are robust by using two approaches. First, we estimate various specifications using equation (1) applied to various subsamples of the data, confirming that the results are robust, regardless of the characteristics of the workers. Second, we employ another estimation method for the earnings function as presented by Topel (1991). Both results suggest that returns to employer tenure are lower than the findings of previous studies, regardless of the estimation methods or the characteristics of the individuals.

5.2.1 Estimation on Various Subsamples

In this section, we divide the sample into various subsamples and employ the same estimation technique used in the previous section. For example, in many Japanese firms, regular employees are often reemployed as non-regular employees after they retire at the age of 60. Given this, including workers over the age of 60 could appear as being inappropriate in the context of assessing human capital accumulation. Alternatively, firm size might also affect the extent of wage growth, as it is known that wage paid by large firms are relatively higher than those paid by small firms (see, e.g., Oi and Idson (1999) and Koike (2005)).

Further, professionals, such as lawyers, doctors, or researchers, would be assumed to be rewarded by occupation tenure than by employer tenure compared with workers engaged in other occupations. Since the heterogeneity of tasks across firms would be small in such professional occupations, the importance of employer tenure might be lower than for other occupations. We made the same estimation for nonprofessional samples, to determine whether the result of the entire sample is influenced by individuals in professional occupations.

Finally, from the viewpoint of human capital accumulation, one could think it appropriate to estimate the earnings function (1) using only the data on regular employees, so we excluded non-regular employees from the sample.

those in Hashimoto and Raisian (1985). However, they still report substantially larger wage growth than that obtained by our estimation.

Table 4: Estimated returns to employer tenure, using various subsamples.

	Under 59-year-old		Large Firms ($\geq$ 500)		Small Firms ($<$ 500)		Non-Professional		Regular Employee	
	OLS (1)	AS's IV (2)	OLS (3)	AS's IV (4)	OLS (5)	AS's IV (6)	OLS (7)	AS's IV (8)	OLS (9)	AS's IV (10)
2 years	.1043***	.0225	.0697	.0310	.1120***	.0235	.0794***	.0181	.1081***	.0322
	(.0311)	(.0505)	(.0567)	(.0843)	(.0312)	(.0534)	(.0299)	(.0495)	(.0358)	(.0592)
5 years	.1388***	.0285	.1259**	.0336	.1452***	.0359	.1253***	.0224	.1452***	.0403
	(.0303)	(.0510)	(.0561)	(.0878)	(.0303)	(.0547)	(.0291)	(.0501)	(.0348)	(.0587)
10 years	.1946***	.0453	.2087***	.0374	.1963***	.0587	.1942***	.0306	.2035***	.0555
	(.0307)	(.0604)	(.0576)	(.1030)	(.0306)	(.0684)	(.0295)	(.0602)	(.0347)	(.0656)
15 years	.2481***	.0708	.2780***	.0406	.2419***	.0844	.2536***	.0401	.2574***	.0727
	(.0318)	(.0731)	(.0601)	(.1192)	(.0317)	(.0877)	(.0305)	(.0737)	(.0354)	(.0761)
20 years	.2995***	.1051	.3338***	.0432	.2820***	.1128	.3035***	.0507	.3068***	.0919
	(.0327)	(.0866)	(.0620)	(.1321)	(.0324)	(.1098)	(.0313)	(.0873)	(.0359)	(.0876)
25 years	.3486***	.1480	.3761***	.0451	.3166***	.1441	.3438***	.0627	.3518***	.1132
	(.0333)	(.1025)	(.0630)	(.1427)	(.0327)	(.1355)	(.0317)	(.1015)	(.0362)	(.1008)
Observations	6842	6842	3036	3036	4612	4612	6489	6489	6787	6787

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
This table reports the calculated wage returns to 2, 5, 10, 15, 20, and 25 years of employer tenure based on the coefficients of the corresponding columns of Table 2. Columns (1), (3), (5), (7), and (9) denote the calculated returns estimated using OLS, and columns (2), (4), (6), (8), and (10) denote those obtained using AS's IV method. We present the returns for calculating which we use the sample of individuals under 59-year-old in columns (1) and (2), the sample of individuals who belong to firms with more than 500 employees in columns (3) and (4), the sample of individuals who belong to firms with less than 500 employees in columns (5) and (6), the sample of individuals excepting workers who respond that s/he works as professional in columns (7) and (8), and the sample of the regular employees in columns (9) and (10).

Table 4 reports the calculated wage returns on employer tenure based on the estimates of earnings function (1) in each subsample. The calculations are based on the coefficients in the corresponding columns of Table A3, shown in Appendix C. Almost all of the coefficients of earnings function (1) that use the subsamples appear to have tendencies similar to those in the entire dataset. Regardless of the specification, the calculated returns to employer tenure become insignificant when AS's IV method is used, while the corresponding returns are significantly positive with the usage of OLS..

We also examine how each of the control variables affects the estimation results. That is, we compare the estimation results by and without adding a control variable to the earnings function (1). The control variables used for main results are education dummies, firm size dummies, year dummies, marital status dummy, union dummy, regular employee dummy, and industry and occupation codes. We estimate earnings function (1) by adding these control variables one by one and excluding them from the equation. None of the variables has a significant effect on the estimation results, and the main results are supported.

Altonji and Williams (2005) highlight that the method of controlling for time trends may affect the estimation results. They show that using year dummies instead of detrending wages first by using a time trend index reduces the returns to 10 years of employer tenure by half in the United States. Here, we use instead year trend for estimating the earnings function (1). The use of alternative time trend, however, does not affect the estimation results. The wage returns to 10 years of employer tenure is around 20% and 7.5% when we include year variable as trend and use the OLS and AS's IV estimators, respectively. These returns are almost the same as the returns obtained by including year dummies.

So far, we have examined various specifications of the estimation of the earnings function (1). All of these different specification estimations suggest that our main results are robust, and that the returns to employer tenure become insignificant after controlling biases from unobserved hets erogeneity.

5.2.2 Alternative Estimation Based on Topel (1991)

In this section, an alternative estimation of the earnings function is implemented based on Topel (1991). He argues that the AS's IV method would estimate the returns to employer tenure downward due to a employer-match component, λ_{ij}. Topel (1991) indicates that the employer-match component produces a downward bias in the coefficient of employer tenure, β_1, and provides the alternative estimation method.[*26] Although, following Altonji and Williams (2005), who compare the sensitivity of both AS's IV and the 2SFD estimators, we mainly report the results obtained from AS's IV estimator in this paper, it is still nice to examine the robustness of our main results using the 2SFD.

