Department of Economics

Working Paper No. 0302

http://nt2.fas.nus.edu.sg/ecs/pub/wp/wp0302.pdf

Union Wage Effect: New Evidence From Matched Employer-Employee Data

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Abstract: This paper estimates a union wage effect, using matched employer-employee data and estimation models that control an association between a worker's union status and an employer's characteristics. Failure to control this association may cause previous studies' estimates of the union wage effect to be biased. As long as a worker is more likely to become a union worker in a firm that offers her a higher potential for better pay, the union status is (positively) associated with employer characteristics. The empirical finding of this paper verifies this possibility. Estimates of the union wage effect are shown to be upward-biased in the estimation models without control of the employer characteristics. The estimated union wage effect of this study (in an approximate range of 0.2~3.2 percent) is less than a quarter of cross-sectional estimates, and half of individual panel estimates with unobservable person effects.

JEL classification: J31, C23
Keywords: Union, Wage, Endogeneity, Person Effect, Firm Effect

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1 Introduction

What do unions do in a wage determination? It is one of the widely addressed questions in labor economics. Answering the question has been to measure the true wage premium to a union worker relative to the hypothetically same non-union worker. In an effort to measure this union wage premium, labor economists found that a worker's union status is not exogenous in the wage determination. While union status may affect a worker's wage rate, the latter will also influence the decision of the same worker in becoming a union worker.

Given the quite general agreement that a worker's union status is endogenous, the main question in measuring exactly the union wage premium is how to control the endogeneity in the wage equation to avoid bias. In order to control this, labor economists have taken advantage of various methods, depending on available data and objectives of the studies. Among others, longitudinal methods, intrumental variable methods and sample-selectivity correction methods are three of the most widely adopted econometric techniques. The longitudinal methods (Card (1996), Freeman (1984), Jakubson (1991)) control unobservable individual component of wage that affects a worker's union status in the form of unmeasurable individual attributes and productivity. The instrumental variable methods (Duncan and Stafford (1980), Robinson (1989)) control the union status endogeneity by relying on instrumental variables. The approaches of sample selection (Duncan and Leigh (1980), Lee (1978), Robinson and Tomes (1984)) focus on the fact that a worker's wage rate is observable only in one state (for example, union) and that measuring the true union wage premium requires a hypothetical wage rate of the same worker in the other state (for example, non-union). It views a wage rate as only being observable after a worker's endogenous decision to become a union worker is made.

In spite of the differences in their econometric specifications, however, these studies on union wage differentials commonly specify a worker's union status as affected only by the worker's

personal characteristics – that may be either observable or unobservable to researchers – in their estimation. In contrast to this line of literature, I view a worker's union status as not only associated with the worker's personal characteristics, but with characteristics of the employer (whether observable or unobservable to researchers). As long as a worker is more likely to become a union worker with the employer that offers higher potential for better pay, or as long as a firm pays higher wages in the face of a worker's greater likelihood of becoming a union worker, the union status is positively associated with the employer characteristics that are closely related with higher wage. In this case, a failure to control the association between a worker's union status and (compensation-related) characteristics of the employer may cause previous studies' estimates of union wage effect to be biased. In the specifications of the previous studies, the employer's characteristics are usually omitted, and these omitted variables are likely correlated with a worker's union status[1]. Based on this view, this paper re-estimates a union wage effect and evaluates the previous studies' estimates of the effect, using matched employer-employee data that contain longitudinal information of employers as well as workers, and estimation models that control employer effects and its characteristics.

The rest of the paper is organized as follows. In the next section, I illustrate the possibility that an employer characteristic is associated with a worker's union status by employing a widely used U.S. national household survey data – the National Longitudinal Survey for Youth, 1979. In Section 3, the estimation models that incorporate a worker's firm attributes together with personal ones are explained in the context of union wage effect estimation. The data used for the estimation is discussed in Section 4. The estimation results are presented in Section 5. Section 6 concludes the paper.

[1]There are some exceptions that have tried to consider the employer characteristics in the estimation of union wage premium. Among others, Podgursky (1986) and Wunnava and Ewing (1999) control the establishment size as a measure of employer characteristics in the estimation of union wage premium. However, this measure may not be an ideal one, in that the characteristics of a *firm* will be more important in a wage determination, than those of an *establishment* of the same firm. This issue will be revisited in a later section.

2 Union Density and Establishment Size

Many of the empirical studies on the determination of a worker's union status[2] specify it as associated with personal characteristics. This implies that an individual worker's likelihood of becoming a union worker depends only on the worker's personal characteristics. However, as Abowd and Farber (1982) and Card (1996) point out, a worker's observed union status is not only determined by a worker's desire to join a union. It is also affected by the employer's selection from union applicants. Although an individual worker with this or that personal characteristic is more (or less) inclined to join a union, her desire may not be realized unless the employer's decision coincides with the worker's desire. If employers' decision to employ union workers systematically differ, depending on their characteristics, a worker's observed and realized union status will be associated with the employer characteristics as well as with the worker's personal attributes.

