Are Japanese Nominal Wages Downwardly Rigid? (Part II): Examinations Using a Friction Model

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This paper confirms the existence of downward nominal wage rigidity in Japan as presented in Kuroda and Yamamoto (2003a) and quantifies the extent of this downward nominal wage rigidity by applying econometric methods to Japanese longitudinal data. Using 1993–98 data, we find that downward nominal wage rigidity does exist in Japan even after controlling the individual characteristics and the measurement errors in reported nominal wages. In addition, we find that the extent of the downward nominal wage rigidity is sensitive to the choice of wage measures. While the hourly wages of part-time female employees exhibit almost complete downward rigidity, the extents of the downward rigidity are limited for the regular monthly salaries and annual earnings of full-time employees. For example, our estimates show that the regular monthly salaries of full-time male and female employees will not be cut as long as the notional wages do not decline by more than about 7.7 percent and 4.0 percent, respectively. However, when the notional wage change rates exceed these threshold values, nominal wage cuts do occur.

Keywords: Downward nominal wage rigidity; Inflation rate; Monetary policy; Longitudinal data; Measurement errors; Friction model; Simulated maximum likelihood
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I. Introduction

From the late 1990s, many economists have advised that the Bank of Japan should target a small but positive rather than zero inflation rate to facilitate real wage adjustments. Such arguments are based on the idea that since nominal wages are downwardly rigid, a monetary policy of moderate inflation could "grease the wheels" of the labor market, assisting the downward flexibility of real wages.

To examine the validity of this argument, Kuroda and Yamamoto (2003a) empirically investigate whether or not nominal wages are downwardly rigid in Japan with 1993–98 longitudinal data. In that paper, we conclude that nominal wage rigidity does exist in Japan, but that the extent of the downward rigidity is limited for the regular monthly salaries and annual earnings of full-time employees. Those conclusions are mainly based on the fact that the nominal wage change distributions are statistically skewed to the right with large spikes near zero, while there are a sizable number of negative nominal wage changes.

Kuroda and Yamamoto (2003a) adopts widely accepted statistical procedures from the prior literature to test the downward nominal wage rigidity by examining the shape of the nominal wage change distributions.[1] However, that approach has the following shortcomings. First, as noted in McLaughlin (1994, 2000), the right-skewness of the nominal wage change distributions may be spurious since it may simply be a statistical artifact of mixing heterogeneous groups.[2] Second, it does not provide us with a quantitative estimate of the extent to which the nominal wages are downwardly rigid, or indications of when nominal wage cuts will occur.[3] Third, as pointed out by Akerlof *et al.* (1996), the interpretation of the right-skewed nominal wage change distributions may vary depending on the assumptions regarding the data-generating process of measurement errors in reported nominal wages.[4]

To address these shortcomings, in this paper, we apply econometric models to the same longitudinal data set and check the robustness of the findings in Kuroda and Yamamoto (2003a). The model used in this paper is a version of the friction model employed in Altonji and Devereux (1999) and Fehr and Götte (2000).

Our model assumes that there is an optimal nominal wage that the firm would like to offer in the absence of downward nominal wage rigidity (the "notional wage"). Each worker's notional wage is estimated by controlling the workers' characteristics (such as age, tenure, labor market experience, years of education, and occupation)

1. The previous literature that observes the shape of the nominal wage change distributions and statistically tests whether or not they are skewed to the right includes McLaughlin (1994, 1999, 2000), Lebow *et al.* (1995), Kahn (1997), Card and Hyslop (1997), and Kuroda and Yamamoto (2003a).
2. For example, when distributions with different demographic groups are aggregated, the aggregated distribution could be right-skewed even when the original distributions are all symmetrical. For details, see McLaughlin (1994, 2000). Kuroda and Yamamoto (2003a) report that even after controlling the workers' characteristics, the nominal wage change distributions still remained skewed to the right.
3. For example, it is difficult to intuitively interpret the extent of the downward nominal wage rigidity based on the skewness coefficients of the nominal wage distributions.
4. If respondents make any clerical mistakes in filling out their survey forms, or provide incorrect data due to lapses of memory, such measurement errors may affect the conclusions. For example, if a respondent reports his/her nominal wage lower than the previous year even though his/her true nominal wage was unchanged, we could fail to identify downward nominal wage rigidity that actually exists. The possibility of measurement errors is excluded in Kuroda and Yamamoto (2003a).

and considering the macroeconomic environment he or she faces. The model expects that there may be a difference between the notional wage change and the observed nominal wage change for those samples with negative notional wage changes. More specifically, it assumes that the nominal wages of all samples with a notional wage range from a certain negative threshold value to zero will remain unchanged, whereas the nominal wages with notional wage changes below this threshold will be cut to some degree. The distance between the threshold and zero point indicates the range of the downward nominal wage rigidity, i.e., the extent to which the nominal wages are downwardly rigid. Moreover, this statistical procedure can account for the measurement errors of the reported nominal wages.

We obtain the following estimation results. First, judging from the analyses using 1993–98 data, downward nominal wage rigidity does exist in Japan, even after controlling workers' characteristics and measurement errors. Second, the extent of the downward nominal wage rigidity is sensitive to the choice of nominal wage measures. While the hourly wages of part-time female employees show almost perfect downward rigidity, the regular monthly salaries and annual earnings of full-time males and females show only partial downward rigidity. Third, the estimated thresholds indicate that the regular monthly wages of full-time male and female employees will remain unchanged as long as the notional wage change rates range from –7.7 to zero percent, and from –4.0 to zero percent, respectively. The annual earnings of full-time males and females remain unchanged as long as the notional wage change rates remain within –3.5 to zero percent. The hourly wages of part-time females remain unchanged whenever the notional wage change rates are negative.

The structure of this paper is as follows. Section II reviews the data used for the analyses herein. Section III derives and explains the empirical models. Section IV shows the estimation results. Section V summarizes the contents and presents concluding remarks.

II. Data

A. Data Description, Samples, and Variables

In this paper, we apply econometric models to the same longitudinal data set used in Kuroda and Yamamoto (2003a). The data source is the 1993–98 waves of the *Japanese Panel Survey of Consumers* (JPSC).[5]

In estimating empirical models, we use the following information from the data: nominal wages, sex, employment status, age, tenure, total years of work experience, years of education, prefecture of residence, occupation, number of employees at workplace, and industry. We use the samples who worked at the same firm for two consecutive years. Those who were self-employed, working in family businesses, switching jobs, or unemployed are excluded.

5. For the detailed information regarding the data, see Kuroda and Yamamoto (2003a).

We examine five types of nominal wages: (1) the regular monthly salaries[6] of full-time male employees; (2) the annual earnings of full-time male employees; (3) the regular monthly salaries of full-time female employees; (4) the annual earnings of full-time female employees; and (5) the hourly wage of part-time female employees.[7]

Since the bonus payments to employees prevailing in Japan are unlike those in other countries, the extent of Japanese downward nominal wage rigidity may differ substantially depending on whether or not bonus payments are included.[8] Thus, we analyze both regular monthly salaries and annual earnings that include bonus payments.[9] In addition, since detailed data on working hours are not available, we do not convert the monthly salaries and annual earnings to an hourly wage basis. We also divide the samples by sex (male or female) and employment status (full-time or part-time) because the Japanese labor markets for male, female, and full- and part-time employees may well have different characteristics, and because the survey was conducted solely on females.[10]

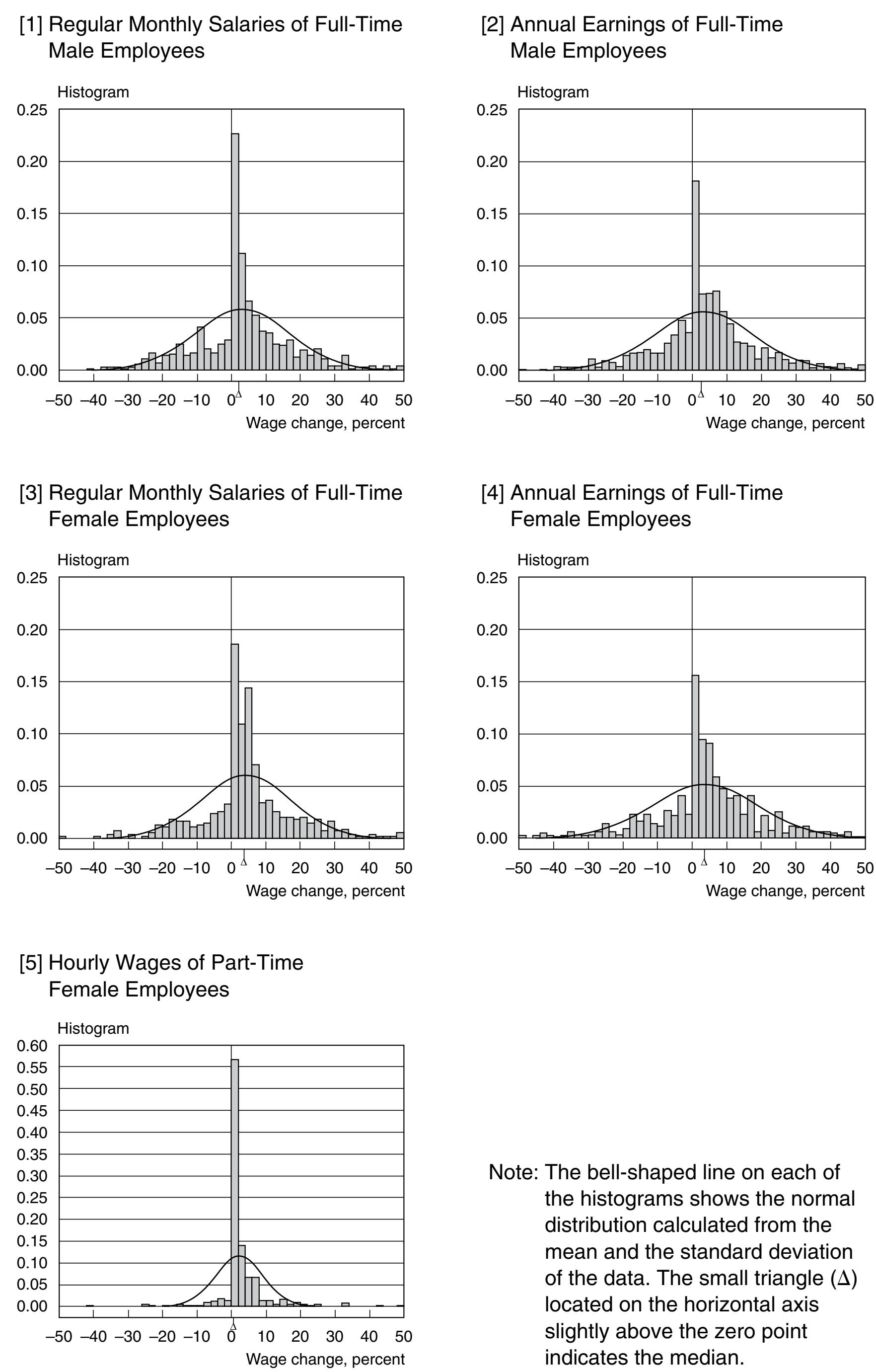
The number of samples in each nominal wage type are (1) 735 for the regular monthly salaries of full-time males (1994–98), (2) 1,384 for the annual earnings of full-time males (1994–97), (3) 557 for the regular monthly salaries of full-time females (1993–98), (4) 804 samples for the annual earnings of full-time females (1993–97), and (5) 436 for the hourly wages of part-time females (1993–98).[11,12]

B. Data Characteristics: Nominal Wage Change Distributions

Figure 1 shows the nominal wage change distributions for the five types of wages. The bell-shaped line on each of the histograms shows the normal distribution

6. The JPSC only reports monthly salaries including overtime pay. To eliminate the effects of overtime pay adjustments from the regular monthly salaries, we only use the samples whose overtime working hours did not change significantly from the previous year.
7. As for the nominal wage units, the regular monthly salaries are expressed in ¥1,000, the annual earnings are expressed in ¥10,000, and the hourly wages of part-time employees are expressed in ¥1. We assume that the possible effects of rounding errors in reported nominal wages are negligible.
8. Suruga (1987) points out that bonuses account for over 20 percent of Japanese wage flexibility, and that the contribution of bonuses to wage adjustment is far more prominent when business performance is poor than when it is favorable.
9. The annual earnings include overtime pay as well as regular monthly salaries and bonuses. The majority of the changes in overtime pay reflect quantitative adjustments in the number of overtime working hours. Thus, ideally we should use annual earnings net of overtime pay to examine downward nominal wage rigidity. However, firms that reduce their bonus during recessions may well simultaneously reduce overtime working hours as well. If we only use the annual earnings samples in which overtime working hours did not change significantly from the previous year, this could cause some bias in the annual earnings changes. Therefore, in this paper we consider the changes in annual earnings as the outcome of the overall adjustment of personnel expenses, covering regular salaries and bonuses payments as well as overtime pay.
10. Because the survey respondents (females) answer wage-related questions both for themselves and for their spouses (males), the measurement errors in the reported nominal wages may well vary by sex. This is another reason why we separate males and females in our analyses.
11. The sample for the annual earnings of full-time male and female employees includes employees temporarily transferred to other companies (*shukko*), and those who experienced job rotation within the same firm (*haiten*). The numbers of such cases are six males and two females for *shukko*; and 263 males and 108 females for *haiten*.
12. To eliminate the influence from obvious measurement errors, samples whose wage change rate has an absolute value of over 100 percent are also excluded. The analyses of the hourly wages of part-time females exclude all samples below the minimum wage. Also, because some of the male data for 1993 are unusable, the analyses for male employees are limited to 1994–98. As for the annual earnings, since the survey question asks employees about their earnings of the past year, there is a one-year time lag for these data. For example, the responses to the 1998 survey indicate the earnings received during 1997. As a result, the annual earnings data are effectively one year shorter compared with the regular monthly salary and part-time hourly wage data.

Figure 1 Nominal Wage Change Distributions



Note: The bell-shaped line on each of the histograms shows the normal distribution calculated from the mean and the standard deviation of the data. The small triangle (Δ) located on the horizontal axis slightly above the zero point indicates the median.

calculated from the mean and the standard deviation of the data. The small triangle (Δ) located on the horizontal axis slightly above the zero point indicates the median.

All of the histograms seem to be skewed to the right, since there are spikes near the zero points and the number of samples to the right of these spikes is greater than the number to the left. This feature is outstanding for the hourly wages of part-time female employees, where the distribution has an exceptionally large spike near the zero point and almost no samples at all with negative nominal wage changes. In contrast, while the data for the regular monthly salaries and annual earnings do include a substantial number of samples in the zero spike, they also include a sizable number of samples with negative nominal wage changes.

If there were absolutely no downward nominal wage rigidity, then the distribution should exhibit a symmetry on both sides of the median. Thus, the observed right-hand skewness can be interpreted as the existence of downward nominal wage rigidity.[13] It should be noted, however, that the substantial number of samples with negative nominal wage changes indicates some downward flexibility as well. In the next section, we proceed to examine these nominal wage change properties more strictly by estimating friction models.

III. Friction Model and Estimation Method

A. Outline of the Empirical Models

In this section, we explain the outline of the empirical model. The model assumes that the notional wages, being derived from the workers' characteristics such as labor market experience and number of years of education, do not necessarily match the observed nominal wages. That is, the nominal wage change rate remains zero as long as the notional wage change ranges from a certain negative threshold value to zero. When the notional wage change rates fall below this threshold value, however, the model allows nominal wage cuts to occur. In this sense, the model exhibits partial downward nominal wage rigidity, and is therefore called a "friction model." It is important to note that the model also exhibits perfect downward nominal wage rigidity as a special case when the threshold value approaches $-\infty$, which means that the nominal wage cuts never occur. We call this case a "Tobit model." Therefore, the empirical models to be estimated below nest a perfectly downward nominal wage rigidity model (the Tobit model) and a model that allows for nominal wage cuts in certain circumstances (the friction model).