The estimation used by Topel (1991) proceeds in two steps. The first estimates the

[*26] Although he shows that the difference between AS's IV and the 2SFD estimators is due to bias from employer-match component, λ_{ij} is -0.0015 (that is, this difference generates the difference in returns to 10 years of employer tenure by -0.015), this value explains only less than 1% of the difference in the calculated wage returns to 10 years of employer tenure.

combined effect of the linear experience and employer tenure ($B = \beta_1 + \beta_2$ in equation (1)). The OLS is applied to observations of individuals who does not change their employer since the last interview*27:

$$\Delta \ln w_{ijt} \equiv \ln w_{ijt} - \ln w_{ijt-1} = B + \varepsilon_{it} - \varepsilon_{it-1}. \tag{3}$$

Since the original error term in the earnings function is decomposed to $e_{ijt} = \mu_i + \lambda_{ij} + \varepsilon_{it}$, taking the first difference of the wage enables us to remove the time-invariant components μ_i and λ_{ij} from the equation, so only the purely random term remains. Here, current experience is the sum of the initial experience with an employer, $W0_{ijt}$, and employer tenure, T_{ijt}, that is, $W_{ijt} = W0_{ijt} + T_{ijt}$. Then, the original earnings function is written as

$$\ln w_{ijt} = \hat{B}T_{ijt} + \beta_2 W0_{ijt} + \nu_{ijt}.$$

where $\hat{B}$ is the OLS estimates from (3) and $\nu_{ijt} = T_{ijt}(B - \hat{B}) + \varepsilon_{ijt}$. Therefore, the second step estimates a coefficient of the linear experience (β_2) using OLS to

$$\ln w_{ijt} - \hat{B}T_{ijt} = \beta_2 W0_{ijt} + \nu_{ijt}. \tag{4}$$

Finally, the coefficient of the linear employer tenure (β_1) is obtained as $\hat{B} - \hat{\beta}_2$. We refer to this estimator as the two-step first-difference (2SFD) estimator.

The estimator $\hat{B}$ is efficient if the differences between the employer tenure and error term, ε_{it}, are not correlated. We can then obtain an efficient estimator of β_2, and thus β_1, if the initial experience of the employer, $W0_{ijt}$, is correlated neither with μ_i nor λ_{ij}.

In practice, the quadratic terms of employer tenure and working experience are also included in these equations. The coefficients of these terms are estimated in the first step, and then the predicted values are subtracted from the log of hourly wages in the second step. We also include individual characteristics and year dummies, which are shown in equation (4). We use the same control variables for the estimation using 2SFD as in the estimation using AS's IV, namely, education dummies, occupation and industry dummies, a union membership dummy, a marital status dummy, firm size dummies, and a regular employee dummy.

The results of this estimation are presented in Table 5. The corresponding wage returns to employer tenure are shown in column (5) of Table 3, which is an estimate based on the coefficients in column (2) of Table 5. As shown in column (1) of Table 5, the sum of the coefficients of linear employer tenure and working experience (constant term in the first step) is significantly negative when we use only the linear term of the employer tenure and working experience. The estimate of constant term gradually increases to positive values by adding quadratic, cubic and quartic terms. Corresponding to this increase, the estimate of the coefficient of linear term of working experience also increases from negative to positive. The estimates of higher order terms of employer tenure also vary from negative to positive values. It seems that the 2SFD estimators are sensitive to the specification of the estimation equation.

*27 Here, we exclude old job dummy, following the specification used by Topel.

Table 5: Estimation results, using the method of 2SFD estimation

	(1)	(2)	(3)	(4)
First stage				
Constant	-.0245***	-.0098	-.0023	.0745
	(.0053)	(.0145)	(.0296)	(.0523)
Emp.ten.^{2} × 100		.0019	.1900**	-.0074
		(.0260)	(.0935)	(.2099)
Emp.ten.^{3} × 1000			-.0342**	.0566
			(.0165)	(.0842)
Emp.ten.^{4} × 10000				-.0119
				(.0104)
Experience^2 × 100		-.0293	-.1873	-.6877*
		(.0280)	(.1368)	(.3899)
Experience^3 × 1000			.0228	.1643
			(.0176)	(.1114)
Experience^4 × 10000				-.0134
				(.0109)
second stage				
Total experience	-.0185***	-.0032***	.0283***	.0943***
	(.0006)	(.0006)	(.0012)	(.0006)
Employer tenure	-.0060	-.0066	-.0306	-.0198
	(.0053)	(.0155)	(.0327)	(.0623)
Observations from				
first stage	4818	4815	4815	4815
second stage	7827	7824	7824	7824

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
The dependent variable is the log of real hourly wages. Other covariates include an intercept, year dummies, education dummies, occupation and industry dummies, a union membership dummy, a marital status dummy, dummies of firm size, and a regular employee dummy. The model for estimation is given by the earnings function (1).

The coefficient of linear employer tenure, β_1, by using the 2SFD is around -0.01, which is not statistically different from zero except when we use only linear term of the employer tenure and working experience. Negative coefficient of the employer tenure implies that staying at the same employer for one year longer brings negative wage return. As a result, the column (5) of Table 3 shows that the calculated return to employer tenure is also negative throughout all years. Although the negative returns to employer tenure are a result that neither human capital theory nor matching theory predicts, this result is consistent with the result from AS's IV in terms that the return to employer tenure does not significantly differ from zero.

We offer several caveats regarding the interpretation of the results of the 2SFD estimator. First, these estimates seem to be sensitive to specifications of the earnings function. The coefficients and corresponding returns vary greatly depending upon the specification. For example, the 2SFD estimators are sensitive to how we control for a time trend and which control variables the earnings function includes. Thus, the 2SFD method has shown to provide an unstable result.[*28] We present the other results based on the 2SFD method in Appendix E.

The 2SFD estimator may also cause another problem. Since unobserved individual abilities, μ_i and the employer-match component, λ_{ij} are included in the error term in the second step, ν_{ijt}, both may be correlated with the individual's initial experience with the employer, $W0_{ijt}$. If so, the 2SFD estimator would produce biased results. This is exactly what Altonji and Williams (2005) point out as a problem of the 2SFD estimator.