Another explanation regarding the interaction between employer characteristics and worker's union status will be possible by relying on the framework of demand and supply of union. This explanation specifies the direction of the interaction in more detail. First, take a look at the supply and cost aspects of the union membership. Focusing on the employer size, among other factors, that is measured by the total number of employees in an establishment in which an individual works, there will be economies of scale in union organization. As discussed in Bramley, Wunnava, and Robinson (1989) and Wunnava and Ewing (1999), the likelihood of unionization is higher in larger firms or establishments, since larger ones provide larger pools of workers than smaller ones. The larger worker pool means a lower cost of unionization for the union organizers. Second, when looking at the demand side, there is evidence that a firm with a larger number of employees or with some degree of market power in the product market

[2]In these studies as well as in this paper, a worker's union status is measured by collective bargaining coverage. That is, one is a union worker as long as her wage contract is covered by the collective bargaining agreement between the firm and union (or similar employee association).

will better pay its employees in the form of economic rents (Abowd, Kramarz, and Margolis (1999), Brown and Medoff (1989), Stewart (1990), Bell (1995)). Given that a union is expected to improve union workers' wages, a worker is more willing to become a union worker in a firm that offers a higher potential for better pay. This tendency will therefore lead to a higher union density in such firms in combination with lower costs of unionization.

This positive association between employer characteristics and union density is illustrated by the empirical finding that follows. Using the 1986, 1989 and 1993 waves of the National Longitudinal Survey of Youth, 1979 (hereafter NLSY79), I construct each year's series of union density with respect to the establishment size reported in the data[3]. As is illustrated in ⟨Figure 1⟩, the union density – the proportion of union workers in each category of the establishment size – generally increases as an establishment hires larger number of workers. In an establishment with less than 10 employees, for example, only 8 to 10 percent of the total number of employees are union workers. In contrast, 23 to 26 percent of the employees are union workers in an establishment with 100 to 200 employees. The proportion becomes higher for an establishment with more than 3,000 employees.

INSERT ⟨Figure 1⟩

Although this simple empirical finding implies a positive association between employer characteristics and the individual worker's likelihood of becoming a union worker, the establishment size has a limitation, when used as a measure for employer characteristics that affect a worker's wage as well as a worker's union status. It may not be true that a component of a worker's wage related to employer's characteristics is determined within the level of establishment, and

[3] An establishment is an economic unit, such as a farm, mine, factory, or store, that produces goods or provides services. It is typically at a single physical location and engaged in one, or predominantly one, type of economic activity. Thus, a single *firm* may have multiple *establishments*. The reason I use the establishment size (on behalf of the firm size) as an employer characteristic here is that it is a widely used and unique measure for employer characteristic that is available in the original NLSY79 data. I will rely on other measures for employer characteristics such as the volume of a firm's sales or the total number of employees in the firm in the main analysis using matched employer-employee data.

that a worker desires to become a union worker in reference to the establishment's economic performances. Rather, what matters to a worker's wage and union status will be the characteristics of a *firm* as a whole rather than those of *establishment(s)* of the same firm[4]. In models of wage determination under the influence of a product market, as well, the matter of interest is the firm's position, not the single establishment's position, in the product market.

This consideration leads us to emphasize the characteristics of *firms* rather than those of *establishments* in the estimation of union wage premium. Thus, the estimation model suggested in later sections will mainly consider firm effects as a measure of the employer characteristics. Estimation results that consider the establishment effects (measured by the employee size of a establishment) as well as the firm effects, however, will be reported later as a supplement to the main results .

3 Estimation Models

A main model that is adopted for our estimation of the union wage effect is described as follows ;

$$W_{it} = X'_{it}\beta_1 + U_{it}\beta_2 + Z'_i\eta + \alpha_i + \psi_{J(i,t)} + \epsilon_{it} \tag{1}$$

where W_{it} is the logarithm of an individual i's hourly wage rate at date t; X_{it} and Z_i are vectors of time-varying and non time-varying exogenous characteristics of individual i, respectively; U_{it} is a dummy variable for i's union status at t that takes 1 if i is a union worker and 0 otherwise; α_i is the unobservable person effect; $\psi_{J(i,t)}$ is the firm effect for the firm at which worker i is employed at date t (denoted by $J(i,t)$); and ϵ_{it} is the statistical residual with mean 0 and

[4]Even and Macpherson (1994) make a distinction between firm size and establishment size and contend that the former effects clearly dominate the effects of the latter. They attribute this pattern to the scale economies in the administration of fringe benefits that are likely related to firm size, and not establishment size. Brown and Medoff (1989) summarize studies that report the independent effect of firm size and establishment size on wages.

variance σ_ϵ^2 given other right-hand side variables[5].

As long as an individual's union status is affected by (or is correlated with) the unobservable person effect and the firm effect, estimation models that fail to control either of them in the estimation of union wage effect are exposed to bias. The direction of the bias will depend on the nature of the relationship between union status and the omitted variable(s). Specifically, an estimation model will produce a biased estimate for union wage effect, if it treats every observation as independent and does not, as a result, explicitly take account of the unobservable person effect and the firm effect. Expecting that a worker's union status is positively correlated with each of these two effects[6], we anticipate that the estimated union effect is upward-biased[7]. An estimation model that relies on an individual panel data[8] and controls the unobservable person effect may also produce a biased result, if the firm effect is not considered. The latter's positive correlation with a worker's union status makes the estimated union effect upward-biased, as well. In this study, in contrast, I use a matched employer-employee data set that makes it possible to identify different firms and the characteristics of the firms that a particular individual has worked for in his/her work history over time. This data set enables us to control the firm effects as well as the unobservable person effects in the estimation, although detailed treatments of them vary among the estimation methods.