We expect that these models will consistently describe the nature of the nominal wage changes observed in Figure 1. As we saw in the figure, there are large zero spikes and right-skewness in the nominal wage change distributions. These observations are consistent with these models in that the nominal wages are right-skewed because of downward rigidity constraints, although the underlying notional wage changes are symmetrical.

13. As stated above, using 1993–98 data, Kuroda and Yamamoto (2003a) conclude that downward nominal wage rigidity does exist, based on the right-skewed nominal wage change distributions.

Using the data presented in the previous section, we estimate the friction and Tobit models using the maximum likelihood (ML) method. Then, we examine which of these two models more accurately explains the nature of nominal wage changes in Japan with likelihood ratio tests. If the likelihood ratio tests show that the friction model better approximates the data, we conclude that there is partial downward nominal wage rigidity. Additionally, the size and significance of the estimated threshold in the friction model tell us to what extent the nominal wages are downwardly rigid (if the threshold is insignificant, we consider the nominal wages perfectly flexible). On the other hand, if the tests show that the Tobit model applies, we conclude that there is perfect downward rigidity for the nominal wages.

Moreover, we consider the possibility of measurement errors in the reported nominal wages. The previous literature has discussed how measurement errors in longitudinal data could cause severe problems when examining the downward rigidity in nominal wages.

For example, McLaughlin (1994) concludes that nominal wages are generally flexible based on the observation that a substantial number of negative nominal wage change samples exist in the U.S. *Panel Study of Income Dynamics* (PSID). Meanwhile, other studies, such as Akerlof *et al.* (1996), suggest that the frequency of nominal wage cuts in longitudinal data is an artifact of measurement errors. Akerlof *et al.* (1996) conduct a telephone survey in Washington, D.C., and ask respondents whether they experienced nominal wage cuts during the previous year. They report that merely 3 percent of the respondents experienced nominal wage cuts, suggesting strong downward nominal wage rigidity. In short, Akerlof *et al.* (1996) suggest that there are a substantial amount of measurement errors in the PSID data, and that there are almost no instances where true nominal wages actually decline.

Shea (1997) matches a sample of union workers in the PSID to union wage settlements, and concludes that most nominal wage cuts reported in the PSID data are due to measurement errors.[14] Baker *et al.* (1994), Altonji and Devereux (1999), and Wilson (1999) each obtain error-free wage data from the personnel files of large firms to check how many workers received nominal wage cuts. All conclude that nominal wage cuts are extremely rare. Altonji and Devereux (1999) and Fehr and Götte (2000) statistically incorporate measurement errors for the PSID and Swiss longitudinal data to the aforementioned friction models. They conclude that measurement errors have a non-trivial effect on nominal wage change distributions,[15] and that there is fairly strong downward rigidity in both U.S. and Swiss nominal wages even after taking account of measurement errors. Smith (2000) tries to eliminate measurement errors in the responses to the *British Household Panel Study* (BHPS) by using information on whether the payslip was checked in reporting pay.

14. McLaughlin (1999) responds that survey respondents could under-report embarrassing personal information, so the survey conducted by Akerlof *et al.* (1996) has its own type of bias toward undercounting wage cuts. He also points out the problem with Shea (1997), by stating that the wages of union workers could change without corresponding changes in union pay scales in the United States, since the union wages are usually assigned to jobs, and workers regularly move from job to job.

15. For example, Altonji and Devereux (1999) find that 30–50 percent of the variance of nominal wage change is due to measurement errors. Bound *et al.* (1994) also report that measurement errors compose approximately 60 percent of the variance of nominal wage changes.

She concludes that the U.K. labor market is highly flexible, with little downward nominal wage rigidity.

These papers suggest that the conclusions may vary substantially depending on whether or not measurement errors are taken into account. If the observed nominal wage changes are due to measurement errors, the true nominal wages may have even stronger downward rigidity than the reported nominal wage changes, or possibly no downward rigidity whatsoever.[16] While the measurement errors cannot be directly observed from the data itself, we estimate a model that statistically incorporates measurement errors with the same approach adopted in Altonji and Devereux (1999).

B. Model Specification and Remarks

1. Models without measurement errors

First, we consider the case where there is no measurement error in the reported nominal wages. Let w_i^* be the log of the notional wage of the individuals ($i = 1, \ldots, n$). The log of notional wage w_i^* is expressed as a function of a vector of explanatory variables x_i, a parameter β, and a normally distributed error term ϵ_i.

$$w_i^* = \beta' x_i + \epsilon_i, \quad \epsilon_i \overset{i.i.d.}{\sim} N(0, \sigma_\epsilon^2). \tag{1}$$

Using $\tilde{w}_{i,-1}$ as the log of the previous year's nominal wage and $\tilde{w}_i$ as the log of the current nominal wage, the relationship between the notional wage change $w_i^* - \tilde{w}_{i,-1}$ and the reported nominal wage change $\tilde{w}_i - \tilde{w}_{i,-1}$ can be expressed as follows.

$$\tilde{w}_i - \tilde{w}_{i,-1} = \begin{cases} w_i^* - \tilde{w}_{i,-1} & \text{if} \quad 0 < w_i^* - \tilde{w}_{i,-1}, \\ 0 & \text{if} \quad -\alpha < w_i^* - \tilde{w}_{i,-1} \leq 0, \\ w_i^* - \tilde{w}_{i,-1} + \lambda & \text{if} \quad w_i^* - \tilde{w}_{i,-1} \leq -\alpha. \end{cases} \tag{2}$$

If the notional wage change ranges from $-\alpha$ to zero percent, then the model states that the nominal wage change is zero. The model allows nominal wage cuts to occur when the notional wage change is sufficiently negative. The parameter λ determines the extent to which the nominal wage change deviates from the notional wage change rate when the notional wage change rate falls below $-(\alpha \times 100)$ percent. Then, by substituting equation (1) into equation (2), one can derive the empirical model to be estimated.

If the estimated parameter α is significantly positive, we consider that as long as the notional wage change ranges from $-(\alpha \times 100)$ to zero percent, nominal wage cuts

16. There are two possibilities for the relationship between the observed nominal wage change distribution and the true nominal wage change distribution after adjustment for measurement errors. The first possibility is that a portion of the samples forming the zero spike of the observed nominal wage change distribution are located further to the left and right of the zero point in the true nominal wage change distribution. In this case, the extent of downward rigidity of the true nominal wage is weaker than that of the observed nominal wage. The other possibility is that a portion of the positive and negative samples in the observed wage change distribution comprises part of the zero spike in the true nominal wage change distribution. In this case, the extent of downward rigidity of the true distribution is stronger than that of the observed distribution.

do not occur. That is, there exists downward nominal wage rigidity. In addition, when the parameter λ is significantly positive, we recognize the nominal wages as downwardly rigid in the sense that the observed negative nominal wage change rates are still ($\lambda \times 100$) percent higher than the notional ones, even when the notional wage change falls below the threshold. On the other hand, when α is not significantly different from zero and λ is not positive and significantly different from zero, we regard the results as evidence of no downward nominal wage rigidity.

2. Models with measurement errors

Next, we consider measurement errors in the reported nominal wages. When the reported nominal wage has a measurement error u_i, the log of the reported nominal wage w_i is expressed by equation (3).

$$w_i = \widetilde{w}_i + u_i. \tag{3}$$

Substituting equation (1) and equation (3) into equation (2), and assuming that the error term ϵ_i and the measurement error u_i both independently follow normal distributions, we can rewrite the model as follows.

$$w_i - w_{i,-1} = \begin{cases} \beta' x_i + \epsilon_i - w_{i,-1} + u_i & \text{if} \quad 0 < \beta' x_i + \epsilon_i - w_{i,-1} + u_{i,-1}, \\ u_i - u_{i,-1} & \text{if} \ -\alpha < \beta' x_i + \epsilon_i - w_{i,-1} + u_{i,-1} \leq 0, \\ \beta' x_i + \epsilon_i - w_{i,-1} + \lambda + u_i & \text{if} \qquad \beta' x_i + \epsilon_i - w_{i,-1} + u_{i,-1} \leq -\alpha, \end{cases}$$

$$(\epsilon_i, u_i)' \overset{i.i.d.}{\sim} N(0, \textstyle\sum), \ \textstyle\sum = \begin{pmatrix} \sigma_\epsilon^2 & 0 \\ 0 & \sigma_u^2 \end{pmatrix}, \ \ i = 1, \ldots, n. \tag{4}$$

We can derive the Tobit model as a special case of this model where nominal wages have perfect downward rigidity by letting α approach infinity.[17]

$$w_i - w_{i,-1} = \begin{cases} \beta' x_i + \epsilon_i - w_{i,-1} + u_i & \text{if} \quad 0 < \beta' x_i + \epsilon_i - w_{i,-1} + u_{i,-1}, \\ u_i - u_{i,-1} & \text{if} \qquad \beta' x_i + \epsilon_i - w_{i,-1} + u_{i,-1}, \leq 0, \end{cases}$$

$$(\epsilon_i, u_i)' \overset{i.i.d.}{\sim} N(0, \textstyle\sum), \ \textstyle\sum = \begin{pmatrix} \sigma_\epsilon^2 & 0 \\ 0 & \sigma_u^2 \end{pmatrix}, \ \ i = 1, \ldots, n. \tag{4'}$$

3. Remarks on the empirical models

It should be noted that there are several caveats when using the above models. First, unobserved heterogeneity may bias the estimates of the coefficients for the x

17. Aside from equation (4) and equation (4′), we also conducted different types of specifications, such as the case where the rate of change differs when the nominal wage is decreased or increased and the case whereby there is some upward rigidity as well. However, we only show the results of equation (4) and equation (4′) in this paper because the estimation results are believed to be the best, and because we try to maintain compatibility with the previous literature.

variables.[18] Since the models are nonlinear, however, it is difficult to apply standard methods applicable to the fixed effect models or the random effect models.[19] Second, in the above models the prior year's nominal wage $w_{i,-1}$ is assumed to be non-stochastic. If it is an endogenous variable, however, we should consider the endogeneity of $w_{i,-1}$, and therefore estimate $w_{i,-1}$ using instrumental variables. Since we cannot find appropriate instrumental variables, we are unable to do so.[20] Third, while we do consider the measurement errors in nominal wages, we do not consider the measurement errors in explanatory variables x_i.[21] Properly speaking, we should use instrumental variables to omit the bias arising from measurement errors in explanatory variables. But here again we are unable to find appropriate instrumental variables, and thus we do not consider the measurement errors in explanatory variables x_i.

C. Estimation Method

In estimating the friction and Tobit models, we use the simulated maximum likelihood (SML) to incorporate measurement errors.[22] Since the models have two random variables, the error term ϵ_i and the measurement error term u_i, the likelihood function becomes complex, and thus it is difficult to estimate the models via the usual ML.

In this paper, instead of deriving the likelihood function from equation (4) and (4′) with the probability density functions of random variables ϵ_i and u_i, we compute the likelihood function based on the simulated measurement error u_i^m that follows $N(0, \sigma_u^2)$. Although the measurement error u_i is not observable, the simulated one u_i^m is observable just like the other variables (such as w_i and x_i). Therefore, we can reduce the number of random variables in the likelihood function if we treat u_i^m as an observed variable instead of incorporating u_i in the likelihood function. This makes the calculation of the likelihood function less complicated. Then, by seeking the parameters (α, β, λ, σ_ϵ, σ_u) that yield the largest simulated likelihood, we obtain

18. In our models, the unobservable heterogeneity for each sample (such as individual abilities and the detailed characteristics of the firms where the individuals are employed) is all incorporated in the error term. Therefore, if these omitted variables have a correlation with the explanatory variable x_i, we fail to obtain consistent estimates. Moreover, because the data set contains multiple observations for the same individuals, it is likely that the assumption that the variance-covariance matrix is independent and identically distributed (*i.i.d.*) no longer holds. In this case, the efficiency of the estimates declines.
19. It is possible to consider the random effects using the simulated maximum likelihood (SML) estimation presented in Lerman and Manski (1981) or the method of simulated moment (MSM) presented in McFadden (1989). Regardless, as explained below in Section III.C, we do not adopt these methods to consider the random effects because we apply the SML to estimate the models considering measurement errors.
20. Altonji and Devereux (1999) replace $w_{i,-1}$ with its conditional expectation given lagged values of x_i (such as $x_{i,-1}$ and $x_{i,-2}$). In this paper, we do not follow this technique because these lagged values have a high correlation not only with the prior wages ($w_{i,-1}$) but also with the current period's wages (w_i).
21. For example, since the years of education can be regarded as a proxy variable for each individual's human capital, this variable contains some measurement errors. In this case, one may lose consistency because the years of education may be correlated with the error term via measurement errors. In such a case, appropriate instrumental variables, which have a correlation with the true value (e.g., human capital) and no correlation with the measurement errors (e.g., the difference between the years of education and human capital), can be used to remove the bias. For discussions on the consistency and the measurement errors when using proxy variables, see Wickens (1972), for example.
22. See Gouriéroux and Monfort (1996) and Mariano *et al.* (2000) for detailed explanations of the SML.

the SML estimates for those parameters. See Appendix 1 for details regarding the estimation method using the SML.

It is important to note that the large zero spikes in the nominal wage change distributions are not consistent with models where the measurement error follows a normal distribution like equation (4).[23,24] To address this point, we specify that u_i is equal to zero with probability p and equal to a random variable u_i^m generated from $N(0, \sigma_u^2)$ with probability $(1-p)$. In other words, we assume that p percent of the samples do not have the measurement errors, and that the remaining $(1-p)$ percent of the samples do.

IV. Estimation Results and Interpretation

We now estimate the friction and Tobit models for five types of nominal wages: (1) the regular monthly salaries of full-time male employees; (2) the annual earnings of full-time male employees; (3) the regular monthly salaries of full-time female employees; (4) the annual earnings of full-time female employees; and (5) the hourly wages of part-time female employees.

The vector of the explanatory variables, x_i, includes the following variables: a constant; age; tenure; tenure squared; labor market experience; labor market experience squared; years of education; 13 big cities dummy (a value of one for those who live in Japan's 13 biggest cities and a value of zero for those who live elsewhere); firm size dummies (indicating the number of employees at the company where the individual is employed, assuming those with 1,000 or more employees as the base); industry dummies (variable based on the industry that the company where the individual is employed belongs to, assuming the service industry as the base); occupational dummies (assuming laborer as the base); year dummies (assuming 1997 as the base); current profit to sales ratio (by industry and employee scale); the price level by prefecture of residence (consumer price index [CPI], overall); and the unemployment rate by region of residence and sex.[25,26] The descriptive statistics for all of these variables are presented in Table 1.

23. This point was also noted in Altonji and Devereux (1999) and Fehr and Götte (2000).

24. Since u_i is normally distributed in our models, it implies that $u_i - u_{i,-1}$ is also normally distributed. This is inconsistent with the fact pointed out in Kuroda and Yamamoto (2003a) that about 10 to 40 percent of all the samples show a nominal wage change rate of zero. If all the samples have a measurement error u_i that follows a normal distribution with positive variance, then the probability of zero nominal wage change should be zero.

25. The age variable is included for x_i to account for the annual wage accrual (*teisho*), which is a distinctive characteristic of Japan's employment practices.

26. The current profit to sales ratio is sourced from the *Tankan Short-Term Economic Survey of Enterprises in Japan* (Bank of Japan), except for data on firms in the financial and insurance industries, which are sourced from the *Financial Statements of Japanese Banks* (Bank of Japan) by dividing the current profit by the current earnings. The CPI is sourced from *Consumer Price Index Annual* (Ministry of Public Management, Home Affairs, Posts and Telecommunications) and adjusted for the April 1997 consumption tax increase. The unemployment rate is sourced from the *Labour Force Survey* (Ministry of Public Management, Home Affairs, Posts and Telecommunications).