After reviewing this criticism from Topel (1991), Altonji and Williams (2005) argue that the upward bias in the 2SFD estimator of the linear employer tenure coefficient due to the individual-specific component, μ_i is more serious than the downward bias of AS's IV when using data from of the United States.

They confirm this by replicating Topel's sample. They use both of the estimation methods, AS's IV and the 2SFD, with various specifications to ascertain the impact of each source of bias on the estimation results. Interestingly, the 2SFD estimators in their estimations are also unstable. They conclude that when the trend in the data is properly accounted for, Topel's estimation method suggests that the upward bias due to individual-specific components is substantial.

However, it is difficult to believe that negative tenure effects contain upward biases. In fact, the 2SFD method could produce a downward bias depending upon the correlations between employer tenure, working experience, initial experience with the employer, the employer-match component, and the individual-specific component. We discuss the condition under which the 2SFD estimator produces downward a bias when using JHPS/KHPS in Appendix D. We find that the coefficient in the regression of working experience on employer-match component must be sufficiently large to produce a downward bias.

Given the instability of the results and the potential bias in the 2SFD estimator,

[*28] As we discuss below, Toda (2008) also uses JHPS/KHPS for applying the AS's IV and the 2SFD method to Japanese data. He also finds that the results using the 2SFD are unstable depending on how many higher-order terms of employer tenure and working experience are controlled.

AS's IV estimator appears to be more reliable than the 2SFD estimator. Following the argument put forth by Altonji and Williams (2005), we decide to use the results of the AS's IV as our main results. However, note that the results from the 2SFD estimator are consistent with those from the AS's IV in that the estimated returns to employer tenure are not significantly different from zero.

5.3 Discussion

Although this study tries to correct for the potential biases of the coefficients of tenure in the earnings equation of previous literatures, it is not the first attempt to correct for such biases. Toda (2008) makes a similar attempt. He also uses JHPS/KHPS data to apply AS's IV and the 2SFD methods to Japan, but his results are not consistent with our as described above. We discuss the source of the differences in this section.

Toda (2008) reports that the estimated wage returns on 2, 5, and 10 years of employer tenure based on AS's IV are lower than those based on the OLS and that they reverse after 15 years of employer tenure. Although he does not mention whether the estimated wage returns are significantly different when obtained from AS's IV method versus OLS, he interprets his results as suggesting that Japanese workers accumulate firm-specific human capital through experience with their employers and concludes that the matching theory is not well supported by his results.

His conclusions contrast sharply with ours. Our main results suggest that employer tenure has little effect on wage growth after taking for unobservable individual ability and employer-match. We also find that estimated wage returns on employer tenure derived from AS's IV are significantly different from those computed using OLS when the employer tenure is more than three years, which suggests that workers move to employers with whom they have a better match through job-shopping, as indicated by matching theory.

The obvious question is what causes this notable difference between our and Toda's (2008) results? To answer this question, we replicate Toda's (2008) estimates. Our replicated results, using the same data sample and variables that are defined as closely possible to his definitions, are presented in Appendix F. These results reveal that, we obtain the same conclusions based on the replicated sample.

Unfortunately, he utilizes only four years of data, which is the only data available at that time. We assume that this limited dataset makes him unable to provide convincing evidence to support his conclusions regarding the of Japanese labor market. Note that Altonji and Shakotko (1987) use 14 years and Altonji and Williams (2005) and Topel (1991) use 16 years of PSID in their studies, respectively. We use the same data covering 11 years.

We believe the data must cover a longer period than what is used in Toda (2008) for AS's IV and the 2SFD methods, because these methods rely on variation in average tenure and in initial experience with the current employer to identify the coefficients of employer tenure and working experience, respectively. The variations in these variables are generated from observations of individuals who change to different employers. The fraction of such observations is around 5% in our data. We believe that the length of the panel data plays an important role in obtaining sufficient variation in these estimation methods, especially in Japan where the probability of a change in employer is lower than in the United States.

Other differences in our estimations, such as the way of controlling for trends in the economy or definitions of variables, account for less of the difference between our and Toda's (2008) results. For example, his study does not control for economic trends due to a small number of years contained in his dataset; therefore, his estimation model includes neither a year trend term nor year dummy terms. We use both ways of controlling for economic trends in our estimation and find that the method has little effect on the coefficients of employer tenure when using the AS's IV method. Associated with this, Toda (2008) uses raw log of hourly wage data as the dependent variable, whereas we use the real log of wages standardized as of 2010. However, we confirm that the results for the replicated sample do not change when using the standardized wage approach. Therefore, we believe the difference between our and Toda's (2008) results arises from using a longer dataset, which is necessary to obtain more reliable result.

6 Conclusion

We estimate the return to employer tenure in Japan using JHPS/KHPS data. The returns to 2, 5, 10 and 15 years of employer tenure are approximately 9.4%, 13.3%, 19.3%, and 24.6%, respectively, using the ordinary least squares method. The corresponding returns are approximately 3.2%, 4.2%, 5.7%, and 7.2%, respectively, using AS's instrumental variable method. The significance of the coefficients obtained using OLS disappears when we use AS's IV method. Since AS's IV estimators of employer tenure remove biass caused from correlations between employer tenure and both employer-match quality and unobserved ability, we can see that selection bias is included in OLS estimators. We conclude that a substantial part of the effects of employer tenure on wage growth may come from the fact that individuals with a better employer match and high unobserved abilities remain with an employer for a long time. We conclude that the return to employer tenure is less important in Japan than what is found in previous studies after correcting for the biases due to unobserved ability and unobserved matching quality. This implies that some part of wage returns may come from workers' job shopping to find a better employer match. These results are robust across the subsamples and do not depend on the estimation method.

It is important to note that this study only deals with unobservable abilities and deviations from matching quality, which are additively separable and time-invariant. We cannot control for bias from unobserved time-vairant or non-separable components. Although we present the possibility that the importance of employer tenure on wage growth is less than what is argued in previous literatures, we cannot conclude that there is no causal effect of employer tenure on wage growth. Further, we are unable to claim that workers do not accumulate employer-specific human capital through their experience with a specific employer, nor can we state that the theory of delayed payment contracts does not explain our results. Even if employer-specific human capital exists, if the employer pays all cost of training specific to the employer and reaps the rent from employer-specific human capital, the wage profile may be flat. If we take retirement allowances into account, our results, which suggest little effect of employer tenure on wage growth, may be consistent with the theory of delayed payment contracts. At a minimum, our results point out the need to carefully analyze causal effects of employer tenure in future research.