In the matched panel data analysis, I implement two methods that differ in the way of treating the unobservable person effects and firm effects in the estimation. The first method

[5]Abowd, Kramarz, and Margolis (1999) and Abowd and Kramarz (1999) have also used similar specifications to analyze their matched employer-employee data

[6]The positive correlation between union status and the person effect has been explained in the following two ways. First, a worker with a higher unobservable attribute is more likely to join a union, since anticipated earnings in a union is higher than in non-union alternative (Duncan and Leigh (1980), Lee (1978)). Second, a union worker has a higher unmeasured (by researchers) productivity, since employers respond to higher union wages by raising hiring standards (Pettengill (1980), Pencavel (1981)). However, the positive correlation between union status and the *firm* effect has not been highlighted as much. From the finding of higher union density in larger establishments, and persistent employer-size wage differentials reported by other studies, we can infer that a worker is more likely to be a union worker in firms that offer a higher potential for better pay.

[7]Until given proper consideration, we shall set aside the issue of measurement errors that cause the estimates to be biased toward zero(so-called attenuation bias).

[8]To distinguish it from the *matched* panel data, I will call the panel data without longitudinal information of employers the *individual* panel data.

employed is the fixed effects method, which views the unobservable person effects and firm effects as time-constant fixed components of a worker's wage. The second method is the random effects method, which specifies the unobservable person and firm effects as random variables generated by relevant statistical processes[9]. These two estimation methods have their own merits and weakness that can be supplemented by each other, giving rise to the same interpretation of the results.

The fixed effects method in our estimation is very simple and straightforward, in that it views the unobservable person effects (α_i) and firm effects ($\psi_{J(i,t)}$) as sets of parameters and estimates them together with other interesting parameters. It is also intuitively appealing that we add variables that are omitted and, thus, cause bias in simpler models, and that we allow for any forms of association between union status, and α_i or $\psi_{J(i,t)}$ in the estimation. In spite of these merits, however, this method is known to be exposed to some limitations in its application to our matched data analysis.

Among other things, the fixed effects methods are, in general, more vulnerable (than the random effects methods) to measurement errors, which bias the estimated effect toward zero. This problem arises mainly from the fact that they are basically difference-based estimation methods rather than level-based ones. Intuitively, a measurement error of an observation at one date is confined to this date in estimation of the level-based methods, whereas, in the difference-based methods, one date's measurement error can spill over to the other dates' transformed values of calculation in taking mean-differences or any kind of differences[10]. Studies on union wage effects very often indicate that the measurement errors of workers' reported union status

[9] Abowd and Kramarz (1999) explain the relationship between fixed and random effects specifications and correctly point out economists' confusion about the comparison of the two in the literature on matched employer-employee data. They name the economists' random effects model the mixed (effects) model, in order to make their econometric specifications coherent with the statistical literature on these types of models. In this paper, however, I follow the old (possibly misleading from a statistical viewpoint) term of the random effects methods to better contrast with the fixed effects methods.

[10] See Griliches and Hausman (1986), Freeman (1984) and Chowdhury and Nickell (1985) regarding the measurement error that exacerbates the bias in difference-based estimation methods for panel data.

are one of the main obstacles in obtaining true union effects on wage[11].

In addition, although it is specific only to our data analysis, the fixed effects method may suffer from a sampling bias of our matched data set in considering the firm effects as well as the union wage effect. Ideally, the firm effects (i.e. $\psi_{J(i,t)}$ in our specification) in individuals' wage constructs are the part of the wage that is shared by all employees in the same firm and, thereby, can be correctly measured when one has the wage information of all employees in that firm available. This is possible only in ideal employer-employee matched data that is derived from administrative sources. Our data set, which is basically derived from a household survey, lacks this ideal property for matched data, as it has available only a small portion of employees of any firm identified in the data set[12]. This may cause a bias in the estimates of firm effects, and it may influence the estimates of the union wage effect of our main interest.

In contrast, the random effects method[13] can supplement the fixed effects method while also serving as its alternative. It is less sensitive to the problem of measurement errors, since it is a level-based method, and to small number of employees identified as working for the same firm, since a firm's administrative records are used for controlling the firm effects.

In our specification, the random effects method views α_i and $\psi_{J(i,t)}$ as random variables derived from (assumed) respective distributions and takes account of this statistical property in the estimation step. Specifically, it relies on the maximum likelihood (ML) method for estimation, and α_i and $\psi_{J(i,t)}$ are integrated out as variables causing nuisance, in the construction of the likelihood function of wage rate. The ML method is preferred to a least squares method for estimation, since variance components of α_i and $\psi_{J(i,t)}$ should remain positive, and this

[11] Freeman (1984) and Card (1996) make detailed descriptions of the influence of measurement errors associated with union status on the estimated union wage effect.

[12] As a result, the firm effects estimated in our data analysis are, to be more exact, the fixed effects of firms shared only by those employees identified in the data set, which may not be representative of all employees in the same firm.