Table 1 Descriptive Statistics (Means and Standard Errors)

	Male employees		Female employees		
	Full-time		Full-time		Part-time
	Regular monthly salaries	Annual earnings	Regular monthly salaries	Annual earnings	Hourly wages
Nominal wage change (percent)	2.83 (15.00)	3.23 (15.82)	4.05 (14.28)	3.21 (18.58)	2.02 (6.72)
1994	— —	— —	6.49 (13.61)	4.33 (18.42)	2.72 (7.74)
1995	2.53 (15.52)	3.19 (17.61)	3.80 (14.41)	2.57 (17.70)	2.18 (6.67)
1996	5.04 (16.01)	3.83 (15.27)	1.78 (12.45)	4.71 (19.75)	2.35 (6.75)
1997	2.92 (14.83)	2.69 (14.50)	3.18 (11.20)	0.65 (18.59)	1.97 (5.79)
1998	1.04 (13.60)	— —	2.66 (17.52)	— —	1.44 (6.91)
Nominal wage level (¥1,000)	361.2 (125.5)	5,675.4 (2,019.8)	215.6 (60.2)	3,466.9 (1,081.1)	0.86 (0.32)
Age (years)	36.17 (5.13)	35.45 (4.78)	30.45 (3.76)	30.25 (3.46)	33.19 (3.63)
Tenure (years)	11.97 (6.81)	11.78 (6.38)	7.36 (4.21)	7.37 (4.22)	3.16 (2.65)
Labor market experience (years)	15.75 (5.62)	15.07 (5.30)	10.26 (4.05)	10.07 (3.85)	10.41 (3.64)
Years of education (years)	14.00 (1.99)	14.02 (1.99)	13.58 (1.43)	13.58 (1.51)	12.82 (1.31)
13 big cities dummy	0.20 (0.40)	0.22 (0.42)	0.28 (0.45)	0.30 (0.46)	0.21 (0.41)
Firm size dummy					
29 or less	0.28 (0.45)	0.20 (0.40)	0.29 (0.45)	0.23 (0.42)	0.47 (0.50)
30 to 99	0.17 (0.38)	0.16 (0.37)	0.17 (0.38)	0.16 (0.36)	0.17 (0.38)
100 to 999	0.31 (0.46)	0.35 (0.48)	0.31 (0.46)	0.32 (0.47)	0.22 (0.42)
Industry dummy					
Construction	0.12 (0.33)	0.11 (0.32)	0.11 (0.31)	0.08 (0.28)	0.02 (0.13)
Manufacturing	0.29 (0.45)	0.32 (0.47)	0.18 (0.38)	0.19 (0.39)	0.17 (0.38)
Wholesaling or retailing	0.23 (0.42)	0.21 (0.41)	0.18 (0.38)	0.17 (0.37)	0.42 (0.49)
Finance, insurance, or real estate	0.08 (0.28)	0.09 (0.28)	0.14 (0.35)	0.17 (0.38)	0.04 (0.20)
Transportation or telecommunications	0.08 (0.28)	0.09 (0.28)	0.02 (0.15)	0.03 (0.17)	0.03 (0.16)
Occupation dummy					
Manager	0.06 (0.24)	0.04 (0.20)	— —	0.00 (0.06)	— —
Expert, engineer, or teacher	0.20 (0.40)	0.19 (0.39)	0.23 (0.42)	0.22 (0.41)	0.09 (0.29)
Clerical worker	0.34 (0.47)	0.35 (0.48)	0.59 (0.49)	0.59 (0.49)	0.28 (0.45)
Sales or service worker	0.14 (0.35)	0.13 (0.34)	0.11 (0.31)	0.11 (0.32)	0.39 (0.49)
Year dummy					
1994	— —	— —	0.32 (0.47)	0.32 (0.47)	0.15 (0.35)
1995	0.23 (0.42)	0.33 (0.47)	0.18 (0.39)	0.27 (0.45)	0.17 (0.37)
1996	0.24 (0.43)	0.33 (0.47)	0.14 (0.35)	0.21 (0.41)	0.16 (0.37)
1998	0.28 (0.43)	— —	0.21 (0.35)	— —	0.30 (0.42)
Current profit to sales ratio	0.82 (6.83)	1.55 (3.57)	0.59 (7.54)	1.26 (3.94)	0.90 (5.94)
CPI by prefecture	104.41 (4.19)	104.44 (4.17)	104.37 (4.42)	104.51 (4.53)	104.25 (4.16)
Unemployment rate by region and sex	4.26 (0.89)	3.93 (0.67)	3.97 (0.91)	4.11 (0.71)	4.43 (0.91)
Number of samples	735	1,384	557	804	436

Notes: 1. Figures inside parentheses are standard errors. Nominal wage change is log difference between the current and the prior year.
2. The base of firm size dummy is 1,000 or more employees, that of industry dummy is service, that of occupation dummy is laborer, and that of year dummy is 1997.

A. Estimation Results

Table 2 presents the estimation results for the five types of nominal wages under the friction and Tobit models. In Table 2, we show the results that had the largest log likelihood among the five patterns of the percentage of the measurement errors in each model (p = 1.0, 0.8, 0.6, 0.4, 0.2).[27] The shaded columns on each type of nominal wage in this table denote the larger log likelihood between the friction and the Tobit model.[28] The whole estimation results are summarized in Appendix Tables 1 and 2.

As shown in Table 2, the Tobit model is chosen for the hourly wages of part-time female employees and the friction model for all other cases. In the friction model, the estimated threshold value α is positive and statistically significant in all cases. These results indicate that the hourly wages of part-time female employees have almost perfectly downward rigidity, and that both the regular monthly salaries and the annual earnings for full-time males and females have partial downward rigidity.

The estimated threshold value α is 0.077 for the regular monthly salaries of full-time males, 0.035 for their annual earnings, 0.040 for the regular monthly salaries of full-time females, and 0.035 for their annual earnings. This indicates that the threshold of the downward rigidity of regular monthly salaries is –7.7 percent for males and –4.0 percent for females, and that of the annual earnings is around –3.5 percent for both males and females.[29] Most of the estimated parameters for λ are negative, although their significance is statistically low in some cases. This result suggests that when the notional wage changes exceed the threshold values, the nominal wages will decrease by more than the amount that would be expected based on the notional wage.[30]

Next, we take a look at the percentage of the samples to which measurement errors were attributed. Table 2 shows p = 0.2 for the regular monthly salaries and annual earnings of both male and female full-time employees, and p = 0.8 for the hourly wages of part-time female employees. These results suggest that 80 percent of the sample for full-time employees and 20 percent of the sample for part-time female employees have some measurement error. However, the size of the measurement errors themselves is relatively small. The measurement errors only comprise 0.1 percent of the variance of total nominal wage changes for the regular monthly salaries of full-time males, and at most 5.9 percent for the annual earnings of full-time females.[31]

27. Properly speaking, the percentage of samples with no measurement errors, p, should be estimated. However, when we include p in the likelihood function as a parameter, the estimation does not converge. Thus, we estimate several models with different p's (0.2, 0.4, 0.6, 0.8, 1.0) and choose the one with the largest log likelihood. When doing so, we also check the significance of the estimated standard deviation of the measurement errors σ_u.
28. The likelihood ratio test also chooses the shaded columns.
29. It is important to note that the downward rigidity in the annual earnings may reflect not only changes in regular monthly salaries and bonuses but also quantitative adjustments in overtime working hours. In any event, the smaller downward rigidity in annual earnings compared with regular monthly salaries is consistent with the Japanese labor market characteristics whereby labor costs can be flexibly adjusted via adjustments in bonuses and overtime working hours.
30. The "probability of wage cuts" and "probability of wage freezes" presented at the bottom of Table 2 and Appendix Tables 1 and 2 are sample mean values of the probabilities calculated for all the individuals, based on the estimation results.
31. Following Altonji and Devereux (1999), the variance of the changes in the measurement errors $u_i - u_{i,-1}$ is calculated as $Var(u_i - u_{i,-1}) = 2(1-p)\sigma_u^2$.

Table 2 Estimation Results

[1] Full-Time Male Employees

	Regular monthly salaries		Annual earnings	
	Friction model	Tobit model	Friction model	Tobit model
	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)
Constant	2.466 (10.65)	2.756 (14.51)	5.498 (97.96)	5.800 (126.07)
Age	0.028 (6.40)	0.022 (3.89)	0.014 (4.07)	0.013 (3.01)
Tenure	0.005 (1.04)	0.009 (1.64)	–0.003 (–0.83)	0.008 (1.74)
Tenure squared	–0.000 (–0.78)	–0.000 (–1.86)	0.000 (0.47)	–0.000 (–0.90)
Labor market experience	0.018 (3.13)	0.025 (2.77)	0.037 (5.63)	0.031 (3.69)
Labor market experience squared	–0.001 (–4.39)	–0.001 (–3.25)	–0.001 (–5.37)	–0.001 (–3.69)
Years of education	0.021 (3.25)	0.026 (3.11)	0.025 (4.77)	0.033 (5.32)
13 big cities dummy	–0.077 (–3.26)	–0.041 (–1.41)	–0.017 (–0.99)	–0.016 (–0.80)
Firm size dummy				
29 or less employees	–0.140 (–5.22)	–0.150 (–4.54)	–0.288 (–12.83)	–0.328 (–12.19)
30 to 99 employees	–0.152 (–5.27)	–0.177 (–4.90)	–0.262 (–11.49)	–0.301 (–10.65)
100 to 999 employees	–0.148 (–6.23)	–0.173 (–5.82)	–0.200 (–11.17)	–0.219 (–10.43)
Industry dummy				
Construction	–0.021 (–0.66)	–0.051 (–1.30)	0.027 (1.02)	0.013 (0.40)
Manufacturing	–0.034 (–1.31)	–0.059 (–1.83)	–0.035 (–1.69)	–0.038 (–1.59)
Wholesaling or retailing	0.043 (1.49)	–0.022 (–0.62)	–0.030 (–1.27)	–0.037 (–1.29)
Finance, insurance, or real estate	0.044 (0.89)	0.002 (0.03)	0.097 (2.08)	0.051 (0.91)
Transportation or telecommunications	0.037 (0.97)	–0.078 (–1.55)	–0.086 (–2.90)	–0.076 (–2.03)
Occupation dummy				
Manager	0.327 (7.83)	0.317 (6.03)	0.273 (7.31)	0.267 (6.08)
Expert, engineer, or teacher	0.068 (2.27)	0.048 (1.34)	0.143 (6.41)	0.098 (3.84)
Clerical worker	0.001 (0.03)	0.008 (0.25)	0.109 (5.20)	0.048 (1.92)
Sales or service worker	–0.097 (–2.87)	–0.055 (–1.33)	–0.013 (–0.47)	–0.045 (–1.40)
Year dummy				
1995	0.004 (0.16)	–0.049 (–1.61)	–0.052 (–3.03)	–0.016 (–0.79)
1996	0.020 (0.84)	–0.002 (–0.08)	0.004 (0.25)	0.013 (0.63)
1998	–0.021 (–0.78)	–0.026 (–0.79)	— —	— —
Current profit to sales ratio	–0.002 (–1.20)	–0.001 (–0.40)	0.003 (0.75)	–0.002 (–0.48)
CPI by prefecture	0.021 (8.89)	0.017 (7.52)	0.021 (16.49)	0.017 (13.04)
Unemployment rate by region and sex	–0.029 (–2.50)	–0.007 (–0.48)	–0.032 (–2.94)	–0.030 (–2.38)
α	0.077 (4.87)	∞ —	0.035 (5.97)	∞ —
λ	–0.029 (–1.43)	— —	–0.027 (–1.70)	— —
σ_ϵ	0.227 (110.14)	0.205 (93.70)	0.250 (396.62)	0.205 (110.59)
σ_u	0.012 (9.06)	0.118 (32.35)	0.018 (13.68)	0.141 (29.79)
p	0.200	0.800	0.200	0.800
Number of samples	735	735	1,384	1,384
Log likelihood	–19.655	–140.605	–154.756	–295.475
Probability of wage cuts (percent)	35.7	0.0	41.4	0.0
Probability of wage freezes (percent)	9.5	50.8	4.0	51.2

Note: The base of firm size dummy is 1,000 or more employees, that of industry dummy is service, that of occupation dummy is laborer, and that of year dummy is 1997.

Table 2 (continued)

[2] Full-Time Female Employees

	Regular monthly salaries				Annual earnings			
	Friction model		Tobit model		Friction model		Tobit model	
	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	3.490	(49.20)	3.185	(42.48)	5.559	(79.73)	5.497	(96.19)
Age	0.002	(0.39)	0.005	(1.09)	–0.002	(–0.42)	–0.001	(–0.14)
Tenure	0.030	(3.60)	0.021	(2.33)	0.023	(2.72)	0.034	(3.34)
Tenure squared	–0.001	(–1.90)	–0.000	(–0.68)	–0.000	(–0.40)	–0.001	(–1.38)
Labor market experience	0.010	(0.82)	0.025	(1.92)	–0.010	(–0.79)	–0.003	(–0.22)
Labor market experience squared	0.000	(0.35)	–0.001	(–1.60)	0.001	(1.48)	0.000	(0.81)
Years of education	0.059	(7.19)	0.058	(6.39)	0.059	(7.64)	0.050	(5.88)
13 big cities dummy	0.061	(2.69)	0.049	(1.96)	–0.041	(–1.89)	–0.038	(–1.48)
Firm size dummy								
29 or less employees	–0.114	(–4.03)	–0.095	(–3.10)	–0.299	(–10.72)	–0.295	(–8.77)
30 to 99 employees	–0.028	(–0.88)	–0.026	(–0.77)	–0.161	(–5.20)	–0.142	(–3.92)
100 to 999 employees	–0.027	(–1.02)	–0.048	(–1.69)	–0.131	(–5.37)	–0.128	(–4.41)
Industry dummy								
Construction	–0.034	(–1.00)	–0.058	(–1.53)	–0.067	(–1.85)	–0.082	(–1.93)
Manufacturing	–0.071	(–2.33)	–0.062	(–1.89)	–0.188	(–6.58)	–0.105	(–3.07)
Wholesaling or retailing	–0.005	(–0.17)	–0.006	(–0.18)	–0.012	(–0.40)	0.047	(1.31)
Finance, insurance, or real estate	0.101	(2.60)	0.086	(2.03)	0.004	(0.10)	0.087	(1.93)
Transportation or telecommunications	–0.044	(–0.68)	–0.060	(–0.88)	–0.122	(–2.17)	–0.125	(–1.84)
Occupation dummy								
Manager	—	—	—	—	–0.375	(–2.50)	–0.095	(–0.27)
Expert, engineer, or teacher	0.072	(1.59)	0.068	(1.37)	0.072	(1.73)	0.226	(4.16)
Clerical worker	0.000	(0.01)	0.000	(0.01)	–0.011	(–0.29)	0.127	(2.56)
Sales or service worker	0.037	(0.74)	–0.039	(–0.70)	–0.110	(–2.38)	–0.045	(–0.75)
Year dummy								
1994	–0.004	(–0.13)	0.037	(1.13)	–0.034	(–1.17)	–0.012	(–0.36)
1995	0.022	(0.68)	0.048	(1.38)	–0.009	(–0.32)	–0.006	(–0.18)
1996	–0.027	(–0.82)	–0.033	(–0.89)	0.050	(1.70)	0.016	(0.47)
1998	–0.078	(–2.26)	–0.046	(–1.21)	—	—	—	—
Current profit to sales ratio	0.003	(2.05)	0.003	(1.55)	–0.000	(–0.04)	0.005	(1.14)
CPI by prefecture	0.006	(3.18)	0.007	(3.32)	0.018	(9.22)	0.016	(7.59)
Unemployment rate by region and sex	0.025	(1.69)	0.043	(2.63)	–0.004	(–0.28)	0.022	(1.17)
α	0.040	(3.41)	∞	—	0.035	(4.05)	∞	—
λ	–0.031	(–1.74)	—	—	–0.022	(–1.05)	—	—
σ_ϵ	0.206	(169.01)	0.207	(388.17)	0.247	(343.96)	0.206	(68.73)
σ_u	0.020	(2.01)	0.010	(10.77)	0.013	(2.24)	0.141	(37.92)
p	0.200		0.600		0.200		0.800	
Number of samples	557		557		804		804	
Log likelihood	47.333		–41.419		–71.481		–167.892	
Probability of wage cuts (percent)	37.1		0.0		42.4		0.0	
Probability of wage freezes (percent)	5.4		48.6		4.1		48.6	