Another limitation of this study is that we cannot recognize concrete change in the content of a job for a given employer. Recent papers divide jobs into certain types of tasks (e.g., cognitive and noncognitive tasks) and focus on the returns to the tasks (see, e.g., Gathmann and Schönberg, 2010; Yamaguchi, 2012; Schulz et al., 2013; Handel et al., 2013, and Kok, 2014).[*29] Tsuru et al. (2003) point out compensation structures have been shifting from a seniority-based structure to an alternative structure based on the workers' skills on the job and on a grade that reflects a worker's capability. Although our results are consistent with matching theory, if workers change tasks within the same employer, the workers may accumulate human capital in terms of tasks and their wages may increase with respect to their productivity i doing particular tasks. Dividing jobs into tasks would bring a deeper understanding of the kind of experiences that allow workers to accumulate human capital. We hope that accumulating more data will enable us to further conduct this kind of analysis in Japan.

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Appendix A Occupation code

1. Agriculture, forestry, or fishery worker
2. Mine worker
3. Salesperson (retail or wholesale shop manager or worker, outside salesperson, real estate agent, etc.)
4. Service worker (worker, cleaner, etc. at a barber shop, beauty parlor, restaurant, inn, etc.)
5. Manager (national or local government assembly member; section chief or higher position at a company, organization or government office)
6. Clerical worker (general clerk, accountant, operator, sales clerk, etc.)
7. Transportation or communications worker (railway or motor vehicle driver; ship or airplane pilot; conductor; cable or wireless radio operator, etc.)
8. Manufacturing, construction, maintenance or freight worker
9. Information technology engineer (systems engineer, programmer, etc.)
10. Specialized or technical worker *excluding IT engineer (company researcher or engineer; medical practitioner; legal practitioner; teacher; artist; etc.)
11. Public safety employee (SDF, police, fire department, security guard, etc.)
12. Other

Appendix B Industry code

1. Agriculture
2. Fishery, forestry, marine products
3. Mining
4. Construction
5. Manufacturing (including publishing and printing)
6. Wholesale, retail (including department stores and supermarkets)
7. Restaurants, accommodations
8. Finance, insurance
9. Real estate
10. Transportation
11. Information services and surveys
12. Information and telecommunications other than information services and surveys (telephone and other communications, broadcasting, internet services)

13. Utilities (provision of electricity, gas, water, heat)
14. Medicine, welfare
15. Education, learning support
16. Other services
17. Public service
18. Other

Appendix C Other Estimation Results

The coefficients that have been obtained from the estimation based on (1) with quadratic, cubic and quartic terms of tenure and experience variables are presented in Table A1 and A2. The coefficients based on the estimation of the same earning function as above for various subsamples are showed in Table A3. We can confirm that the coefficients of employer tenure are qualitatively similar in all of the regressions; we cannot reject the hypothesis that these coefficiesnts are zero. Including the higher-order terms of tenure and experience, and including occupation tenure do not change the results. Furthermore, the results are the same when we divide into subsamples.

Table A1: Earnings function estimates, using the AS's IV method, occupation tenure is not included.

	OLS			AS's IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Employer tenure	.0140***	.0106**	.0155*	.0032	.0001	.0054
	(.0020)	(.0045)	(.0088)	(.0058)	(.0095)	(.0148)
Emp.ten.^{2} $\times$ 100	-.0132***	.0107	-.0459	-.0006	.0244	-.0433
	(.0051)	(.0269)	(.0864)	(.0150)	(.0606)	(.1528)
Emp.ten.^{3} $\times$ 100		-.0004	.0018		-.0005	.0024
		(.0004)	(.0031)		(.0010)	(.0057)
Emp.ten.^{4} $\times$ 1000			-.0000			-.0000
			(.0000)			(.0000)
Old job	.0661**	.0799***	.0688**	.0260	.0366	.0274
	(.0283)	(.0310)	(.0348)	(.0460)	(.0475)	(.0510)
Total experience	.0203***	.0058	.0238	.0398***	.0113	.0614**
	(.0027)	(.0074)	(.0150)	(.0080)	(.0166)	(.0289)
Experience^2	-.0004***	.0003	-.0011	-.0007***	.0005	-.0034
	(.0001)	(.0003)	(.0011)	(.0001)	(.0007)	(.0021)
Exp.^{3} $\times$ 100		-.0008**	.0031		-.0016*	.0099
		(.0004)	(.0031)		(.0009)	(.0061)
Exp.^{4} $\times$ 10000			-.0000			-.0000*
			(.0000)			(.0000)
Observations	7648	7648	7648	7648	7648	7648

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
The dependent variable is the log of real hourly wages. Other covariates include an intercept, year dummies, education dummies, occupation and industry dummies, a union membership dummy, a marital status dummy, dummies of firm size, and a regular employee dummy. Columns (1) to (3) denote the coefficients of earnings function (1) which is estimated by OLS, and columns (4) to (6) denote those computed using AS's IV method.

Table A2: Earnings function estimates, using the AS's IV method, occupation tenure is included.