[13] To the best of my knowledge, Abowd and Kramarz (1999) is the first paper that suggests using a mixed (effects) model (i.e. a random effects model, in this paper's terminology) to analyze matched employer-employee data.

property may not be maintained in the latter method[14]. In the integration of α_i and $\psi_{J(i,t)}$ in the likelihood function, it is usually assumed that they are orthogonal to the other observable explanatory variables (such as X_{it} and U_{it} in our case). This assumption, however, is highly questionable in statistical application to economic data, let alone in our estimation of union wage effect. To control the association with X_{it} and U_{it}, following Mundlak (1978) and Chamberlain (1982), I model α_i as a function of within-individual mean of each variable, and $\psi_{J(i,t)}$ as a function of firm's characteristics, as follows;

$$\alpha_i = \overline{X'_{i\cdot}}\gamma_1 + \overline{U_{i\cdot}}\gamma_2 + \varsigma_i \tag{2}$$

$$\psi_{J(i,t)} = F'_{jt}\gamma_3 + \upsilon_j \tag{3}$$

where $\overline{X_{i\cdot}}$ and $\overline{U_{i\cdot}}$ are i's mean vector of X_{it} and U_{it} over all t, respectively; F_{jt} is a vector of observable firm $j(= J(i,t))$'s characteristics at t; and ς_i and υ_j are statistical errors following $N(0, \sigma_\varsigma^2)$ and $N(0, \sigma_\upsilon^2)$ that are associated with α_i and ψ_j, respectively[15]. It is assumed that ς_i and υ_j are independent of each other as well as of X_{it}, U_{it} and F_{jt}. Given these specifications, ς_i or υ_j are actually integrated out in the construction of the likelihood function, instead of α_i or $\psi_{J(i,t)}$.

In contrast to its advantages described earlier, the random effects method also has two main drawbacks. First, arbitrariness may arise when constructing a model of random effects. Since

[14] As also pointed out by Abowd and Kramarz (1999), the statistical models and estimation methods discussed here are very similar to those appearing in statistical and biometric literature under the subject 'generalized linear mixed models'. The difference exists in the fact that $\psi_{J(i,t)}$ in our model is specified as non-nested random effect, while it is usually specified as nested (within a same i) effect in theirs. The other model of ours (to be presented shortly) with job effects (i.e job match effect or person-firm interaction effects) on behalf of firm effects is the same as the generalized linear mixed models, since the job effect is nested within a same i. See Searle, Casella, and McCulloch (1992, Ch.6) for specifications and estimation methods of the 'generalized linear mixed models'.

[15] Instead of the linear form, one may try other functional forms of association between X_{it} and U_{it}, on the one hand, and α_i and ψ_j, on the other hand. However, given that a linear equation is a general approximation to a wage equation as long as all the necessary explanatory variables are included along with their higher order terms (such as quadratic and cubic terms, for instance), this linear form will not cause serious problems in approximating the association of our interest.

it relies on the ML estimation method, it may be vulnerable to a specification of the statistical properties of random variables and, as a result, to mis-specification of them. In addition, the mis-specification that may be associated with the equations (2) and (3) given earlier may not guarantee the independence of ς_i and υ_j. If there remains something uncontrolled in (2) and (3), it may cause the independence assumption for ς_i and υ_j to fail. Second, a large number of observations are lost when using a firm's administrative records as part of the explanatory variables in the wage equation. In our analyzed data, about 40 percent of the observations that have a firm's identification confirmed fail to also have its accounting information (such as total employee size, sales etc.) incorporated. As a result, using it as a set of explanatory variables leads to the loss of those observations. In contrast, the fixed effects method, which uses only the firm's identification while neglecting the accounting information, can avoid this limitation.

In sum, given their own merits and drawbacks as described so far, when interpreting the estimation results on the union wage effect, I do not make exclusive use of one of the two methods of estimation. Instead, I implement both methods and give an equal amount of weight to each method of the fixed and random effects. Thus, I report the true union wage effect as a range of estimates that are provided by each method.

Using the aforementioned complementarity of the fixed and random effects methods, I try another specification that can also supplement the estimation of union wage effect based on the firm effects model. This is the job effects model, which is very similar to the model specification given by the equation (1) with one exception that *job* effects are incorporated into the specification of wage rates on behalf of the *firm* effects. This job effects model supplements the results of the firm effects model on the basis of different observation units of comparison. While the firm effects model compares the wage rates of hypothetically same (except for the union status) workers in the same *firm*, the job effects model does the same comparison within the same *job match*. This job match is unique for a particular individual in a particular firm. Nonetheless,

it implies no difference in the interpretation of the union wage effect estimated from the firm effects model. The estimate is interpreted as a difference in wage rates between a union and non-union worker in the same job match (that is, in the same firm) who are, hypothetically, exactly same in all other respects. Given the unchanged interpretation of the results, the use of the job effects model is due, in particular, to the computational convenience of the random effects method. In constructing the likelihood function, the firm effects model involves an integration of the random terms across different individuals sharing the same firm effect, while the job effects model involves their integration within the same individual. The latter produces far greater advantages in the computation.