(Continued on next page)

Table 2 (continued)

[3] Part-Time Female Employees

	Hourly wages			
	Friction model		Tobit model	
	Coeff.	(t-value)	Coeff.	(t-value)
Constant	–2.612	(–9.56)	–2.910	(–14.09)
Age	–0.003	(–1.15)	–0.005	(–1.70)
Tenure	–0.037	(–3.61)	–0.018	(–1.93)
Tenure squared	0.003	(3.55)	0.002	(2.08)
Labor market experience	0.010	(0.90)	0.017	(1.52)
Labor market experience squared	–0.000	(–0.44)	–0.000	(–0.13)
Years of education	0.038	(5.42)	0.040	(5.49)
13 big cities dummy	0.043	(1.54)	0.045	(1.67)
Firm size dummy				
29 or less employees	–0.120	(–3.87)	–0.104	(–3.53)
30 to 99 employees	–0.097	(–2.66)	–0.117	(–3.33)
100 to 999 employees	–0.124	(–3.68)	–0.115	(–3.61)
Industry dummy				
Construction	0.374	(5.06)	0.353	(4.80)
Manufacturing	–0.082	(–2.51)	–0.082	(–2.55)
Wholesaling or retailing	–0.070	(–2.63)	–0.106	(–4.10)
Finance, insurance, or real estate	–0.070	(–0.90)	–0.109	(–1.42)
Transportation or telecommunications	0.032	(0.52)	–0.065	(–1.03)
Occupation dummy				
Expert, engineer, or teacher	0.266	(6.11)	0.159	(3.42)
Clerical worker	–0.014	(–0.45)	0.046	(1.49)
Sales or service worker	–0.066	(–2.03)	0.044	(1.36)
Year dummy				
1994	–0.024	(–0.72)	–0.019	(–0.59)
1995	0.071	(2.28)	0.040	(1.34)
1996	0.023	(0.75)	0.017	(0.58)
1998	0.039	(1.28)	–0.057	(–1.84)
Current profit to sales ratio	0.000	(0.02)	0.000	(0.01)
CPI by prefecture	0.020	(6.41)	0.021	(7.54)
Unemployment rate by region and sex	0.002	(0.10)	0.031	(2.07)
α	0.034	(6.13)	∞	—
λ	0.017	(0.38)	—	—
σ_ϵ	0.188	(23.50)	0.158	(71.05)
σ_u	0.051	(1.10)	0.034	(12.73)
p	0.200		0.800	
Number of samples	436		436	
Log likelihood	–34.619		0.976	
Probability of wage cuts (percent)	40.7		0.0	
Probability of wage freezes (percent)	5.2		51.7	

Note: The base of firm size dummy is 1,000 or more employees, that of industry dummy is service, that of occupation dummy is laborer, and that of year dummy is 1997.

In Appendix Tables 1 and 2, we see that most of the estimated thresholds α with measurement errors are smaller than the ones without measurement errors. Therefore, if we view the result with no measurement errors as a maximum estimate of α, the possible range of α can be considered 4.2 to 11.9 percent for the regular monthly salaries of full-time males, 3.5 to 9.6 percent for their annual earnings, 3.4 to 9.7 percent for regular monthly salaries of full-time females, and 3.5 to 15.2 percent for their annual earnings.

Figure 2 summarizes the relation between the notional wage change rate (on the horizontal axis) and the observed nominal wage change rate (on the vertical axis) based on the estimates for α and λ. The thin 45° line on each graph indicates where these two have the same values. When the notional wage change rate is positive, the notional and observed nominal wage change rates are assumed to be equal. When the notional wage change rate is less than zero, the observed nominal change rate becomes zero, turns flat, and deviates from the thin 45° line.

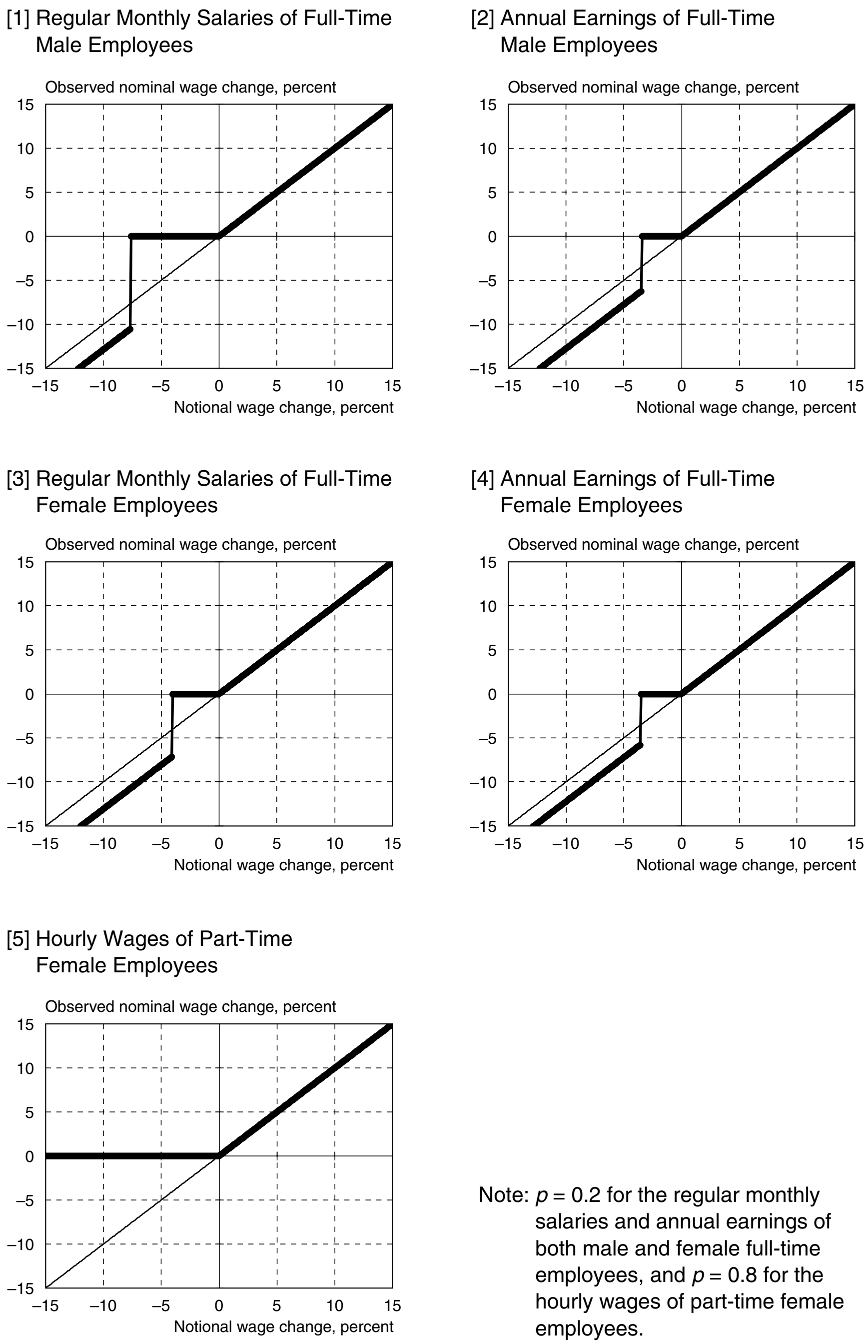
For the hourly wages of part-time female employees, for which the Tobit model was chosen, the nominal wage change rate remains at zero as long as the notional wage change rate remains non-positive, illustrating perfect downward nominal wage rigidity.

For the regular monthly wages of full-time male and female employees, for which the friction model was chosen, as long as the notional wages do not decline by more than about 7.7 percent and 4.0 percent, respectively, nominal wage cuts do not occur. In other words, the downward nominal wage rigidity for these wages exists within this range (–7.7 to zero percent and –4.0 to zero percent, respectively). However, when the notional wage change rate falls below this –7.7 percent threshold, nominal wage cuts occur. Moreover, these nominal wage cuts tend to be greater than those indicated by the decline in the notional wage, since the estimated λ are negative. As for annual earnings for both males and females, downward nominal wage rigidity is observed within a notional wage change rate from –3.5 to zero percent. Beyond that level, the nominal wages are cut by a greater degree than that indicated by the decline in the notional wages.

Finally, we confirm whether or not the extent of downward nominal wage rigidity α changes in response to changes in the inflation rate. Even when there is downward nominal wage rigidity, it may be viewed as a temporary phenomenon if its extent weakens as the inflation rate decreases. To check this possibility, we assume that the threshold value is a linear function of the rate of inflation, as $-(\alpha + \alpha'\pi)$ where π is the inflation rate. Then, we estimate the friction model to see whether the threshold values for the regular monthly salaries and annual earnings of full-time males change depending on the inflation rate π.[32]

32. For the inflation rate, we use the CPI by prefecture (adjusted for the April 1997 increase in the consumption tax rate). Also, we use $p = 0.2$ for the percentage of samples with no measurement error.

Figure 2 Relation between the Notional Wage Change and the Observed Nominal Wage Change



Note: $p = 0.2$ for the regular monthly salaries and annual earnings of both male and female full-time employees, and $p = 0.8$ for the hourly wages of part-time female employees.

The results are shown in Table 3. Table 3 shows no statistical significance for any of the estimated parameter values of α'. This indicates that the threshold values for the regular monthly salaries and annual earnings do not change along with the

Table 3 Estimation Results: Test for the Threshold Value α

	Regular monthly salaries of full-time male employees		Annual earnings of full-time male employees	
	Coeff.	(*t*-value)	Coeff.	(*t*-value)
Constant	2.732	(13.43)	6.156	(171.92)
Age	0.032	(7.20)	0.007	(1.99)
Tenure	0.023	(5.29)	–0.000	(–0.04)
Tenure squared	–0.001	(–4.90)	0.000	(1.65)
Labor market experience	0.003	(0.49)	0.032	(4.92)
Labor market experience squared	–0.000	(–2.03)	–0.001	(–4.51)
Years of education	0.006	(0.85)	0.030	(5.79)
13 big cities dummy	0.015	(0.63)	–0.047	(–2.78)
Firm size dummy				
29 or less employees	–0.144	(–5.34)	–0.293	(–13.27)
30 to 99 employees	–0.139	(–4.78)	–0.270	(–12.03)
100 to 999 employees	–0.144	(–5.99)	–0.200	(–11.39)
Industry dummy				
Construction	–0.039	(–1.24)	–0.003	(–0.12)
Manufacturing	–0.047	(–1.79)	–0.110	(–5.45)
Wholesaling or retailing	–0.000	(–0.00)	–0.006	(–0.28)
Finance, insurance, or real estate	–0.009	(–0.17)	0.029	(0.63)
Transportation or telecommunications	–0.065	(–1.70)	–0.127	(–4.39)
Occupation dummy				
Manager	0.349	(8.30)	0.311	(8.46)
Expert, engineer, or teacher	0.027	(0.91)	0.125	(5.70)
Clerical worker	0.001	(0.05)	0.067	(3.22)
Sales or service worker	–0.087	(–2.57)	–0.102	(–3.85)
Year dummy				
1995	–0.014	(–0.55)	–0.016	(–0.97)
1996	–0.008	(–0.32)	0.032	(1.83)
1998	–0.058	(–2.16)	—	—
Current profit to sales ratio	–0.003	(–1.61)	–0.003	(–0.76)
CPI by prefecture	0.019	(8.66)	0.016	(14.10)
Unemployment rate by region and sex	–0.013	(–1.09)	–0.001	(–0.07)
α	0.023	(4.47)	0.034	(5.81)
α'	0.007	(0.71)	0.006	(0.56)
λ	–0.030	(–1.52)	–0.033	(–2.07)
σ_ϵ	0.228	(133.13)	0.245	(536.69)
σ_u	0.000	(0.00)	0.017	(8.34)
Number of samples	735		1,384	
Log likelihood	–47.985		–151.626	
Probability of wage cuts (percent)	41.7		41.2	
Probability of wage freezes (percent)	3.1		4.1	

Notes: 1. The measurement error considered is (p = 0.2).
2. The base of firm size dummy is 1,000 or more employees, that of industry dummy is service, that of occupation dummy is laborer, and that of year dummy is 1997.

inflation rate. Thus, we confirm that the extent of the downward nominal wage rigidity obtained in this section does not change, at least for the period examined in this paper.[33,34]

B. Interpreting the Estimation Results

From the above results, we find that nominal wages for the regular monthly salaries and annual earnings of full-time male and female employees are partially downwardly rigid.[35] The estimated friction model with measurement errors indicates that the regular monthly wages of full-time male and female employees remain unchanged as long as the notional wage change rates range from –7.7 to zero percent, and –4.0 to zero percent, respectively. The annual earnings of full-time males and females remain unchanged as long as the notional wage change rates range from –3.5 to zero percent.

How should we interpret these results? Should the estimated extent of the downward rigidity for the regular monthly salaries of full-time males (–7.7 to zero percent) be considered "large"? These nominal wages can be taken as "rigid" inasmuch as they will not actually be cut unless the notional wages decrease by more than 7.7 percent. On the contrary, one may also consider them "flexible" since they will indeed be cut once the notional wage falls by more than 7.7 percent. Similarly, how should we interpret the downward rigidity of the regular monthly salaries for full-time females, which will not be cut unless the notional wage falls by more than 4.0 percent? It is difficult to make any generalized judgments regarding whether the estimated extent of the downward nominal wage rigidity is "large" or "small." Thus, it is instructive to compare our evidence with that found in the previous literature.

Estimating the same type of friction models with 1971–92 U.S. data, Altonji and Devereux (1999) show that U.S. nominal wage cuts do not occur unless the notional wages decrease by more than 65.4 percent.[36] The threshold value of 65.4 percent far exceeds the results obtained in this paper. Such a direct comparison, however, demands caution since the prevailing economic conditions during the estimation periods in their paper differ from ours. For example, the U.S. inflation rate was relatively high throughout the estimation period covered in their paper. Under such circumstances, the nominal wages, on average, must have grown at a relatively high rate as well. Under those conditions, the downward nominal wage rigidity may not have been binding on the nominal wage setting. If so, their findings may not accurately represent the extent of downward nominal wage rigidity in the United States.[37]

33. Throughout this analysis period, the inflation rate remained within a low and narrow range from –1.17 to 2.19 percent. Therefore, we cannot deny the possibility that the threshold value α might change under an inflation rate outside of this range. Kuroda and Yamamoto (2003a) examine the correlations between the skewness coefficients of nominal wage change distributions and the regional inflation rates. In that paper, we regard the threshold α as a structural parameter, and examine whether the skewness coefficients of the nominal wage change distributions would vary in response to changes in the inflation rate. In contrast, the analysis here considers the possibility that the threshold α may change during periods of low inflation. Therefore, the findings here do not contradict those in Kuroda and Yamamoto (2003a).
34. In Appendix 2, we report the estimates of β.
35. The partial downward rigidity can be interpreted as indicating that nominal wage cuts will not occur as long as negative shocks are small, but will occur when such shocks are more substantial.
36. Altonji and Devereux (1999) estimate the extent of downward nominal wage rigidity by various types of models. The estimation result presented here for comparison is the one estimated from the model closest to ours.
37. It is also important to note that the definitions of nominal wages must be comparable when comparing the results between different countries. The nominal wage used in Altonji and Devereux (1999) is the hourly wage

On the other hand, the analyses of Fehr and Götte (2000) using 1991–98 Swiss data cover a period of relatively low inflation, at around zero to 4.7 percent, and their definition of the nominal wage is basically the same as the annual earnings of full-time employees considered in this paper.[38] Therefore, it is useful to compare the estimation results in Fehr and Götte (2000) with those here. They estimate that the threshold value is around 30 percent. Compared with the findings here, this suggests that the extent of downward nominal wage rigidity is considerably smaller in Japan than it is in Switzerland.