	OLS			AS's IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Employer tenure	.0134***	.0084*	.0087	.0043	.0041	.0019
	(.0022)	(.0050)	(.0095)	(.0062)	(.0103)	(.0160)
Emp.ten.^{2} × 100	-.0125**	.0218	.0173	-.0060	.0032	.0514
	(.0058)	(.0301)	(.0920)	(.0165)	(.0646)	(.1710)
Emp.ten.^{3} × 100		-.0006	-.0000		-.0003	-.0028
		(.0005)	(.0032)		(.0011)	(.0067)
Emp.ten.^{4} × 1000			-.0000			.0000
			(.0000)			(.0000)
Old job	.0733**	.0880***	.0807**	.0265	.0285	.0283
	(.0295)	(.0325)	(.0364)	(.0473)	(.0491)	(.0526)
Occupation tenure	.0009	.0040	.0119**	-.0074	.0014	.0092
	(.0017)	(.0032)	(.0052)	(.0045)	(.0073)	(.0119)
Occ.ten.^{2} × 100	-.0017	-.0230	-.1104**	.0227	-.0550	-.1964
	(.0050)	(.0198)	(.0480)	(.0142)	(.0538)	(.1680)
Occ.ten.^{3} × 100		.0003	.0031**		.0015	.0081
		(.0003)	(.0014)		(.0010)	(.0071)
Occ.ten.^{4} × 10000			-.0025**			-.0090
			(.0011)			(.0089)
Total experience	.0212***	.0071	.0306*	.0417***	.0152	.0702**
	(.0028)	(.0079)	(.0169)	(.0083)	(.0173)	(.0309)
Experience^2	-.0004***	.0002	-.0015	-.0008***	.0004	-.0039*
	(.0001)	(.0003)	(.0012)	(.0002)	(.0007)	(.0022)
Exp.^{3} × 100		-.0008*	.0042		-.0016	.0113*
		(.0004)	(.0034)		(.0010)	(.0064)
Exp.^{4} × 10000			-.0000			-.0000**
			(.0000)			(.0000)
Observations	7519	7519	7519	7519	7519	7519

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
The dependent variable is the log of real hourly wages. Other covariates include an intercept, year dummies, education dummies, occupation and industry dummies, a union membership dummy, a marital status dummy, dummies of firm size, and a regular employee dummy. Columns (1) to (3) denote the coefficients of earnings function (1) which is estimated by OLS, and columns (4) to (6) denote those computed using AS's IV method.

Table A3: Earnings function estimates, using various subsamples.

	Under 59-year-old		Large Firms ($\geq$ 500)		Small Firms ($<$ 500)		Non-Professional		Regular Employee	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Employer tenure	.0118***	.0008	.0206***	.0009	.0119***	.0037	.0166***	.0013	.0130***	.0024
	(.0022)	(.0067)	(.0037)	(.0105)	(.0024)	(.0076)	(.0021)	(.0067)	(.0022)	(.0067)
Emp.ten.^{2} $\times$ 100	-.0044	.0174	-.0270***	-.0013	-.0109*	.0056	-.0190***	.0025	-.0089	.0041
	(.0059)	(.0187)	(.0089)	(.0265)	(.0065)	(.0204)	(.0054)	(.0162)	(.0058)	(.0172)
Old job	.0809**	.0203	.0296	.0292	.0887***	.0159	.0469	.0154	.0824**	.0272
	(.0323)	(.0539)	(.0581)	(.0870)	(.0327)	(.0571)	(.0310)	(.0528)	(.0372)	(.0626)
Total experience	.0166***	.0322***	.0182***	.0546***	.0203***	.0289**	.0166***	.0382***	.0219***	.0380***
	(.0032)	(.0095)	(.0046)	(.0141)	(.0034)	(.0116)	(.0029)	(.0089)	(.0032)	(.0093)
Experience^2	-.0003***	-.0006***	-.0003***	-.0008***	-.0004***	-.0007***	-.0003***	-.0007***	-.0004***	-.0007***
	(.0001)	(.0002)	(.0001)	(.0003)	(.0001)	(.0002)	(.0001)	(.0002)	(.0001)	(.0002)
Observations	6842	6842	3036	3036	4612	4612	6489	6489	6787	6787

Notes: Robust standard errors are in parentheses.

* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

The dependent variable is the log of real hourly wages. Other covariates include an intercept, year dummies, education dummies, occupation and industry dummies, a union membership dummy, a marital status dummy, dummies of firm size, and a regular employee dummy. Columns (1), (3), (5), (7), and (9) denote the coefficients of earnings function (1) which is estimated by OLS, and columns (2), (4), (6), (8), and (10) denote those computed using AS's IV method. We present the coefficients for which we use the sample of individuals under 59-year-old in columns (1) and (2), the sample of individuals who belong to firms with more than 500 employee in columns (3) and (4), the sample of individuals who belong to firms with les than 500 employee in columns (5) and (6), the sample of individuals excepting workers who repond that s/he works as professional in columns (7) and (8), and the sample of the regular employees in columns (9) and (10).

Appendix D The Biases Included in the 2SFD Estimator

In this section, we examine about the condition that the 2SFD estimators contain an upward or downward bias.*30 What we do here is to rewrite the bias which is included in the 2SFD estimator in a form that can be obtained from the data by modifying what Altonji and Williams (2005) shows. In particular, we rewrite the bias from the correlation between unobserved ability and initial experience in the current employer included in the 2SFD estimator using the correlation between employer tenure and working experience.

Topel (1991)'s equation (13) shows that the overall bias included in the 2SFD estimator is equals to

$$E(\beta_1^{\text{2SFD}}) - \beta_1 = -b_1 - \gamma_{W_0 T}(b_1 + b_2) - \gamma_{W_0 \mu} \tag{A-1}$$

where

$$\gamma_{W_0 T} \equiv \frac{\text{Cov}(W_0, T)}{\text{Var}(W_0)} \tag{A-2}$$

and

$$\gamma_{W_0 \mu} \equiv \frac{\text{Cov}(W_0, \mu)}{\text{Var}(W_0)}. \tag{A-3}$$

b_1 and b_2 are the coefficients of the following auxiliary regression between the unobserved employer-match and experience and employer tenure:

$$\lambda_{ij} = b_1 W_{it} + b_2 T_{ijt} + \xi_{ijt}. \tag{A-4}$$

Using additional auxiliary regressions, Altonji and Williams (2005) express (A-1) by parameters that can be calculated from observed data. They specify the following auxiliary regressions:

$$\mu_i = c_1 W_{it} + c_2 T_{ijt} + \omega_{ijt}, \tag{A-5}$$

and

$$T_{ijt} = d_1 \mu_i + d_2 W_{it} + \nu_{ijt}. \tag{A-6}$$

Assuming that

$$\text{Cov}(\mu_{ij}, W_{ijt}) = 0, \tag{A-7}$$

and d_1 and d_2 satisfy $d_1 > 0$ and $d_2 > 0$, we can show that

$$\begin{aligned} c_1 &= -\gamma_{WT} c_2 < 0, \\ c_2 &= \frac{d_1 \,\text{Var}(\mu_i)}{d_1^2 \,\text{Var}(\mu_{ij}) + \text{Var}(\nu_{ijt})} > 0, \end{aligned} \tag{A-8}$$