The job effects model is described as follows;

$$W_{it} = X'_{it}\beta_1 + U_{it}\beta_2 + Z'_i\eta + \alpha_i + \varphi_{ij} + \epsilon_{it} \tag{4}$$

where φ_{ij} is the job effect of an individual i' with a firm j. It is interpreted as an interaction effect between an individual and a firm, or a job match-specific effect that is unique for an individual within a specific firm. Likewise, a fixed effects method treating α_i and φ_{ij} as parameters, and a random effects method treating them as random variables are applied. To control an association with X_{it} and U_{it} in the random effects method, φ_{ij} is modelled as follows ;

$$\varphi_{ij} = F'_{jt}\gamma_3 + \overline{X'_{i\cdot(j)}}\gamma_4 + \nu_{ij} \tag{5}$$

where $\overline{X_{i\cdot(j)}}$ is i's mean vector of X_{it} over all t within same firm j, and ν_{ij} is a statistical error following $N(0, \sigma^2_\nu)$ that is associated with φ_{ij}.

4 Data

For this study, I use match employer-employee data based on the National Longitudinal Survey of Youth, 1979 cohort. This data set was constructed by Abowd and Finer (1999) in which an individual's job-related information provided by the NLSY79 was linked to information of firms that hired the same individual. They compared and matched employer names and other company information (industry, employment size, location, etc.) reported in the NLSY79 with those provided by Standard and Poors COMPUSTAT, the Center for Research on Security Prices at the University of Chicago, and the Directory of Corporate Affiliation given by the National Register Publishing Company[16]. They were able to match a total of 33,979 observations with 4,002 valid employers for 6,673 individuals for the period between 1986 and 1994. Firm's sales, operating income, value of capital and number of total employees as well as a firm's identification comprise the firm information available from the data for each year from 1986 to 1994.

Originally, the NLSY79 data have 113,855 observations for 10,843 individuals for the survey years 1986-94. Our final matched data is about a 30 percent sample of the original data with 33,979 observations for 6,673 individuals for the same sample period. ⟨Table 1⟩ compares descriptive statistics for the matched data with those for the original NLSY79 sample for 1986-94.

INSERT ⟨Table 1⟩

There exist slight but negligible differences between the original sample and matched sample in terms of pure personal characteristics. The means and standard deviations of age, years of experience and schooling, and the proportion of those married, male and white are very similar. In contrast, some differences exist between two samples in terms of characteristics that vary within and across firms. First of all, the establishment size of the matched sample is nearly

[16]See Abowd and Finer (1999) for the detailed process in which individual jobs in NLSY79 are matched with employers.

twice as large as the original sample. Employees in large establishments and, thereby, in large firms are reasonably expected to be matched better. The matched sample is also composed of those workers who are paid slightly higher wage rates, work longer hours a week, stay in a firm for more years and are more likely to be union workers. Slightly longer working hours in the matched sample is explained, as it contains a higher proportion (82 percent) of those working on a full-time basis than in the original sample (76 percent). In addition, the matched sample contains higher mean years of tenure, because the match rate increases as a worker's tenure increases. For example, the match rates for 5, 10, and 15 years of tenure are 48.8, 58.6 and 63.6 percent, respectively (Abowd and Finer (1999, Table 13, p.36)). Given the difference in match rates over working hours and tenure, and the observation that a strong attachment to a firm drives a high match rate, we can expect a higher proportion of union workers in the matched sample. As long as union workers are more likely to be full-time workers and to stay in a firm longer[17], their match rate would be higher, as verified in the table by the higher ratio of union workers in the matched sample. For a similar reason, a slightly higher mean wage of the matched sample would be a form of compensation for the strong attachment to a firm.

5 Estimation Results

5.1 Models with No Control of Firm Effects

In this section, as an intermediate step, the estimated union wage effect is reported for the models that do not have control of the firm effects. The first simplest model is the one that has no control of unobservable person effects and firm effects, and produces the cross-sectional estimate for the union wage effect. It treats the whole term of α_i, $\psi_{J(i,t)}$ and ϵ_{it} in equation (1)

[17] In the original NLSY79 sample, the proportion of union workers are 17.6 and 10.1 percent among full-time and part-time workers, respectively. A union worker's mean years of tenure is 3.53 years, while a non-union member's is 2.48 years.

as an error term, while dealing with every individual observation as an independent observation. ⟨Table 2⟩ displays its estimation results.

INSERT ⟨Table 2⟩

According to the table, union workers get paid approximately 15.1 percent higher, on average, than non-union workers[18]. In more detail, the wage rates of male union workers are approximately 17.9 percent higher than male non-union workers. In contrast, female union workers have an approximate 11.0 percent higher wage rate than female non-union workers. Union wage effect is a little stronger for male workers than their female counterparts. As discussed earlier, however, these estimates for the union effect are likely to be exposed to upward bias, as long as each of α_i and $\psi_{J(i,t)}$ is positively associated with U_{it} among others[19].

The second model has been designed to partly overcome this endogeneity problem by considering unobservable person effect in the regression and using individual panel data for an individual's work history[20]. This model explicitly includes α_i in estimation and considers $\psi_{J(i,t)}$ and ϵ_{it} in equation (1), as a whole, as an error term, treating each observation as independent, given observable explanatory variables and α_i. ⟨Table 3⟩ reports estimation results of this model. The fixed effects method views α_i as a parameter and estimates it for every i using the least squares method. In contrast, the random effects method considers α_i as a random variable and controls the association with observable variables through equation (2).