Another way of evaluating the importance of downward nominal wage rigidity is to quantify its influence on the economy. Downward nominal wage rigidity may influence various macroeconomic variables such as unemployment, consumption, and income. Accordingly, assessing the effects of the estimated downward nominal wage rigidity on the economy would provide another yardstick for making quantitative interpretations of our findings in this paper, but this approach will have to remain as an issue for future research.[39]

V. Summary and Concluding Remarks

Are Japanese nominal wages downwardly rigid? And if so, to what extent? To answer these questions, we use 1993–98 longitudinal data from the JPSC, and analyze the nature of Japanese nominal wage by estimating the friction models employed in Altonji and Devereux (1999) and Fehr and Götte (2000).

According to our findings, the answer to the first question is yes—Japan does have downward nominal wage rigidity. This conclusion is consistent with that reached in Kuroda and Yamamoto (2003a), which identifies the downward rigidity based on examinations of the shape of the nominal wage change distributions. This paper confirms that the downward nominal wage rigidity does exist even after we take into account the individual characteristics and the measurement errors in reported nominal wages.[40]

rate. We assume that both full-time and part-time workers could receive wages on an hourly wage basis in the United States. Alternatively, hourly wages in Japan are only common for part-time workers, who are mostly females in the secondary market. Thus, a simple comparison between our estimation results and those in Altonji and Devereux (1999) may not be appropriate.

38. It should be noted that the data used in Fehr and Götte (2000) has wide-ranging coverage, and includes far more elderly samples than the data used in this paper. They also estimate the nominal wage rigidities for part-time workers, and suggest that the downward rigidity of part-time workers' wages is somewhat smaller than that of full-time workers.
39. Kuroda and Yamamoto (2003b) examine whether downward nominal wage rigidities affect employees' quit decisions using survival analysis. In addition, Kuroda and Yamamoto (2003c) simulate a New-Keynesian macro model that incorporates downward rigidity, and see how the downward rigidity affects the male unemployment rate in Japan.
40. As explained in Section II, the data used herein contain a relatively small number of elderly samples. Therefore, it is important to note that the findings here may overestimate the extent of downward nominal wage rigidity if the seniority wage curve became less steep during the prolonged recession in the late 1990s. Kimura and Ueda (2001), however, find more downward nominal wage rigidity among older workers than among younger workers in their analyses using aggregated data.

The answer to the second question—the extent of the downward nominal wage rigidity—depends on the type of nominal wage. While the hourly wages of part-time female employees show almost perfect downward rigidity, the regular monthly salaries and annual earnings of full-time male and female employees show only partial downward rigidity.[41,42] The estimated friction model with measurement errors indicates that the regular monthly wages of full-time male and female employees remain unchanged as long as the notional wage change rates range from –7.7 to zero percent and –4.0 to zero percent, respectively. The annual earnings of full-time males and females remain unchanged as long as the notional wage change rates range from –3.5 to zero percent. Thus, the nominal wages of full-time employees are downwardly rigid within these ranges, but it is still important to note that these nominal wages will be cut when the notional wages decline beyond these ranges.

Before concluding, we make a few cautionary remarks regarding the findings in this paper. This paper examines the existence of downward rigidity in Japanese nominal wages using longitudinal data during a period of extremely low inflation. Although such economic conditions are suitable for examining the existence of downward rigidity, the empirically observed downward wage rigidity could be only nominal, or both nominal and real. This is because the movements of nominal and real wages become more similar under extremely low inflation. In fact, when we prepare a real wage change distribution based on the data in this paper, we find that the shape and location of the real wage change distribution are nearly identical to those of the nominal wage change distribution. Therefore, we cannot exclude the possibility that the estimated downward nominal wage rigidity in this paper reflects downward real wage rigidity.

This distinction between downward nominal wage rigidity and downward real wage rigidity has extremely important implications for monetary policy.[43] For example, let us consider the case where the downward wage rigidity exists on a nominal basis only. Under low inflation, the downward nominal wage rigidity forces firms to freeze nominal wages that would otherwise be cut, effectively locking the firms' labor costs (real wages) at a high level. When the inflation rate is higher, negative real wage changes are easily implemented if firms set their nominal wage growth below the inflation rate. Therefore, when downward wage rigidity exists on a nominal basis only, a monetary policy targeting a small but positive rather than

41. It is important to note that the conclusions reached herein apply only to employees who continue to work for the same companies, and do not suggest any downward rigidity in the nominal wages set for newly hired employees.
42. The different conclusions reached for full-time and part-time employees may reflect what has been termed Japan's "dual labor markets" with a clear segmentation between full-time and part-time employees. Possible reasons for the perfect downward nominal wage rigidity for part-time employees include (1) labor demand factors, (2) labor supply factors, and (3) institutional factors. We need to consider the characteristics of part-time employment, which often requires only general skills. From this, one can understand that (1) firms tend to reduce their labor costs on part-time employees more flexibly through dismissal rather than wage cuts, and (2) part-time employees also tend to move to other firms when wage cuts are offered, because the local external labor markets are well developed. Under these circumstances, nominal wage cuts are difficult to observe. Additionally, as noted by Lebow *et al.* (1995), (3) the minimum wage may also restrict wage flexibility. However, approximately 88 percent of the samples used in this paper have nominal wages at least 10 percent above the minimum wage. This lead us to conclude there is very little possibility that the minimum wage is a main factor causing the perfect downward nominal wage rigidity for the hourly wages of part-time workers.
43. See Kuroda and Yamamoto (2003a) for a detailed discussion of this point.

zero inflation could facilitate real wage adjustments. In contrast, if the observed downward rigidity is due to real wage rigidity, a monetary policy targeting a small but positive inflation would do nothing to facilitate real wage adjustments since the real wage itself is downwardly rigid regardless of the inflation rate.[44]

Therefore, while this paper shows the existence of downward nominal wage rigidity in Japan, one cannot immediately jump to a general conclusion that monetary policy should target a small but positive, rather than zero, inflation. The data used for the analyses herein are all from a period of extremely low inflation, and thus cannot be used to investigate the existence of downward real wage rigidity. Accumulation of additional data and further investigations are essential before we can draw a general conclusion that would support monetary policy targeting a small but positive inflation.

44. As noted by McLaughlin (1999) and Fares and Hogan (2000), the reasons why there may be downward rigidity in real wages include that firms may choose not to reduce real wages as posited by efficiency wage theories, and that the real wage change distribution itself may be skewed due to the skills bias of technological progress.

APPENDIX 1: ESTIMATION METHOD: ESTIMATING FRICTION MODELS USING THE SIMULATED MAXIMUM LIKELIHOOD

This appendix presents the application of the SML to the estimation of friction models.

When the likelihood derived from equation (4) has a measurement error of u_i, it can be expressed as shown in equation (A.1):

$$L_i(\alpha, \beta, \lambda, \sigma_\epsilon, \sigma_u \,|\, w_i, w_{i,-1}, x_i)$$
$$= \int_{-\infty}^{\infty} L_i(\alpha, \beta, \lambda, \sigma_\epsilon \,|\, w_i, w_{i,-1}, x_i, u_i, u_{i,-1}) f(0, \sigma_u^2) du_i \quad i = 1, \ldots, n, \quad \text{(A.1)}$$

where

$$f(y, \sigma^2) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{y^2}{2\sigma^2}\right).$$

Thus, the conditional likelihood on the measurement error of u_i becomes[45]

$$L_i(\alpha, \beta, \lambda, \sigma_\epsilon \,|\, w_i, w_{i,-1}, x_i, u_i, u_{i,-1})$$
$$= f(w_i - \beta' x_i - u_i, \sigma_\epsilon^2)^{J_i^1}$$
$$\bullet \, [F(\alpha + \beta' x_i - w_{i,-1} + u_{i,-1}, \sigma_\epsilon^2) - F(\beta' x_i - w_{i,-1} + u_{i,-1}, \sigma_\epsilon^2)]^{J_i^2}$$
$$\bullet \, f(w_i - \beta' x_i - u_i + \lambda, \sigma_\epsilon^2)^{J_i^3}, \quad \text{(A.2)}$$

where

$$J_i^1 = I(w_i - w_{i,-1} > u_i - u_{i,-1}),$$
$$J_i^2 = I(w_i - w_{i,-1} = u_i - u_{i,-1}),$$
$$J_i^3 = I(w_i - w_{i,-1} < u_i - u_{i,-1}),$$

and

$$F(y, \sigma^2) = \int_{-\infty}^{y} \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{s^2}{2\sigma^2}\right) ds.$$

By substituting equation (A.2) into equation (A.1), and expressing the expected value of the measurement error as E_u, the likelihood can be expressed as shown in equation (A.3).

45. $I(c)$ is an index function which becomes 1 (0) when the condition c is (is not) met.

$$
\begin{aligned}
&L_i(\alpha, \beta, \lambda, \sigma_\epsilon, \sigma_u \,|\, w_i, w_{i,-1}, x_i) \\
&\quad = \int_{-\infty}^{\infty} \Big\{ f(w_i - \beta' x_i - u_i, \sigma_\epsilon^2)^{J_i^1} \\
&\qquad \cdot [F(\alpha + \beta' x_i - w_{i,-1} + u_{i,-1}, \sigma_\epsilon^2) - F(\beta' x_i - w_{i,-1} + u_{i,-1}, \sigma_\epsilon^2)]^{J_i^2} \\
&\qquad\quad \cdot f(w_i - \beta' x_i - u_i + \lambda, \sigma_\epsilon^2)^{J_i^3} \Big\} f(0, \sigma_u^2) du_i \\
&\quad = E_u \Big\{ f(w_i - \beta' x_i - u_i, \sigma_\epsilon^2)^{J_i^1} \\
&\qquad \cdot [F(\alpha + \beta' x_i - w_{i,-1} + u_{i,-1}, \sigma_\epsilon^2) - F(\beta' x_i - w_{i,-1} + u_{i,-1}, \sigma_\epsilon^2)]^{J_i^2} \\
&\qquad\quad \cdot f(w_i - \beta' x_i - u_i + \lambda, \sigma_\epsilon^2)^{J_i^3} \Big\}. \qquad \text{(A.3)}
\end{aligned}
$$

The SML uses the simulated likelihood by generating values for the measurement error u_i through the simulation, and replacing the sample mean with the expectation regarding the measurement error. Using the simulated measurement error u_i^m ($m = 1, \ldots, M$ where M is the number of simulations), equation (A.3) can then be approximated by equation (A.4).

$$
\begin{aligned}
&L_i(\alpha, \beta, \lambda, \sigma_\epsilon, \sigma_u \,|\, w_i, w_{i,-1}, x_i) \\
&\quad \approx \frac{1}{M} \sum_{m=1}^{M} \Big\{ f(w_i - \beta' x_i - u_i^m, \sigma_\epsilon^2)^{J_i^1} \\
&\qquad \cdot [F(\alpha + \beta' x_i - w_{i,-1} + u_{i,-1}^m, \sigma_\epsilon^2) - F(\beta' x_i - w_{i,-1} + u_{i,-1}^m, \sigma_\epsilon^2)]^{J_i^2} \\
&\qquad\quad \cdot f(w_i - \beta' x_i - u_i^m + \lambda, \sigma_\epsilon^2)^{J_i^3} \Big\}. \qquad \text{(A.4)}
\end{aligned}
$$

Hence, with the individual data ($i = 1, \ldots, n$), the simulated likelihood function becomes as shown in equation (A.5).

$$
\begin{aligned}
&L^m(\alpha, \beta, \lambda, \sigma_\epsilon, \sigma_u \,|\, w_i, w_{i,-1}, x_i) \\
&\quad = \prod_{i=1}^{n} \frac{1}{M} \sum_{m=1}^{M} \Big\{ f(w_i - \beta' x_i - u_i^m, \sigma_\epsilon^2)^{J_i^1} \\
&\qquad \cdot [F(\alpha + \beta' x_i - w_{i,-1} + u_{i,-1}^m, \sigma_\epsilon^2) - F(\beta' x_i - w_{i,-1} + u_{i,-1}^m, \sigma_\epsilon^2)]^{J_i^2} \\
&\qquad\quad \cdot f(w_i - \beta' x_i - u_i^m + \lambda, \sigma_\epsilon^2)^{J_i^3} \Big\}. \qquad \text{(A.5)}
\end{aligned}
$$

It is known that when $n, M \to \infty$ and $\sqrt{n}/M \to 0$, the SML estimates are asymptotically equivalent to the maximum likelihood (ML) estimates, so the estimates are consistent (see, for example, Lee [1993] and McFadden and Ruud [1994]). According to Gouriéroux and Monfort (1996), while the SML estimates are inconsistent when M is fixed, the value of M required to secure consistency is regarded as moderate in practice.[46]

46. In conducting the estimation in this paper, we adopted $M = 30$.

APPENDIX 2: ESTIMATION RESULTS REGARDING THE VARIABLES OTHER THAN DOWNWARD NOMINAL WAGE RIGIDITY

In this appendix, we report on the estimates of β, i.e., the coefficients of the x variables in the results.

First, the estimated coefficients on age and years of education are positive, so the nominal wages rise as these variables increase. Next, in general, the estimated coefficients of the tenure and labor market experiences are positive and those of the squared terms of these variables are negative. Thus, these variables have a positive but decreasing effect on nominal wages. We note, however, that some of the coefficients on tenure and labor market experiences for the annual earnings of full-time female employees and the hourly wages of part-time employees show the opposite signs. To examine this, we checked the marginal influence from tenure and labor market experience. In both cases, we found that they exerted a positive but decreasing influence on the dependent variable.[47]

Next, looking at the 13 big cities dummy coefficients, most of the estimates are negative, which implies that the notional wage is lower for employees residing in major urban areas. However, it is likely that the 13 big cities dummy estimates may not be accurate because of the other regional-based variables, such as the price level and the unemployment rate. In fact, the sign of the 13 big cities dummy estimates may change depending on the percentage of measurement errors.

The coefficients on the price level range from 0.007 to 0.020. Based on these estimates, the elasticity of the price level to notional wages is calculated as 0.69 to 2.19, which is not around the theoretically posited value of 1.00. We infer several possibilities for this discrepancy. First, the high correlation between the price level and the other variables such as those for economic trends and regional characteristics may produce multicolinearity. Second, the price level by prefecture in the CPI may not represent the true price level that workers face. Third, workers' characteristics may not be fully controlled with the explanatory variable x_i. To check the first possibility, we estimate the models excluding several variables (the 13 big cities dummy, the year dummies, the current profit to sales ratio, and the unemployment rate). The estimated elasticities of the price level become 0.78 for the regular monthly salaries of full-time males, 1.71 for the annual earnings of full-time males, 1.35 for the regular monthly salaries of full-time females, and 1.56 for the annual earnings of full-time females, with all these figures moving slightly closer to 1.00. For the hourly wages of part-time females, however, the elasticity remains around 2.00 even after changing the choices of the explanatory variables. In this regard, our estimates herein may not appropriately control the female part-time workers' characteristics.

Lastly, the coefficients of the scale dummy variables for full-time male and female employees are larger for their annual earnings than for their regular monthly salaries. This may be because annual earnings (which include bonus payments) vary more by firm size, compared with monthly salaries.

47. The squared terms of tenure and labor market experience are adopted to consider the gradual decrease in the increase of the wage profiles. However, because the female data used in this paper are for females in their 20s and 30s with relatively short employment histories, they do not include samples of older workers whose wage increases gradually ease. The results obtained in this paper may reflect this characteristic of the sample.