*30 According to Altonji and Williams (2005), the upward bias due to the correlation between tenure and individual's time-invariant ability, μ, is more serious than the downward bias due to the correlation between tenure and employer-matching component, λ in the United States. They report that the difference between the AS's IV and the 2SFD estimators due to bias from λ is -0.0015, which leads to the difference of -0.015 between returns to 10 years of employer tenure.

where $\gamma_{WT} \equiv d_2 = \frac{\mathrm{Cov}(T,W)}{\mathrm{Var}(W)}$, since (A-7) is assumed. The numerator of (A-3) is rewritten as

$$\mathrm{Cov}(W_0, \mu) = \mathrm{Cov}(W - T, \mu) = -\mathrm{Cov}(T, \mu) = -d_1 \mathrm{Var}(\mu) \tag{A-9}$$

The second equation comes from the assumption that $\mathrm{Cov}(\mu_{ij}, W_{ijt}) = 0$ and the third equation comes from (A-6). The denominator of (A-3) is rewritten as

$$\mathrm{Var}(W_0) = \mathrm{Var}(W - T) = \mathrm{Var}(W) - 2\,\mathrm{Cov}(W, T) + \mathrm{Var}(T). \tag{A-10}$$

Then, (A-3) is rewritten as

$$\begin{aligned}\gamma_{W_0\mu} &= -\frac{d_1 \mathrm{Var}(\mu)}{\mathrm{Var}(W) - 2\,\mathrm{Cov}(W,T) + \mathrm{Var}(T)} \\ &= -\frac{c_2[d_1^2 \mathrm{Var}(\mu_{ij}) + \mathrm{Var}(\nu_{ijt})]}{\mathrm{Var}(W) - 2\,\mathrm{Cov}(W,T) + \mathrm{Var}(T)} \\ &= -c_2 \frac{\mathrm{Var}(\zeta)}{\mathrm{Var}(W) - 2\,\mathrm{Cov}(W,T) + \mathrm{Var}(T)} \end{aligned} \tag{A-11}$$

where $\zeta \equiv T - E(T|W)$, which is residual obtained by regressing T on W, and its variance is equals to $d_1^2 \mathrm{Var}(\mu_{ij}) + \mathrm{Var}(\nu_{ijt})$ since (A-6) is assumed. Finally, the bias in the 2SFD estimator is rewritten as:

$$\begin{aligned} E(\beta_1^{\mathrm{2SFD}}) - \beta_2 = &- b_1 - \gamma_{W_0T}(b_1 + b_2) \\ &+ c_2 \frac{\mathrm{Var}(\zeta)}{\mathrm{Var}(W) - 2\,\mathrm{Cov}(W,T) + \mathrm{Var}(T)}. \end{aligned} \tag{A-12}$$

From JHPS/KHPS, we obtain $\gamma_{W_0T} \approxeq -.5$, then the second term in this equation is positive as long as $b_1 + b_2 > 0$. We also obtain $\mathrm{Var}(\zeta) \approxeq 110$, $\mathrm{Var}(W) \approxeq 120$, $\mathrm{Var}(T) \approxeq 129$, and $\mathrm{Cov}(W,T) \approxeq 46$ from the sample, then $\mathrm{Var}(\zeta)/[\mathrm{Var}(W) - 2\,\mathrm{Cov}(W,T) + \mathrm{Var}(T)] \approxeq .7$. Since c_2 is assumed to be positive in (A-8), the third term in this equation is also positive. In addition, b_1 is likely to be positive as matching models and conventional search models show (for example, Burdett, 1978; Jovanovic, 1979), the bias in 2SFD estimator could be negative, provided that $-b_1 + .5(b_1 + b_2) + .7c_2 < 0 \Leftrightarrow .5(b_1 - b_2) > .7c_2$. If the correlation between employer-match component and experience, b_1, is sufficiently large, that is, if workers move to better matched employer through their experience in Japanese labor market, the 2SFD estimator might include downward bias in Japan, rather than upward bias that Altonji and Williams (2005) concern about.

Appendix E Results of the 2SFD with Varioius Specification

We have conduct various specification for estimating the coefficient of employer tenure. First, we try multiple ways of controlling time trend. The wage equation that have used by Topel (1991) includes neither time trend nor time dummies since he detrends the realwage using the wage index from Murphy and Welch (1992) before the first step of the estimation. However, Altonji and Williams (2005) argues that the way of controlling time trend affects the estimated returns to employer tenure.

Then, we follow them and have tried six ways of controlling time trend: (1) Sum of year dummies are included in the earnings function (Sum1), (2) Sum of year dummies are included in the earnings function and year dummies are included in the second step (Sum2), (3) Year dummies are included in the first step (Dum1), (4) Year dummies are included in the second step as well as other control variables (Dum2), (5) Year dummies are included in the first and second step (Dum3), and (6) The first-difference of the real wage is detrended by year dummies before the first step (Det).

We try to allow that the first difference of real wage to depend on the first difference of year dummies in the cases Sum1 and Sum2. For this purpose, we define an alternative earnings function for these cases:

$$\ln w_{ijt} = \beta_0 + \beta_1 T_{ijt} + \beta_2 W_{ijt} + \beta_t + e_{ijt} \tag{A-13}$$

where, like the basic earnings function defined in Section 4, $e_{ijt} = \mu_i + \lambda_{ij} + \varepsilon_{ijt}$. Suppose that the coefficient of the initial year of the survey is normalize to be zero (that is, $\beta_{2004} = 0$). Then the first-difference of this earnings function is

$$\ln w_{ijt} - \ln w_{ijt-1} = B + \gamma_t + \varepsilon_t - \varepsilon_{t-1} \tag{A-14}$$

where $B = \beta_1 + \beta_2$ again, and $\gamma_t = \beta_t - \beta_{t-1}$. We apply the OLS to equation (A-14) and obtain $\hat{B}$, and $\hat{\gamma}_t$. Thus, the second step equation becomes

$$\ln w_{ijt} - \left(\hat{B} T_{ijt} + \sum_{\tau \in \mathcal{T}} \hat{\gamma}_\tau \right) = \beta_2 W0_{ijt} + \mu_i + \lambda_{ij} + \varepsilon_{ijt} \tag{A-15}$$

where $\mathcal{T}$ denotes the set of the year that individual i responds to the survey, and $W0$ is again the initial experience on the employer. We obtain $\hat{\beta}_2$ by applying the OLS to the equation (A-15), and finally, $\hat{\beta}_1 = \hat{B} - \hat{\beta}_2$ is obtained.