INSERT ⟨Table 3⟩

Overall, the second model produces smaller estimates for union wage effect than the first one. When we examine the estimates of the fixed effects method, union workers are estimated to

[18]This amount of union wage premium is very similar to the cross-sectional estimates of Lewis (1986, Table 20.1, p.1164) and Jakubson (1991, Table 1, p.977) for U.S. data.

[19]There is, however, a possibility that these estimates are downward-biased due to measurement errors associated with workers' reported union status. The measurement error problem will be discussed and explicitly dealt with in section (5.3.1).

[20]I will refer to the estimate given by this model as the *individual* panel estimate, in contrast to the *matched* panel estimate of this paper's focus.

get paid approximately 7.4 percent higher, on average, than non-union workers[21]. This degree of union effect is just half of the estimate given by the former model (i.e. 15.1 percent). When looking at the effect for males and females separately, the wage rates of male and female union workers are approximately 8.3 and 6.2 percent higher than those of their non-union counterparts. These amounts are also about half of those given by the former model (i.e. 17.9 and 11.0 percent, respectively). The estimates of the random effects method confirms that the union wage effect is weaker for either male, female or for both than when estimated in the model without a control for the unobservable person effect.

In addition, it is worth noting that these estimates of the random effects method are very close to those of the fixed effects method. This observation sheds some light on the issue of measurement error. Generally, if measurement errors are uncorrelated over time, a downward bias arising from the errors is much more severe in a difference-based estimation method (such as a fixed effects method) than in a level-based method (such as a random effects method). Given the possibility of a severe downward bias of the estimated union effect of our fixed effects method and the similar estimates of our random effects method, we may infer that the measurement error may not be a big problem when using the NLSY79 matched data to estimate the union wage effect. With a large measurement error, the estimated union effect would be fairly different when using the fixed and random effects methods.

5.2 Models with Controls of Firm Effects and Job Effects

The two models given previously with no controls of firm effects are the ones usually used in the studies of union wage effect with many variations of specifications (Duncan and Leigh (1980), Jakubson (1991), Robinson (1989) and Card (1996) and etc.). In contrast, the estimation model of our study is unique in the sense that it controls the firm effect explicitly, and avoids the bias

[21]This amount of the union wage premium is also very similar to the individual panel estimates of Jakubson (1991, Table 2, p.979) under homoscedasticity that are obtained using PSID, 1976-1980.

that may arise from the association between workers' union status and firm characteristics.

As discussed in Section 3, the first model applied to is a model with firm effects. In controlling the firm effects, I use three different specifications for each method of the fixed and random effects. In the fixed effects method, one specification uses firms' identification only, while the other specifications use information of sales per employee and number of total employees in the firm. In the random effects method, the firm effects are controlled by sales per employee, operating income per employee, or total number of firm employees. Note that the specifications with controls of firms' accounting records lead to losses in analytic observations that have firm identifications, while missing the information on those variables. ⟨Table 4⟩ and ⟨Table 5⟩ report the fixed and random effects estimation results, respectively, of the model with the firm effects[22]. The different specifications are labelled as (1), (2) and (3) in the tables.

INSERT ⟨Table 4⟩

INSERT ⟨Table 5⟩

According to the fixed effects estimates, the union wage effect does not really exist as much for the whole sample. As long as two workers who are identical with respect to tenure, experience and unobservable personal characteristics work in the same firm, their wage rates do not differ as much as is estimated by previous models without the firm effects, whether or not they are union workers (that is, whether their wages are set by a union contract or not, following our definition of union workers). A union worker receives only an approximate 0.2 percent higher wage rate, on average, than a non-union worker (who is otherwise identical) in the same firm. This amount of union wage premium is not even statistically significant. In addition, it turns out that this result is an outcome of counteracting effects between male and female workers. A

[22]For the fixed effects estimation, I make use of a module "Proc GLM" in SAS. For the random effects estimation, I use a statistical software "GenStat". See GenStat 5 Committee (1993) for the description of the method. I acknowledge John M. Abowd's permission to use this software in the CISER computing facilities in Cornell University.

male union worker receives an approximate 0.9∼2.5 percent higher wage rate, on average, than a male non-union worker (who is otherwise identical) in the same firm, although the amount of the union wage effect varies slightly depending on the firm characteristics used. In contrast, a female union worker gets paid approximately 0.5∼2.3 percent *less*, on average, than a female non-union worker (who is, again, otherwise identical) in the same firm. Although the estimate of the fixed effects method can be limited by the measurement errors and the relatively small number of firm employees identified, as indicated earlier, this result is quite surprising. A union wage effect estimated without a control of firm effects appears to be upward-biased due to the association between union status and uncontrolled firm effects in the wage equation.

This observation is readily confirmed by the random effects estimates of the union wage effect. Although it shows a slightly more pronounced wage effect than given by the fixed effect estimates, a union fails to increase union workers' wages as much as expected by previous studies that have no control of firm effects. For the whole sample, a union worker receives an approximate 3.1∼3.2 percent higher wage rate, on average, than a non-union worker in the same firm. As expected from the fixed effect results, union wage effect is stronger among male workers than among female workers. A male union worker receives an approximate 4.6∼4.7 percent higher wage rate than a male non-union worker in the same firm. In contrast, a female union worker gets paid approximately 0.9∼1.0 percent (statistically insignificant) more than a female non-union worker in the same firm. These estimated union effects are less than a quarter of those previously given by models without control of unobservable person and firm effects, and less than half of those with a control of unobservable person effect only.