Appendix Table 1 Estimation Results of the Friction Model

[1] Regular Monthly Salaries of Full-Time Male Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)
Constant	1.864	(6.71)	1.640	(6.67)	2.976	(16.90)	3.837	(55.72)	2.466	(10.65)
Age	0.019	(4.16)	0.039	(8.64)	–0.005	(–1.18)	0.015	(3.42)	0.028	(6.40)
Tenure	0.011	(2.38)	0.022	(4.71)	0.020	(4.28)	0.000	(0.02)	0.005	(1.04)
Tenure squared	–0.000	(–1.80)	–0.001	(–4.43)	–0.001	(–4.09)	0.000	(0.12)	–0.000	(–0.78)
Labor market experience	0.014	(1.89)	–0.040	(–5.24)	0.028	(3.71)	0.021	(2.78)	0.018	(3.13)
Labor market experience squared	–0.000	(–1.78)	0.001	(3.04)	–0.000	(–0.69)	–0.000	(–2.32)	–0.001	(–4.39)
Years of education	0.014	(2.06)	0.009	(1.28)	0.050	(7.04)	0.027	(3.94)	0.021	(3.25)
13 big cities dummy	–0.094	(–3.79)	–0.093	(–3.73)	–0.087	(–3.55)	0.019	(0.85)	–0.077	(–3.26)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.108	(–3.78)	–0.107	(–3.66)	–0.163	(–5.84)	–0.116	(–4.24)	–0.140	(–5.22)
30 to 99 employees	–0.155	(–5.05)	–0.135	(–4.28)	–0.148	(–4.89)	–0.131	(–4.45)	–0.152	(–5.27)
100 to 999 employees	–0.124	(–4.92)	–0.134	(–5.16)	–0.153	(–6.17)	–0.097	(–3.98)	–0.148	(–6.23)
Industry dummy (base = service)										
Construction	–0.046	(–1.37)	0.054	(1.57)	–0.055	(–1.65)	–0.083	(–2.60)	–0.021	(–0.66)
Manufacturing	–0.089	(–3.21)	–0.020	(–0.72)	–0.048	(–1.76)	–0.032	(–1.19)	–0.034	(–1.31)
Wholesaling or retailing	–0.136	(–4.48)	0.013	(0.42)	0.007	(0.22)	–0.049	(–1.66)	0.043	(1.49)
Finance, insurance, or real estate	–0.110	(–2.10)	0.052	(0.96)	0.161	(3.10)	–0.014	(–0.27)	0.044	(0.89)
Transportation or telecommunications	–0.097	(–2.43)	–0.014	(–0.33)	–0.035	(–0.90)	–0.003	(–0.07)	0.037	(0.97)
Occupation dummy (base = laborer)										
Manager	0.457	(10.31)	0.416	(9.05)	0.361	(8.26)	0.386	(9.04)	0.327	(7.83)
Expert, engineer, or teacher	0.114	(3.56)	0.042	(1.28)	0.093	(3.02)	0.114	(3.80)	0.068	(2.27)
Clerical worker	0.188	(6.44)	0.017	(0.57)	–0.065	(–2.24)	0.013	(0.48)	0.001	(0.03)
Sales or service worker	0.060	(1.69)	–0.058	(–1.59)	–0.094	(–2.67)	–0.045	(–1.32)	–0.097	(–2.87)
Year dummy (base = 1997)										
1995	0.027	(1.02)	–0.028	(–1.05)	–0.049	(–1.91)	–0.056	(–2.21)	0.004	(0.16)
1996	–0.048	(–1.87)	0.023	(0.85)	–0.016	(–0.63)	–0.047	(–1.88)	0.020	(0.84)
1998	–0.052	(–1.83)	–0.055	(–1.91)	–0.003	(–0.12)	–0.052	(–1.89)	–0.021	(–0.78)
Current profit to sales ratio	–0.005	(–2.46)	–0.002	(–1.19)	–0.002	(–1.00)	–0.004	(–2.22)	–0.002	(–1.20)
CPI by prefecture	0.027	(14.06)	0.029	(18.90)	0.020	(9.09)	0.009	(6.40)	0.021	(8.89)
Unemployment rate by region and sex	0.034	(2.71)	0.005	(0.38)	–0.014	(–1.10)	0.006	(0.45)	–0.029	(–2.50)
α	0.119	(10.89)	0.049	(9.78)	0.042	(8.45)	0.045	(6.67)	0.077	(4.87)
λ	–0.115	(–5.62)	–0.008	(–0.38)	–0.042	(–2.06)	–0.010	(–0.47)	–0.029	(–1.43)
σ_ϵ	0.240	(113.32)	0.246	(133.25)	0.236	(145.97)	0.226	(127.59)	0.227	(110.14)
σ_u	—	—	0.013	(3.40)	0.028	(7.13)	0.061	(5.26)	0.012	(9.06)
Number of samples	735		735		735		735		735	
Log likelihood	–248.473		–302.779		–218.461		–117.819		–19.655	
Probability of wage cuts (percent)	30.3		41.4		39.1		40.1		35.7	
Probability of wage freezes (percent)	13.5		5.8		5.1		5.6		9.5	

(Continued on next page)

Appendix Table 1 (continued)

[2] Annual Earnings of Full-Time Male Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	7.157	(265.35)	4.873	(62.85)	6.487	(209.15)	6.854	(228.86)	5.498	(97.96)
Age	0.009	(2.44)	0.036	(9.82)	0.011	(2.97)	0.012	(3.39)	0.014	(4.07)
Tenure	–0.008	(–2.13)	0.016	(3.99)	0.017	(4.36)	0.000	(0.05)	–0.003	(–0.83)
Tenure squared	0.001	(3.99)	–0.001	(–4.37)	–0.000	(–2.93)	0.000	(1.47)	0.000	(0.47)
Labor market experience	0.008	(1.16)	0.020	(3.24)	0.002	(0.37)	0.006	(0.96)	0.037	(5.63)
Labor market experience squared	–0.000	(–1.09)	–0.001	(–5.38)	0.000	(0.59)	–0.000	(–0.96)	–0.001	(–5.37)
Years of education	0.027	(4.84)	0.015	(2.93)	0.030	(5.56)	0.022	(4.04)	0.025	(4.77)
13 big cities dummy	–0.013	(–0.76)	–0.015	(–0.86)	–0.054	(–3.11)	0.004	(0.25)	–0.017	(–0.99)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.302	(–13.06)	–0.268	(–11.86)	–0.234	(–10.25)	–0.299	(–13.18)	–0.288	(–12.83)
30 to 99 employees	–0.271	(–11.54)	–0.232	(–10.08)	–0.220	(–9.48)	–0.278	(–12.05)	–0.262	(–11.49)
100 to 999 employees	–0.192	(–10.42)	–0.197	(–10.95)	–0.170	(–9.34)	–0.207	(–11.41)	–0.200	(–11.17)
Industry dummy (base = service)										
Construction	0.124	(4.64)	–0.118	(–4.51)	0.017	(0.64)	–0.004	(–0.15)	0.027	(1.02)
Manufacturing	–0.055	(–2.60)	–0.057	(–2.75)	–0.021	(–1.00)	–0.092	(–4.45)	–0.035	(–1.69)
Wholesaling or retailing	–0.086	(–3.52)	0.022	(0.90)	–0.040	(–1.64)	–0.065	(–2.71)	–0.030	(–1.27)
Finance, insurance, or real estate	–0.013	(–0.28)	0.139	(2.98)	0.163	(3.45)	–0.021	(–0.44)	0.097	(2.08)
Transportation or telecommunications	0.027	(0.89)	–0.013	(–0.42)	–0.009	(–0.29)	–0.113	(–3.78)	–0.086	(–2.90)
Occupation dummy (base = laborer)										
Manager	0.379	(9.86)	0.190	(5.05)	0.310	(8.16)	0.324	(8.60)	0.273	(7.31)
Expert, engineer, or teacher	0.205	(8.94)	0.087	(3.89)	0.161	(7.11)	0.142	(6.28)	0.143	(6.41)
Clerical worker	0.167	(7.70)	0.005	(0.25)	0.157	(7.33)	0.119	(5.58)	0.109	(5.20)
Sales or service worker	0.175	(6.31)	–0.131	(–4.82)	0.081	(2.94)	–0.056	(–2.06)	–0.013	(–0.47)
Year dummy (base = 1997)										
1995	0.038	(2.14)	0.023	(1.35)	0.066	(3.82)	0.018	(1.04)	–0.052	(–3.03)
1996	0.013	(0.70)	0.029	(1.61)	0.053	(2.94)	0.016	(0.90)	0.004	(0.25)
Current profit to sales ratio	–0.010	(–2.70)	–0.003	(–0.99)	0.005	(1.40)	–0.001	(–0.27)	0.003	(0.75)
CPI by prefecture	0.006	(6.00)	0.022	(16.39)	0.011	(10.52)	0.011	(10.62)	0.021	(16.49)
Unemployment rate by region and sex	0.018	(1.58)	–0.015	(–1.38)	–0.014	(–1.25)	–0.034	(–3.03)	–0.032	(–2.94)
α	0.096	(12.83)	0.082	(11.71)	0.040	(10.06)	0.044	(8.39)	0.035	(5.97)
λ	–0.040	(–2.62)	–0.053	(–3.34)	–0.018	(–1.09)	0.007	(0.41)	–0.027	(–1.70)
σ_ϵ	0.257	(656.71)	0.251	(287.57)	0.253	(384.40)	0.250	(315.83)	0.250	(396.62)
σ_u	—	—	0.059	(5.74)	0.040	(4.50)	0.045	(6.02)	0.018	(13.68)
Number of samples	1,384		1,384		1,384		1,384		1,384	
Log likelihood	–483.645		–411.692		–407.275		–288.007		–154.756	
Probability of wage cuts (percent)	35.5		36.0		41.3		41.6		41.4	
Probability of wage freezes (percent)	10.5		9.2		4.5		5.1		4.0	

Appendix Table 1 (continued)

[3] Regular Monthly Salaries of Full-Time Female Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)
Constant	3.757	(51.55)	4.874	(89.50)	2.847	(81.31)	3.478	(48.19)	3.490	(49.20)
Age	–0.015	(–3.15)	0.006	(1.27)	0.012	(2.94)	0.006	(1.25)	0.002	(0.39)
Tenure	–0.007	(–0.82)	0.024	(2.76)	–0.011	(–1.50)	0.031	(3.62)	0.030	(3.60)
Tenure squared	0.001	(2.22)	–0.001	(–1.31)	0.002	(3.74)	–0.001	(–2.26)	–0.001	(–1.90)
Labor market experience	0.061	(4.68)	–0.015	(–1.23)	0.036	(5.26)	0.014	(1.15)	0.010	(0.82)
Labor market experience squared	–0.002	(–2.97)	0.001	(2.10)	–0.002	(–5.16)	–0.000	(–0.26)	0.000	(0.35)
Years of education	0.074	(8.28)	0.042	(4.90)	0.054	(6.77)	0.050	(6.03)	0.059	(7.19)
13 big cities dummy	0.082	(3.38)	0.099	(4.19)	0.044	(1.97)	0.093	(4.07)	0.061	(2.69)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.111	(–3.67)	–0.151	(–5.12)	–0.052	(–1.82)	–0.115	(–4.01)	–0.114	(–4.03)
30 to 99 employees	0.008	(0.24)	–0.097	(–2.97)	0.034	(1.06)	–0.029	(–0.92)	–0.028	(–0.88)
100 to 999 employees	–0.048	(–1.71)	–0.056	(–2.06)	–0.017	(–0.64)	–0.059	(–2.24)	–0.027	(–1.02)
Industry dummy (base = service)										
Construction	–0.194	(–5.37)	–0.065	(–1.84)	–0.053	(–1.55)	–0.072	(–2.11)	–0.034	(–1.00)
Manufacturing	–0.123	(–3.77)	–0.086	(–2.70)	–0.067	(–2.19)	–0.084	(–2.71)	–0.071	(–2.33)
Wholesaling or retailing	–0.082	(–2.50)	0.009	(0.29)	–0.014	(–0.45)	–0.015	(–0.48)	–0.005	(–0.17)
Finance, insurance, or real estate	0.014	(0.35)	0.057	(1.40)	0.158	(4.03)	0.095	(2.42)	0.101	(2.60)
Transportation or telecommunications	–0.278	(–4.06)	–0.120	(–1.80)	0.007	(0.10)	0.094	(1.45)	–0.044	(–0.68)
Occupation dummy (base = laborer)										
Manager	–0.044	(–0.91)	0.062	(1.32)	0.033	(0.73)	0.040	(0.89)	0.072	(1.59)
Expert, engineer, or teacher	0.005	(0.13)	0.001	(0.03)	0.001	(0.01)	0.001	(0.03)	0.000	(0.01)
Clerical worker	0.008	(0.15)	–0.023	(–0.45)	–0.102	(–1.93)	–0.038	(–0.76)	0.037	(0.74)
Sales or service worker	0.025	(0.76)	0.011	(0.34)	0.106	(3.34)	0.020	(0.66)	–0.004	(–0.13)
Year dummy (base = 1997)										
1995	0.044	(1.30)	–0.010	(–0.29)	0.106	(3.15)	0.036	(1.13)	0.022	(0.68)
1996	–0.022	(–0.61)	–0.063	(–1.80)	0.052	(1.46)	–0.065	(–1.90)	–0.027	(–0.82)
1997	0.024	(0.65)	–0.085	(–2.36)	0.042	(1.10)	–0.016	(–0.46)	–0.078	(–2.26)
Current profit to sales ratio	0.002	(1.18)	0.001	(0.74)	0.006	(3.54)	0.003	(1.77)	0.003	(2.05)
CPI by prefecture	0.006	(3.04)	–0.005	(–2.77)	0.010	(21.79)	0.006	(3.21)	0.006	(3.18)
Unemployment rate by region and sex	0.000	(0.02)	0.056	(3.67)	0.013	(1.04)	0.026	(1.74)	0.025	(1.69)
α	0.097	(8.32)	0.036	(7.34)	0.043	(6.19)	0.034	(4.49)	0.040	(3.41)
λ	–0.008	(–0.33)	–0.016	(–0.72)	–0.008	(–0.34)	–0.013	(–0.55)	–0.031	(–1.74)
σ_ϵ	0.221	(209.73)	0.215	(285.58)	0.209	(63.06)	0.209	(205.98)	0.206	(169.01)
σ_u	—	—	0.031	(3.09)	0.006	(1.63)	0.020	(5.11)	0.020	(2.01)
Number of samples	557		557		557		557		557	
Log likelihood	–113.220		–122.620		–66.323		9.074		47.333	
Probability of wage cuts (percent)	32.2		39.0		38.4		38.5		37.1	
Probability of wage freezes (percent)	12.1		4.7		5.7		4.6		5.4	

(Continued on next page)

Appendix Table 1 (continued)