For the cases Dum1, Dum2, and Dum3, the earnings equation defined by (1) is used for estimation. Dum2 is the exactlly the basic estimation that is conducted as the 2SFD in Section 5.2. Dum1 includes year dummies in the first step and Dum3 includes year dummies in the first step in addition to year dummies in the second step. The year dummies in the first and second step play a different role. Year dummies in the first step allow the case when the first difference of the wage depends on the year-specific shock. On the other hand, year dummies in the second step control the correlation between time and other control variables. Originally, only time-invariant variables can be included as the control variable in the 2SFD method, but time-variant variables (e.g., occupation and industry an individual engage, firm size, and whether an individual is union member) should affect the initial wage in the current employer.[*31] Those variable may change over time (even if it is less frequent), and it is valid to include time dummies in the second step when they are correlated with time.

[*31] In fact, Topel (1991) also includes marital dummies and union dummies.

Table A4: Estimated returns to employer renure, using 2SFD.

	Sum1 (1)	Sum2 (2)	Dum1 (3)	Dum2 (4)	Dum3 (5)	Det (6)
2 years	.0434	.0434	.0435	-.0130	.0434	-.0177
	(.0435)	(.0434)	(.0435)	(.0307)	(.0435)	(.0306)
5 years	.1086	.1086	.1088	-.0323	.1086	-.0443
	(.1082)	(.1082)	(.1082)	(.0760)	(.1082)	(.0758)
10 years	.2171	.2172	.2176	-.0637	.2172	-.0889
	(.2155)	(.2155)	(.2155)	(.1503)	(.2155)	(.1499)
15 years	.3258	.3259	.3265	-.0941	.3259	-.1337
	(.3229)	(.3229)	(.3229)	(.2244)	(.3229)	(.2239)
20 years	.4344	.4346	.4353	-.1235	.4346	-.1786
	(.4316)	(.4316)	(.4316)	(.3000)	(.4316)	(.2993)
25 years	.5431	.5433	.5443	-.1520	.5433	-.2238
	(.5426)	(.5425)	(.5425)	(.3786)	(.5425)	(.3778)
Observations	7824	7824	7824	7824	7824	7824

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
This table reports the calculated wage returns to 2, 5, 10, 15, 20, and 25 years of employer tenure using 2SFD. The model for estimation is given by the earnings function (1).

Table A5: Estimated returns to employer tenure.

	Time-invariant (1)	Changing Infrequently (2)	All (3)
2 years	.0033	-.0002	-.0130
	(.0307)	(.0307)	(.0307)
5 years	.0085	-.0002	-.0323
	(.0760)	(.0758)	(.0760)
10 years	.0180	.0005	-.0637
	(.1528)	(.1503)	(.1503)
15 years	.0285	.0022	-.0941
	(.2245)	(.2245)	(.2244)
20 years	.0399	.0048	-.1235
	(.3000)	(.3001)	(.3000)
25 years	.0523	.0084	-.1520
	(.3786)	(.3787)	(.3786)
Years of education	√	√	√
Marital status		√	√
Union member		√	√
Occ/Ind code			√
Firm size			√
Regular employee			√
Observations	7959	7889	7824

Notes: Robust standard errors are in parentheses.
* , ** and *** Denote statistical significance at the 10%, 5% and 1% level, respectively.
This table rebports the calculated wage returns to 2, 5, 10, 15, 20 and 25 years of employer tenure using the 2SFD. The model for estimation is given by earning function (1).

Also for the case Det, the earnings equation is given by (1). We first regress the real log wage to the time dummies before the estimation to detrend the wage, and its residual is used for the following estimation instead of using the real log wage. It is the alternative way of detrend used by Altonji and Williams (2005) instead of using the wage index from Murphy and Welch (1992).

Other than the way of controlling time trend is the same as the estimation conducted in Section 5.2. We include quadratic term of employer tenure and working experience in the equation, and education dummies, occupation and industry dummies, a union member dummy, a marital status dummy, firm size dummies, and regular employee dummy are used as control variables here.

The estimated returns to employer tenure in each cases are presented in Table A4. These returns are substantially different depending on the way of controlling time trend as Altonji and Williams (2005) argue.

Second, we change the control variables in the second step of the estimation. Although the key for obtaining consistent estimator using the 2SFD is to drop time-invariant covariates within an individual as well as individual fixed effect in the first step, Topel (1991) includes information about marital status, union membership and residence of respondents as covariates in the second step, which are not ordinarily able to be dropped in the first step. We examine how choice of control variables affect the estimation results by adding the variables in order. First, we use only time-invariant variable, years of education. Second, we add variables which change infrequently, marital status and union membership. Finally, we use all variables including occupation and industry dummies, firm size, and regular employee dummy, and this case have been conducted in Section 5.2. Table A5 shows the estimated return to employer tenure in each cases described above. Although all estimated returns are not significantly different from zero, their point estimation are different: returns by using all variables are negative while those by using only time-invariant vairables are positive. We confirm that the 2SFD estimators are sensitive to the choice of control variables, whereas it has little effect on the AS's IV estimators.

Appendix F Replication of Toda's Results

We have replicated the estimatimation by Toda (2008). He uses JHPS/KHPS for 2004–2007. In addition to the individuals who respond to the survey, he also uses the information of their spouse. The sample is restricted to male of regular employee aged from 20 to 60. We use the same restriction of the data as him as possible. The earnings function that he have used is slightly different from us. First, he includes no time trend variable probably because of the short length of the data he uses. Second, he does not include old job dummy.

Estimated coefficients and returns which follow the specification of Toda (2008) using the AS's IV are presented in Table A6 and Table A7, respectively. Those using the 2SFD are presented in Table A8 and Table A9, respectively. Although we try to use the same sample as Toda, the number of observations are different: we use 2984 observations for estimation, whereas Toda uses 4382 observations. However, our replicated results are qualitatively similar to his. Using the AS's IV method leads to the higher returns to wages than using the OLS. He interprets that human capital theory rather than matching theory well explain the results. We obtain almost the same returns to employer tenure as his when using the 2SFD, except the case when 4th order terms of employer tenure and working experience are included. Taking this replication and other robustness check conducted in Section 5, we believe that we have provided more appropriate results as we have discussed in Section 5.3.