Having the above estimation results available, we are now able to decompose the union wage premium given by the individual panel estimates into two different components. Suppose the

following equation is estimated in absence of the firm effects control;

$$W_{it} = X'_{it}\beta_1 + U_{it}\beta_2 + Z'_i\eta + \alpha_i + e_{it}$$

where $e_{it} = \psi_{J(i,t)} + \epsilon_{it}$.

Then, it is known that the estimated β_2 will converge in the limit to the true β_2 plus a part proportional to $Cov(U_{it}, \psi_{J(i,t)})$. The first component (i.e. the true β_2) is the wage rate of union workers as increased by union activities, compared with those of non-union workers (who are otherwise identical) in the same firm. This is exactly what is estimated in our study. In contrast, the second component is an amount of bias associated with individual panel estimates due to the uncontrolled covariation between a worker's union status and a firm effect. As long as the individual panel estimate of union wage premium is smaller than the estimate of our model with firm effects, the association between a union status and a firm effect turns out to be positive and, thereby, the individual panel estimate is upward-biased. From the estimation results above, it turns out that approximately (at least) 58 percent of the individual panel estimates is due to the uncontrolled association between the union status and firm effect and the remaining (at most) 42 percent is the true union premium in the same firm.

Given these lower estimates for the union wage effects, one may conceive that a union has little capability to increase union workers' wages in general, and may reach the conclusion that a union does not play a big role in wage determination. However, this conjecture and conclusion is not completely true. Although a union worker's wage rate is only slightly higher than a non-union worker's in the same firm, the union worker receives wage rates that are higher by the individual panel estimates, on average, than a non-union worker who is in a different firm. As long as a union has the power to drive the covariance part ($Cov(U_{it}, \psi_{J(i,t)})$) upward, it has the capability of increasing union workers' wages and, thereby, workers will have

enough of an incentive to become union workers. However, from our data and econometric specifications, the source of the increased covariation between union status and firm effects of compensation in union sectors is unclear. It may be due to the physical power of unions in having employers divide a greater portion of the economic rent to union workers, or due to employers' compensation policies in the face of union threats (the threat effect, for example). Searching for the sources of covariation between a worker's union status and firm characteristics will be a subject of further study.

The case of a reduced union wage effect reiterates in the other specification of the model with job effects on behalf of firm effects. The job effect is derived from an interaction between a person and a firm in a specific job match. It should be noted that the fixed *job* effects estimates are identical to the fixed *firm* effects estimates. They are so not only for the union estimate, but for the other estimates, too. This is because both estimation methods of fixed firm effects and job effects are derived from an identical data set and from within-job difference-based methods that are common to them in conceptual sense. While the fixed firm effects method estimates each firm effect and the fixed job effects method estimates each job effect, within-job differences of time-varying variables are exactly the same in both methods, whether the specifications given by the equation (1) or (4) are adopted. Since the within-job differences of the variables are used in the calculation of fixed effects estimates, the fixed job effects estimates happen to be identical to the fixed firm effects estimates.

As a result, the fixed job effects estimates reiterate the fixed firm effects results of the union wage effect, which displays very small effect of union on wage rates for the whole sample. A union worker receives an approximate 0.2 percent higher wage rate than his non-union counterpart, on average, while the union wage effect is more pronounced among male workers than among female workers. When we turn to the random job effects estimates reported in ⟨Table 6⟩, they are also very similar to their counterparts with firm effects. For the whole sample, the union wage effects

are approximately 2.7∼2.9 percent, while they stand at 4.4∼4.8 percent and 0.8∼0.9 percent for male and female workers, respectively. In sum, whether we control an association between a worker's union status and employer characteristics by means of firm effects or job effects, the estimated union wage effects do not differ by much, and they are very small compared to the cross-sectional and individual panel estimates.

INSERT ⟨Table 6⟩

5.3 Supplements to Main Estimation Results

The main estimation models given above have not taken into explicit consideration the following two issues that may, more or less, affect the estimates of union wage effect: (1) measurement errors associated with a worker's (reported) union status, and (2) establishment effects in contrast and in addition to firm effects. The subsequent subsections deal with these two topics as supplements to the main estimation and its results.

5.3.1 Adjustment of Measurement Errors

The issue of measurement errors for a worker's union status has been one of the bias-causing forces in the estimation of the union wage effect. In our data set of the NLSY79, the measurement errors may also be associated with workers' union status. Given this possibility, we need to control them to get a genuine estimate of the union wage effect. Unfortunately, however, there exists no external source of information available for NLSY79, that verifies a worker's true union status[23]. In the face of this limitation, I try to adjust possible measurement errors of reported union status in the following way.