[4] Annual Earnings of Full-Time Female Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)	Coeff.	(*t*-value)
Constant	5.138	(81.31)	5.857	(122.19)	6.327	(216.80)	5.680	(122.42)	5.559	(79.73)
Age	0.007	(1.46)	0.004	(0.77)	–0.002	(–0.39)	0.001	(0.12)	–0.002	(–0.42)
Tenure	0.027	(3.24)	0.043	(5.03)	0.025	(2.86)	0.026	(3.23)	0.023	(2.72)
Tenure squared	–0.000	(–0.68)	–0.001	(–2.97)	–0.000	(–0.56)	–0.000	(–0.64)	–0.000	(–0.40)
Labor market experience	0.041	(3.14)	–0.008	(–0.57)	0.016	(1.21)	–0.006	(–0.50)	–0.010	(–0.79)
Labor market experience squared	–0.002	(–3.35)	0.001	(1.28)	–0.001	(–0.95)	0.000	(0.66)	0.001	(1.48)
Years of education	0.054	(7.21)	0.044	(5.71)	0.044	(5.63)	0.036	(5.00)	0.059	(7.64)
13 big cities dummy	–0.040	(–1.85)	0.008	(0.37)	0.041	(1.88)	–0.092	(–4.42)	–0.041	(–1.89)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.254	(–9.24)	–0.268	(–9.47)	–0.304	(–10.67)	–0.276	(–10.35)	–0.299	(–10.72)
30 to 99 employees	–0.113	(–3.70)	–0.122	(–3.88)	–0.162	(–5.15)	–0.127	(–4.29)	–0.161	(–5.20)
100 to 999 employees	–0.105	(–4.37)	–0.092	(–3.72)	–0.146	(–5.84)	–0.107	(–4.58)	–0.131	(–5.37)
Industry dummy (base = service)										
Construction	–0.069	(–1.92)	–0.120	(–3.25)	–0.074	(–2.00)	–0.090	(–2.60)	–0.067	(–1.85)
Manufacturing	–0.107	(–3.80)	–0.132	(–4.55)	–0.107	(–3.64)	–0.106	(–3.88)	–0.188	(–6.58)
Wholesaling or retailing	0.051	(1.69)	–0.108	(–3.48)	0.074	(2.38)	0.012	(0.42)	–0.012	(–0.40)
Finance, insurance, or real estate	0.159	(4.13)	0.057	(1.45)	–0.001	(–0.02)	0.119	(3.19)	0.004	(0.10)
Transportation or telecommunications	–0.000	(–0.00)	–0.152	(–2.66)	–0.111	(–1.94)	–0.137	(–2.55)	–0.122	(–2.17)
Occupation dummy (base = laborer)										
Manager	–0.186	(–1.26)	–0.677	(–4.46)	–0.474	(–3.10)	–0.119	(–0.83)	–0.375	(–2.50)
Expert, engineer, or teacher	0.097	(2.39)	0.129	(3.08)	0.197	(4.67)	0.283	(7.16)	0.072	(1.73)
Clerical worker	–0.012	(–0.33)	0.032	(0.86)	0.086	(2.30)	0.230	(6.55)	–0.011	(–0.29)
Sales or service worker	–0.150	(–3.31)	–0.042	(–0.91)	–0.068	(–1.44)	0.079	(1.80)	–0.110	(–2.38)
Year dummy (base = 1997)										
1995	–0.053	(–1.88)	0.038	(1.30)	–0.069	(–2.33)	–0.019	(–0.68)	–0.034	(–1.17)
1996	–0.020	(–0.75)	–0.033	(–1.19)	–0.026	(–0.93)	0.008	(0.31)	–0.009	(–0.32)
1997	–0.066	(–2.27)	–0.079	(–2.65)	0.037	(1.23)	0.033	(1.16)	0.050	(1.70)
Current profit to sales ratio	0.009	(2.87)	0.002	(0.54)	–0.001	(–0.35)	0.014	(4.30)	–0.000	(–0.04)
CPI by prefecture	0.018	(9.31)	0.014	(7.33)	0.011	(6.50)	0.015	(8.46)	0.018	(9.22)
Unemployment rate by region and sex	–0.004	(–0.29)	–0.001	(–0.07)	–0.032	(–2.02)	0.039	(2.67)	–0.004	(–0.28)
α	0.152	(8.93)	0.040	(7.97)	0.047	(7.02)	0.066	(5.66)	0.035	(4.05)
λ	–0.218	(–11.08)	–0.084	(–4.10)	–0.016	(–0.74)	–0.071	(–3.31)	–0.022	(–1.05)
σ_ϵ	0.243	(294.91)	0.250	(238.43)	0.252	(424.91)	0.232	(370.73)	0.247	(343.96)
σ_u	—	—	0.011	(6.18)	0.017	(6.05)	0.063	(8.02)	0.013	(2.24)
Number of samples	804		804		804		804		804	
Log likelihood	–155.582		–239.231		–189.599		–100.571		–71.481	
Probability of wage cuts (percent)	24.5		40.0		41.0		37.0		42.4	
Probability of wage freezes (percent)	16.6		4.6		5.4		7.8		4.1	

Appendix Table 1 (continued)

[5] Hourly Wages of Part-Time Female Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	–3.496	(–9.02)	–3.989	(–10.96)	–2.977	(–9.55)	–1.498	(–8.13)	–2.612	(–9.56)
Age	–0.001	(–0.29)	–0.004	(–1.07)	–0.015	(–4.64)	–0.011	(–3.67)	–0.003	(–1.15)
Tenure	–0.018	(–1.37)	–0.033	(–2.71)	–0.078	(–6.95)	–0.033	(–3.09)	–0.037	(–3.61)
Tenure squared	0.001	(0.97)	0.003	(3.11)	0.006	(6.49)	0.002	(2.62)	0.003	(3.55)
Labor market experience	0.012	(0.84)	0.004	(0.29)	0.025	(2.02)	0.005	(0.51)	0.010	(0.90)
Labor market experience squared	–0.001	(–0.94)	0.000	(0.56)	–0.000	(–0.20)	0.000	(0.86)	–0.000	(–0.44)
Years of education	0.025	(3.02)	0.049	(5.99)	0.065	(7.90)	0.038	(4.87)	0.038	(5.42)
13 big cities dummy	0.020	(0.57)	0.010	(0.31)	0.002	(0.08)	0.029	(1.02)	0.043	(1.54)
Firm size dummy (base = 1,000 or more)										
29 or less employees	0.063	(1.60)	–0.155	(–4.28)	–0.178	(–5.27)	–0.188	(–5.94)	–0.120	(–3.87)
30 to 99 employees	0.078	(1.68)	–0.143	(–3.35)	–0.237	(–6.00)	–0.159	(–4.24)	–0.097	(–2.66)
100 to 999 employees	0.028	(0.65)	–0.147	(–3.73)	–0.170	(–4.58)	–0.201	(–5.76)	–0.124	(–3.68)
Industry dummy (base = service)										
Construction	0.419	(4.53)	0.237	(2.76)	0.285	(3.24)	0.326	(4.28)	0.374	(5.06)
Manufacturing	0.035	(0.85)	–0.200	(–5.28)	–0.083	(–2.33)	–0.077	(–2.28)	–0.082	(–2.51)
Wholesaling or retailing	0.089	(2.63)	–0.201	(–6.39)	–0.168	(–5.73)	–0.070	(–2.52)	–0.070	(–2.63)
Finance, insurance, or real estate	0.354	(3.56)	–0.140	(–1.53)	0.007	(0.08)	–0.279	(–3.46)	–0.070	(–0.90)
Transportation or telecommunications	0.236	(3.00)	–0.662	(–9.27)	0.304	(4.24)	0.061	(0.94)	0.032	(0.52)
Occupation dummy (base = laborer)										
Expert, engineer, or teacher	0.316	(5.75)	0.180	(3.51)	0.221	(4.62)	0.271	(5.99)	0.266	(6.11)
Clerical worker	–0.020	(–0.51)	–0.027	(–0.73)	–0.026	(–0.75)	0.060	(1.86)	–0.014	(–0.45)
Sales or service worker	–0.125	(–3.03)	–0.033	(–0.86)	0.049	(1.35)	–0.064	(–1.89)	–0.066	(–2.03)
Year dummy (base = 1997)										
1994	–0.099	(–2.36)	–0.026	(–0.67)	0.005	(0.14)	–0.046	(–1.32)	–0.024	(–0.72)
1995	–0.011	(–0.27)	0.039	(1.06)	0.128	(3.71)	0.030	(0.94)	0.071	(2.28)
1996	–0.114	(–2.94)	–0.057	(–1.57)	–0.005	(–0.14)	–0.025	(–0.79)	0.023	(0.75)
1997	0.061	(1.59)	–0.048	(–1.32)	0.036	(1.08)	–0.094	(–2.93)	0.039	(1.28)
Current profit to sales ratio	–0.001	(–0.19)	–0.000	(–0.12)	–0.000	(–0.09)	–0.000	(–0.02)	0.000	(0.02)
CPI by prefecture	0.030	(7.46)	0.035	(9.53)	0.024	(6.80)	0.010	(3.68)	0.020	(6.41)
Unemployment rate by region and sex	–0.053	(–2.94)	–0.033	(–1.95)	0.003	(0.21)	0.064	(3.99)	0.002	(0.10)
α	0.182	(13.71)	0.156	(12.00)	0.074	(10.31)	0.080	(8.12)	0.034	(6.13)
λ	–0.009	(–0.20)	–0.067	(–1.73)	0.004	(0.11)	–0.023	(–0.76)	0.017	(0.38)
σ_ϵ	0.243	(117.52)	0.226	(154.36)	0.200	(46.60)	0.201	(75.60)	0.188	(23.50)
σ_u	—	—	0.000	(0.00)	0.134	(3.70)	0.002	(0.02)	0.051	(1.10)
Number of samples	436		436		436		436		436	
Log likelihood	–317.422		–231.620		–228.281		–85.110		–34.619	
Probability of wage cuts (percent)	29.0		28.2		37.9		35.0		40.7	
Probability of wage freezes (percent)	21.3		19.6		10.2		11.3		5.2	

Appendix Table 2 Estimation Results of the Tobit Model

[1] Regular Monthly Salaries of Full-Time Male Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	2.368	(8.20)	2.756	(14.51)	2.539	(10.70)	2.665	(12.75)	2.677	(12.16)
Age	0.027	(4.72)	0.022	(3.89)	0.023	(3.95)	0.026	(4.40)	0.023	(3.99)
Tenure	0.009	(1.63)	0.009	(1.64)	0.008	(1.45)	0.009	(1.60)	0.007	(1.39)
Tenure squared	–0.000	(–1.51)	–0.000	(–1.86)	–0.000	(–1.55)	–0.000	(–1.44)	–0.000	(–1.46)
Labor market experience	0.017	(2.29)	0.025	(2.77)	0.023	(2.72)	0.022	(2.49)	0.023	(2.62)
Labor market experience squared	–0.001	(–3.13)	–0.001	(–3.25)	–0.001	(–3.33)	–0.001	(–3.28)	–0.001	(–3.11)
Years of education	0.029	(3.33)	0.026	(3.11)	0.028	(3.22)	0.029	(3.28)	0.028	(3.11)
13 big cities dummy	–0.037	(–1.21)	–0.041	(–1.41)	–0.042	(–1.43)	–0.062	(–2.02)	–0.034	(–1.12)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.162	(–4.67)	–0.150	(–4.54)	–0.143	(–4.24)	–0.145	(–4.14)	–0.152	(–4.35)
30 to 99 employees	–0.181	(–4.86)	–0.177	(–4.90)	–0.170	(–4.64)	–0.201	(–5.18)	–0.181	(–4.81)
100 to 999 employees	–0.179	(–5.84)	–0.173	(–5.82)	–0.163	(–5.34)	–0.158	(–5.03)	–0.172	(–5.50)
Industry dummy (base = service)										
Construction	–0.055	(–1.33)	–0.051	(–1.30)	–0.068	(–1.69)	–0.048	(–1.15)	–0.065	(–1.50)
Manufacturing	–0.063	(–1.87)	–0.059	(–1.83)	–0.070	(–2.11)	–0.070	(–2.04)	–0.059	(–1.74)
Wholesaling or retailing	–0.006	(–0.16)	–0.022	(–0.62)	–0.013	(–0.34)	–0.013	(–0.34)	–0.009	(–0.24)
Finance, insurance, or real estate	0.020	(0.31)	0.002	(0.03)	0.028	(0.46)	0.014	(0.22)	0.008	(0.13)
Transportation or telecommunications	–0.041	(–0.81)	–0.078	(–1.55)	–0.073	(–1.43)	–0.049	(–0.94)	–0.051	(–1.00)
Occupation dummy (base = laborer)										
Manager	0.340	(6.32)	0.317	(6.03)	0.329	(6.15)	0.326	(5.95)	0.347	(6.30)
Expert, engineer, or teacher	0.054	(1.39)	0.048	(1.34)	0.043	(1.17)	0.042	(1.07)	0.063	(1.59)
Clerical worker	0.005	(0.15)	0.008	(0.25)	0.008	(0.21)	0.008	(0.21)	0.010	(0.26)
Sales or service worker	–0.069	(–1.59)	–0.055	(–1.33)	–0.077	(–1.84)	–0.090	(–2.01)	–0.083	(–1.86)
Year dummy (base = 1997)										
1995	–0.052	(–1.61)	–0.049	(–1.61)	–0.055	(–1.75)	–0.058	(–1.77)	–0.055	(–1.68)
1996	–0.008	(–0.24)	–0.002	(–0.08)	–0.017	(–0.57)	–0.017	(–0.53)	–0.023	(–0.74)
1998	–0.027	(–0.79)	–0.026	(–0.79)	–0.035	(–1.06)	–0.031	(–0.88)	–0.033	(–0.94)
Current profit to sales ratio	–0.001	(–0.29)	–0.001	(–0.40)	0.000	(0.09)	–0.001	(–0.45)	–0.001	(–0.54)
CPI by prefecture	0.020	(6.71)	0.017	(7.52)	0.019	(7.33)	0.017	(6.59)	0.018	(6.64)
Unemployment rate by region and sex	–0.011	(–0.75)	–0.007	(–0.48)	–0.006	(–0.41)	–0.006	(–0.37)	–0.007	(–0.44)
α	∞	—	∞	—	∞	—	∞	—	∞	—
λ	—	—	—	—	—	—	—	—	—	—
σ_ϵ	0.263	(89.62)	0.205	(93.70)	0.224	(155.22)	0.241	(372.97)	0.252	(72.36)
σ_u	—	—	0.118	(32.35)	0.114	(33.27)	0.142	(17.76)	0.198	(4.04)
Number of samples	735		735		735		735		735	
Log likelihood	–212.057		–140.605		–166.701		–198.566		–209.000	
Probability of wage cuts (percent)	0.0		0.0		0.0		0.0		0.0	
Probability of wage freezes (percent)	56.0		50.8		52.6		53.7		54.7	

Appendix Table 2 (continued)

[2] Annual Earnings of Full-Time Male Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	5.796	(120.40)	5.800	(126.07)	5.818	(127.31)	5.803	(120.51)	5.942	(141.99)
Age	0.011	(2.68)	0.013	(3.01)	0.010	(2.43)	0.011	(2.65)	0.010	(2.44)
Tenure	0.008	(1.79)	0.008	(1.74)	0.009	(2.09)	0.009	(2.08)	0.009	(2.06)
Tenure squared	–0.000	(–0.67)	–0.000	(–0.90)	–0.000	(–0.84)	–0.000	(–0.89)	–0.000	(–0.89)
Labor market experience	0.028	(3.67)	0.031	(3.69)	0.029	(3.73)	0.029	(3.69)	0.029	(3.81)
Labor market experience squared	–0.001	(–3.37)	–0.001	(–3.69)	–0.001	(–3.71)	–0.001	(–3.45)	–0.001	(–3.56)
Years of education	0.036	(5.75)	0.033	(5.32)	0.037	(5.98)	0.034	(5.38)	0.036	(5.82)
13 big cities dummy	–0.018	(–0.86)	–0.016	(–0.80)	–0.014	(–0.68)	–0.029	(–1.40)	–0.024	(–1.19)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.313	(–11.75)	–0.328	(–12.19)	–0.299	(–11.07)	–0.297	(–10.78)	–0.311	(–11.59)
30 to 99 employees	–0.291	(–10.63)	–0.301	(–10.65)	–0.289	(–10.30)	–0.274	(–9.83)	–0.292	(–10.64)
100 to 999 employees	–0.202	(–9.66)	–0.219	(–10.43)	–0.211	(–9.97)	–0.188	(–8.79)	–0.205	(–9.79)
Industry dummy (base = service)										
Construction	–0.012	(–0.37)	0.013	(0.40)	0.024	(0.77)	0.014	(0.44)	0.010	(0.31)
Manufacturing	–0.059	(–2.42)	–0.038	(–1.59)	–0.050	(–2.06)	–0.040	(–1.63)	–0.047	(–1.93)
Wholesaling or retailing	–0.037	(–1.30)	–0.037	(–1.29)	–0.032	(–1.11)	–0.032	(–1.10)	–0.045	(–1.59)
Finance, insurance, or real estate	0.080	(1.48)	0.051	(0.91)	0.052	(0.93)	0.052	(0.93)	0.027	(0.48)
Transportation or telecommunications	–0.079	(–2.24)	–0.076	(–2.03)	–0.061	(–1.66)	–0.077	(–2.15)	–0.083	(–2.33)
Occupation dummy (base = laborer)										
Manager	0.268	(5.93)	0.267	(6.08)	0.264	(6.03)	0.239	(5.21)	0.265	(5.90)
Expert, engineer, or teacher	0.115	(4.37)	0.098	(3.84)	0.107	(4.15)	0.099	(3.78)	0.124	(4.79)
Clerical worker	0.076	(3.05)	0.048	(1.92)	0.071	(2.83)	0.075	(2.95)	0.079	(3.16)
Sales or service worker	–0.055	(–1.70)	–0.045	(–1.40)	–0.040	(–1.26)	–0.044	(–1.34)	–0.039	(–1.19)
Year dummy (base = 1997)										
1995	–0.002	(–0.09)	–0.016	(–0.79)	–0.017	(–0.84)	–0.016	(–0.78)	–0.008	(–0.39)
1996	0.013	(0.61)	0.013	(0.63)	0.012	(0.57)	0.018	(0.84)	0.015	(0.72)
Current profit to sales ratio	0.000	(0.07)	–0.002	(–0.48)	–0.001	(–0.29)	–0.001	(–0.21)	–0.002	(–0.46)
CPI by prefecture	0.017	(12.57)	0.017	(13.04)	0.018	(13.26)	0.017	(12.49)	0.016	(11.93)
Unemployment rate by region and sex	–0.039	(–3.02)	–0.030	(–2.38)	–0.048	(–3.73)	–0.031	(–2.36)	–0.031	(–2.44)
α	∞	—	∞	—	∞	—	∞	—	∞	—
λ	—	—	—	—	—	—	—	—	—	—
σ_ϵ	0.267	(473.31)	0.205	(110.59)	0.229	(89.44)	0.239	(102.54)	0.254	(229.65)
σ_u	—	—	0.141	(29.79)	0.126	(20.98)	0.184	(12.76)	0.146	(27.19)
Number of samples	1,384		1,384		1,384		1,384		1,384	
Log likelihood	–402.081		–295.475		–336.708		–364.744		–384.601	
Probability of wage cuts (percent)	0.0		0.0		0.0		0.0		0.0	
Probability of wage freezes (percent)	55.0		51.2		53.0		53.3		54.5	