Table A6: Replication of Toda (2008), using AS's IV method

	OLS				AS's IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Employer tenure	.0145***	.0173***	.0317***	.0607***	.0280***	.0623**	.0537	.0827
	(.0009)	(.0033)	(.0076)	(.0138)	(.0098)	(.0266)	(.0347)	(.0509)
Emp.ten.^{2} $\times$ 100		-.0174**	-.1197***	-.4682***		-.1119*	-.0565	-.4454
		(.0087)	(.0457)	(.1431)		(.0590)	(.2093)	(.5505)
Emp.ten.^{3} $\times$ 100			.0018**	.0158***			-.0010	.0154
			(.0008)	(.0054)			(.0036)	(.0216)
Emp.ten.^{4} $\times$ 1000				-.0000***				-.0000
				(.0000)				(.0000)
Total experience		.0370***	.0601***	.0457		.0085	.0335	.0516
		(.0050)	(.0139)	(.0312)		(.0180)	(.0263)	(.0496)
Experience^2		-.0006***	-.0016***	-.0001		-.0001	-.0013	-.0021
		(.0001)	(.0006)	(.0023)		(.0003)	(.0013)	(.0043)
Exp.^{3} $\times$ 100			.0013	-.0040			.0018	.0029
			(.0009)	(.0070)			(.0017)	(.0146)
Exp.^{4} $\times$ 10000				.0000				-.0000
				(.0000)				(.0000)
Observations	2984	2984	2984	2984	2984	2984	2984	2984

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
The data come from the JHPS/KHPS for 2004–2007. The sample includes male regular employee, aged 20–60. The dependent variable is the log of real hourly wages. Other covariates include an intercept, education dummies, occupation and industry dummies, and dummies of firm size. Columns (1) to (4) denote the coefficients of earnings function (1) which is estimated by OLS, and columns (5) to (8) denote those computed using AS's IV method.

Table A7: Estimated returns based on replication of Toda (2008), using the AS's IV method

	OLS				AS's IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2 years	.0290***	.0338***	.0588***	.1039***	.0559***	.1201**	.1050*	.1488*
	(.0017)	(.0063)	(.0134)	(.0225)	(.0196)	(.0515)	(.0632)	(.0844)
5 years	.0724***	.0819***	.1308***	.2051***	.1398***	.2835**	.2530*	.3203**
	(.0043)	(.0145)	(.0278)	(.0409)	(.0491)	(.1230)	(.1387)	(.1623)
10 years	.1448***	.1552***	.2156***	.2793***	.2796***	.5111**	.4699**	.5152**
	(.0086)	(.0250)	(.0394)	(.0475)	(.0982)	(.2283)	(.2326)	(.2381)
15 years	.2172***	.2197***	.2678***	.3015***	.4193***	.6827**	.6429**	.6539**
	(.0129)	(.0316)	(.0411)	(.0435)	(.1474)	(.3200)	(.3133)	(.3129)
20 years	.2896***	.2756***	.3014***	.3238***	.5591***	.7984**	.7644*	.7740*
	(.0172)	(.0349)	(.0385)	(.0395)	(.1965)	(.4031)	(.3977)	(.3960)
25 years	.3620***	.3227***	.3300***	.3716***	.6989***	.8581*	.8264*	.8823*
	(.0215)	(.0354)	(.0359)	(.0391)	(.2456)	(.4840)	(.4860)	(.4839)
Observations	2984	2984	2984	2984	2984	2984	2984	2984

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
This table reports the calculated wage returns to 2, 5, 10, 15, 20, and 25 years of employer tenure based on the coefficients of the corresponding columns of Table A6. Columns (1) to (4) denote the calculated returns estimated using OLS, and columns (5) and (8) denote those obtained using AS's IV method.

Table A8: Replication of Toda (2008), using 2SFD.

	(1)	(2)	(3)	(4)
1st stage				
Constant	.0319**	.1310***	.1639**	.2341
	(.0127)	(.0359)	(.0798)	(.1437)
Emp.ten.^{2} × 100		-.0358	-.0605	-.4641
		(.0734)	(.2519)	(.6003)
Emp.ten.^{3} × 1000			.0047	.1808
			(.0446)	(.2399)
Emp.ten.^{4} × 10000				-.0227
				(.0302)
Experience^2 × 100		-.1768**	-.3169	-.6041
		(.0826)	(.3851)	(1.1045)
Experience^3 × 1000			.0187	.0924
			(.0532)	(.3351)
Experience^4 × 10000				-.0066
				(.0352)
2nd stage				
Total Experience	.0135***	.1013***	.1319***	.1760***
	(.0286)	(.0011)	(.0010)	(.0010)
Employer Tenure	.0184	.0297	.0320	.0580
	(.0128)	(.0374)	(.0774)	(.1163)
Observations				
1st stage	1379	1378	1378	1378
2nd stage	3009	3008	3008	3008

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
The data come from the JHPS/KHPS for 2004–2007. The sample includes male regular employee, aged 20–60. The dependent variable is the log of real hourly wages. Other covariates include education dummies, occupation and industry dummies, and dummies of firm size.

Table A9: Estimated returns based on replication of Toda (2008), using 2SFD.

	(1)	(2)	(3)	(4)
2 years	.0368	.0579	.0617	.0989
	(.0257)	(.0748)	(.1557)	(.2320)
5 years	.0920	.1394	.1456	.1954
	(.0642)	(.1878)	(.3947)	(.5856)
10 years	.1839	.2610	.25644	.2745
	(.1285)	(.3802)	(.8133)	(1.2030)
15 years	.2759	.3646	.3600	.3217
	(.1927)	(.5813)	(1.2579)	(1.1843)
20 years	.3679	.4504	.4359	.3874
	(.2569)	(.7945)	(1.7213)	(2.4805)
Observations	3009	3008	3008	3008

Notes: Robust standard errors are in parentheses.
* , ** and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
This table reports the calculated wage returns to 2, 5, 10, 15, 20, and 25 years of employer tenure using 2SFD for the replicated sample of Toda (2008).