(Continued on next page)

Appendix Table 2 (continued)

[3] Regular Monthly Salaries of Full-Time Female Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	2.841	(32.66)	3.188	(40.83)	3.185	(42.48)	3.001	(36.21)	2.985	(33.53)
Age	0.006	(1.08)	0.005	(0.92)	0.005	(1.09)	0.004	(0.84)	0.004	(0.73)
Tenure	0.015	(1.52)	0.021	(2.24)	0.021	(2.33)	0.020	(2.12)	0.019	(2.00)
Tenure squared	0.000	(0.25)	–0.000	(–0.35)	–0.000	(–0.68)	–0.000	(–0.71)	–0.000	(–0.74)
Labor market experience	0.042	(3.06)	0.027	(2.00)	0.025	(1.92)	0.030	(2.26)	0.028	(2.02)
Labor market experience squared	–0.002	(–2.98)	–0.001	(–1.96)	–0.001	(–1.60)	–0.001	(–1.65)	–0.001	(–1.43)
Years of education	0.059	(6.20)	0.055	(5.86)	0.058	(6.39)	0.064	(6.95)	0.064	(6.52)
13 big cities dummy	0.039	(1.49)	0.043	(1.63)	0.049	(1.96)	0.042	(1.66)	0.046	(1.72)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.098	(–3.04)	–0.113	(–3.45)	–0.095	(–3.10)	–0.099	(–3.18)	–0.111	(–3.43)
30 to 99 employees	–0.002	(–0.05)	–0.024	(–0.68)	–0.026	(–0.77)	–0.034	(–0.98)	–0.026	(–0.72)
100 to 999 employees	–0.039	(–1.31)	–0.059	(–2.01)	–0.048	(–1.69)	–0.056	(–1.96)	–0.056	(–1.87)
Industry dummy (base = service)										
Construction	–0.078	(–1.95)	–0.049	(–1.21)	–0.058	(–1.53)	–0.056	(–1.47)	–0.052	(–1.29)
Manufacturing	–0.083	(–2.37)	–0.054	(–1.62)	–0.062	(–1.89)	–0.066	(–1.97)	–0.064	(–1.81)
Wholesaling or retailing	–0.016	(–0.46)	–0.006	(–0.16)	–0.006	(–0.18)	–0.005	(–0.14)	–0.005	(–0.15)
Finance, insurance, or real estate	0.074	(1.65)	0.066	(1.50)	0.086	(2.03)	0.110	(2.56)	0.089	(2.01)
Transportation or telecommunications	–0.063	(–0.86)	–0.040	(–0.55)	–0.060	(–0.88)	–0.061	(–0.87)	–0.085	(–1.20)
Occupation dummy (base = laborer)										
Manager	0.057	(1.10)	0.062	(1.20)	0.068	(1.37)	0.053	(1.05)	0.056	(1.04)
Expert, engineer, or teacher	0.000	(0.00)	0.000	(0.01)	0.000	(0.01)	0.001	(0.01)	0.001	(0.01)
Clerical worker	–0.053	(–0.90)	–0.078	(–1.31)	–0.039	(–0.70)	–0.047	(–0.84)	–0.048	(–0.80)
Sales or service worker	0.036	(1.06)	0.028	(0.81)	0.037	(1.13)	0.049	(1.47)	0.036	(1.04)
Year dummy (base = 1997)										
1995	0.049	(1.36)	0.061	(1.66)	0.048	(1.38)	0.068	(1.94)	0.052	(1.43)
1996	–0.031	(–0.80)	–0.023	(–0.59)	–0.033	(–0.89)	–0.020	(–0.54)	–0.032	(–0.81)
1997	–0.044	(–1.09)	–0.036	(–0.88)	–0.046	(–1.21)	–0.030	(–0.78)	–0.037	(–0.90)
Current profit to sales ratio	0.003	(1.35)	0.003	(1.58)	0.003	(1.55)	0.003	(1.75)	0.003	(1.49)
CPI by prefecture	0.010	(4.19)	0.008	(3.55)	0.007	(3.32)	0.008	(3.61)	0.009	(3.77)
Unemployment rate by region and sex	0.036	(2.09)	0.041	(2.47)	0.043	(2.63)	0.043	(2.60)	0.035	(2.02)
α	∞	—	∞	—	∞	—	∞	—	∞	—
λ	—	—	—	—	—	—	—	—	—	—
σ_ϵ	0.217	(144.54)	0.173	(46.92)	0.207	(388.17)	0.210	(269.42)	0.210	(571.98)
σ_u	—	—	0.122	(19.47)	0.010	(10.77)	0.014	(9.70)	0.129	(21.21)
Number of samples	557		557		557		557		557	
Log likelihood	–74.682		–43.295		–41.419		–52.689		–70.647	
Probability of wage cuts (percent)	0.0		0.0		0.0		0.0		0.0	
Probability of wage freezes (percent)	50.8		46.7		48.6		49.4		50.0	

Appendix Table 2 (continued)

[4] Annual Earnings of Full-Time Female Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	5.432	(75.68)	5.497	(96.19)	5.496	(80.92)	5.571	(91.24)	5.454	(74.99)
Age	0.000	(0.07)	–0.001	(–0.14)	0.001	(0.14)	–0.000	(–0.05)	0.000	(0.06)
Tenure	0.036	(3.70)	0.034	(3.34)	0.030	(3.08)	0.030	(3.04)	0.029	(3.02)
Tenure squared	–0.001	(–1.85)	–0.001	(–1.38)	–0.001	(–1.10)	–0.001	(–0.93)	–0.001	(–1.06)
Labor market experience	–0.003	(–0.19)	–0.003	(–0.22)	–0.003	(–0.22)	–0.003	(–0.22)	–0.003	(–0.21)
Labor market experience squared	0.001	(0.85)	0.000	(0.81)	0.000	(0.73)	0.000	(0.58)	0.000	(0.75)
Years of education	0.042	(4.88)	0.050	(5.88)	0.042	(4.95)	0.042	(4.89)	0.042	(4.94)
13 big cities dummy	–0.044	(–1.74)	–0.038	(–1.48)	–0.048	(–1.91)	–0.044	(–1.72)	–0.034	(–1.36)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.292	(–9.07)	–0.295	(–8.77)	–0.281	(–8.71)	–0.280	(–8.50)	–0.277	(–8.59)
30 to 99 employees	–0.173	(–4.75)	–0.142	(–3.92)	–0.169	(–4.68)	–0.135	(–3.69)	–0.160	(–4.41)
100 to 999 employees	–0.159	(–5.61)	–0.128	(–4.41)	–0.142	(–5.04)	–0.123	(–4.26)	–0.137	(–4.84)
Industry dummy (base = service)										
Construction	–0.083	(–1.99)	–0.082	(–1.93)	–0.074	(–1.74)	–0.082	(–1.89)	–0.077	(–1.82)
Manufacturing	–0.118	(–3.60)	–0.105	(–3.07)	–0.096	(–2.95)	–0.102	(–3.08)	–0.096	(–2.94)
Wholesaling or retailing	0.027	(0.78)	0.047	(1.31)	0.027	(0.78)	0.043	(1.21)	0.037	(1.04)
Finance, insurance, or real estate	0.021	(0.47)	0.087	(1.93)	0.062	(1.40)	0.098	(2.18)	0.054	(1.19)
Transportation or telecommunications	–0.196	(–2.79)	–0.125	(–1.84)	–0.135	(–1.95)	–0.164	(–2.34)	–0.181	(–2.54)
Occupation dummy (base = laborer)										
Manager	–0.421	(–1.03)	–0.095	(–0.27)	–0.114	(–0.42)	–0.192	(–0.59)	–0.151	(–0.52)
Expert, engineer, or teacher	0.146	(3.07)	0.226	(4.16)	0.185	(3.92)	0.193	(3.86)	0.187	(3.90)
Clerical worker	0.067	(1.57)	0.127	(2.56)	0.084	(1.99)	0.095	(2.11)	0.094	(2.20)
Sales or service worker	–0.048	(–0.90)	–0.045	(–0.75)	–0.030	(–0.56)	–0.032	(–0.58)	–0.016	(–0.31)
Year dummy (base = 1997)										
1995	0.007	(0.20)	–0.012	(–0.36)	–0.017	(–0.49)	–0.019	(–0.57)	–0.027	(–0.82)
1996	0.010	(0.33)	–0.006	(–0.18)	–0.005	(–0.14)	–0.005	(–0.14)	–0.004	(–0.11)
1997	0.057	(1.67)	0.016	(0.47)	0.019	(0.57)	0.013	(0.38)	0.016	(0.46)
Current profit to sales ratio	0.000	(0.06)	0.005	(1.14)	0.003	(0.83)	0.006	(1.40)	0.003	(0.80)
CPI by prefecture	0.017	(7.91)	0.016	(7.59)	0.017	(8.03)	0.016	(7.91)	0.018	(8.07)
Unemployment rate by region and sex	0.027	(1.52)	0.022	(1.17)	0.017	(0.96)	0.020	(1.09)	0.016	(0.87)
α	∞	—	∞	—	∞	—	∞	—	∞	—
λ	—	—	—	—	—	—	—	—	—	—
σ_ϵ	0.260	(672.87)	0.206	(68.73)	0.239	(128.12)	0.232	(84.60)	0.249	(223.38)
σ_u	—	—	0.141	(37.92)	0.103	(19.93)	0.102	(24.34)	0.141	(17.57)
Number of samples	804		804		804		804		804	
Log likelihood	–217.086		–167.892		–191.188		–183.311		–205.597	
Probability of wage cuts (percent)	0.0%		0.0		0.0		0.0		0.0	
Probability of wage freezes (percent)	52.8		48.6		51.2		50.6		51.6	

(Continued on next page)

Appendix Table 2 (continued)

[5] Hourly Wages of Part-Time Female Employees

	$p = 1$		$p = 0.8$		$p = 0.6$		$p = 0.4$		$p = 0.2$	
	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	–2.893	(–9.62)	–2.910	(–14.09)	–2.751	(–10.93)	–2.957	(–10.61)	–2.823	(–10.15)
Age	–0.008	(–1.93)	–0.005	(–1.70)	–0.006	(–1.82)	–0.007	(–2.03)	–0.006	(–1.70)
Tenure	–0.038	(–2.67)	–0.018	(–1.93)	–0.025	(–2.35)	–0.019	(–1.61)	–0.021	(–1.62)
Tenure squared	0.002	(2.21)	0.002	(2.08)	0.001	(1.75)	0.001	(1.54)	0.001	(1.45)
Labor market experience	0.016	(1.06)	0.017	(1.52)	0.019	(1.60)	0.019	(1.47)	0.017	(1.22)
Labor market experience squared	0.000	(0.24)	–0.000	(–0.13)	–0.000	(–0.03)	–0.000	(–0.04)	–0.000	(–0.04)
Years of education	0.045	(4.34)	0.040	(5.49)	0.031	(3.97)	0.037	(4.27)	0.038	(3.98)
13 big cities dummy	0.080	(2.12)	0.045	(1.67)	0.057	(1.91)	0.047	(1.41)	0.073	(2.09)
Firm size dummy (base = 1,000 or more)										
29 or less employees	–0.150	(–3.56)	–0.104	(–3.53)	–0.080	(–2.43)	–0.073	(–2.00)	–0.118	(–2.97)
30 to 99 employees	–0.204	(–3.99)	–0.117	(–3.33)	–0.129	(–3.25)	–0.108	(–2.48)	–0.152	(–3.22)
100 to 999 employees	–0.146	(–3.14)	–0.115	(–3.61)	–0.083	(–2.31)	–0.082	(–2.07)	–0.089	(–2.04)
Industry dummy (base = service)										
Construction	0.447	(4.70)	0.353	(4.80)	0.311	(3.87)	0.376	(4.65)	0.431	(4.98)
Manufacturing	–0.008	(–0.17)	–0.082	(–2.55)	–0.080	(–2.27)	–0.069	(–1.78)	–0.048	(–1.14)
Wholesaling or retailing	–0.056	(–1.44)	–0.106	(–4.10)	–0.103	(–3.55)	–0.101	(–3.13)	–0.078	(–2.18)
Finance, insurance, or real estate	–0.134	(–1.11)	–0.109	(–1.42)	–0.142	(–1.62)	–0.118	(–1.21)	–0.179	(–1.52)
Transportation or telecommunications	–0.085	(–0.88)	–0.065	(–1.03)	–0.032	(–0.45)	–0.093	(–1.17)	–0.027	(–0.31)
Occupation dummy (base = laborer)										
Expert, engineer, or teacher	0.290	(4.78)	0.159	(3.42)	0.231	(4.79)	0.181	(3.39)	0.283	(5.02)
Clerical worker	0.002	(0.04)	0.046	(1.49)	0.045	(1.31)	0.052	(1.40)	0.037	(0.92)
Sales or service worker	0.005	(0.11)	0.044	(1.36)	0.035	(0.97)	0.054	(1.36)	0.028	(0.66)
Year dummy (base = 1997)										
1994	0.012	(0.27)	–0.019	(–0.59)	0.017	(0.47)	–0.041	(–1.05)	–0.031	(–0.74)
1995	0.027	(0.61)	0.040	(1.34)	0.052	(1.55)	0.001	(0.02)	–0.005	(–0.13)
1996	0.039	(0.90)	0.017	(0.58)	0.015	(0.46)	–0.065	(–1.77)	–0.046	(–1.15)
1997	–0.035	(–0.81)	–0.057	(–1.84)	–0.046	(–1.35)	–0.088	(–2.34)	–0.085	(–2.12)
Current profit to sales ratio	0.000	(0.01)	0.000	(0.01)	0.000	(0.02)	0.000	(0.05)	0.000	(0.01)
CPI by prefecture	0.020	(5.03)	0.021	(7.54)	0.020	(6.57)	0.022	(6.42)	0.020	(5.50)
Unemployment rate by region and sex	0.038	(1.71)	0.031	(2.07)	0.020	(1.22)	0.016	(0.87)	0.033	(1.66)
α	∞	—	∞	—	∞	—	∞	—	∞	—
λ	—	—	—	—	—	—	—	—	—	—
σ_ϵ	0.237	(159.92)	0.158	(71.05)	0.181	(96.17)	0.199	(117.17)	0.217	(168.53)
σ_u	—	—	0.034	(12.73)	0.024	(23.04)	0.023	(19.96)	0.036	(10.04)
Number of samples	436		436		436		436		436	
Log likelihood	–105.689		0.976		–24.393		–58.183		–83.850	
Probability of wage cuts (percent)	0.0		0.0		0.0		0.0		0.0	
Probability of wage freezes (percent)	62.8		51.7		54.7		57.5		59.7	

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