I check the reported sequence of union status of an individual within the same job to find unreasonable changes in the status, and then correct the sequence if these changes exist. I

[23]Although there are some studies on the measurement (or reporting) errors for job tenures in the NLSY79 (Brown and Light (1992)), I have failed to find corresponding research on those of the union status in the NLSY79.

suspect that the unreasonable changes are rather likely arising from reporting errors of an individual's union status at a given date. The general principle I follow is that, within the same job of an individual, if a specific year's union status is different from that of two (behind and ahead) adjacent years, which are identical to each other, it is corrected to maintain the sequence. For example, if a sequence of union status within the same job is given by 11011, the third 0 is corrected to 1, so as to be modified as 11111. Likewise, 00100 is modified to 00000. However, if the union status of the two adjacent years are different (e.g. 00110) or if one of them is missing (e.g. 001.0), I do not correct the sequence of the raw data. In addition, I do not correct the sequence if the status alternates year by year (1101011 or 001010, for example), since I do not know which status is affected by mis-measurement. In this process of adjustment, a total of 337 modifications were made from the original matched data set. After the measurement errors were adjusted, the proportion of union workers falls a little from the original figure of 18.2 percent (as in ⟨Table 1⟩) to 17.2 percent. ⟨Table 7⟩ displays the estimation results based on supposedly correct union status.

INSERT ⟨Table 7⟩

After the adjustments, the union wage effect is estimated to be slightly higher (by approximately 1 percentage point higher) than previously shown in models with firm and job effects. Given that measurement errors cause bias of the interesting estimates toward zero, it shows that the reported union status of individuals has some (but not substantial) degree of errors. According to the whole sample estimates, union workers' wage rates are approximately 0.2∼0.8 percent or 3.8∼4.3 percent higher than those of non-union workers, according to the fixed and random effects estimates, respectively. Likewise, the union wage effect is stronger for male workers than for female workers. In addition, the observation still holds that a union wage effect estimated without a control of firm effects is upward-biased. The estimated union effects with

controlled firm effects are, at most, a quarter of the cross-sectional estimates, and half of the individual panel estimates with unobservable person effects.

5.3.2 Consideration of Establishment Effects

So far, the effects of employer characteristics on workers' wages are controlled by a single channel of *firm* effects in the estimation. However, some studies reports the independent effects of firm and establishment on workers' wages. Given this possibility, econometric specifications that control the establishment effects as well as the firm effects (or job effects) deserve to be implemented. Yet, an application of these specifications to the data does not come without a price in our case. As long as the establishment effects are controlled via total number of employees in the establishment (i.e. establishment size), which is the only measure of establishment effects available from our data set, we lose some part (roughly 20∼25 percent) of observations that have been used in the specifications with firm (or job) effects only[24]. This loss arises due to the fact that the firm data is obtained from outside source of administrative firm information (i.e. COMPUSTAT, the Center for Research on Security Prices and the Directory of Corporate Affiliation), while the establishment's employment size is available from the NLSY79 respondents' self-reports, which may have a lot of missing information. This loss in the number of observations induces me to choose the specification with the firm (or job) effects as a main model, while adopting the specification with the firm/establishment effects as a supplementary one. As ⟨Table 8⟩ shows, however, the estimated union wage effects with the firm/establishment controls are very similar to those of the main specification with the firm (or job) effects only, while most of the union effect estimates with the establishment control are roughly 1∼1.8 percentage points

[24]For instance, the total number of observations that are used in the fixed firm effects method for the whole sample is 22,970 with establishment size control, while it is 29,801 without it. In case of the random firm effects method for the whole sample, it is 12,867 with the establishment control, and 15,983 without it.

smaller than those without it[25]. For the whole sample, for instance, the fixed effects estimates for union wage effect are *negative* 0.8∼1.2 percent with the control of establishment size, while they are *positive* 0.2 percent without it. The random effects estimates are 0.9∼1.5 percent with such control, while they are 3.1∼3.2 percent without it.

INSERT ⟨Table 8⟩

6 Conclusion

Recent developments in matched employer-employee data makes it possible for labor economists to re-address, in a more sophisticated manner, the questions that have previously been raised and dealt with. The estimation of the true union wage premium is one of the topics that may be reconstructed, using the matched data.

In this study, using matched data, I estimate the union wage differential with control for an association between a worker's union status and firm characteristics. It is shown that the union wage effect estimated in previous literature with no control for this association is exposed to upward bias. The reason is that a worker's union status is positively associated with firm characteristics. A worker is more likely to become a union worker in a firm that offers a higher potential for better pay. The estimated union wage effect of this study is in the approximate range of 0.2∼3.2 percent, depending on the estimation method. This estimate of union wage effect is less than a quarter of cross-sectional estimates and half of individual panel estimates with unobservable person effects. In addition, the study finds that the union wage effect is a little stronger for male workers than their female counterparts. Again, depending on the estimation methods, a male union worker receives an approximate 0.9∼4.7 percent higher wage rate than a male non-union worker in the same firm. In contrast, a female union worker gets

[25]This comparison is made on the basis of the union effect estimates obtained from the union-status-unadjusted data.

paid approximately *negative* 2.3 $\sim$ *positive* 1.0 percent more than a female non-union worker in a same firm. However, the (reported) small degree of union wage effects does not imply that a union has little capability in increasing union workers' wages in general. As long as a union has the power to drive upward the covariation between a worker's union status and firm (or job) effects of compensation, it has the capability of increasing union workers' wages and, thereby, workers will have enough of an incentive to become union workers.

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Figure 1: Union Density and Establishment Size

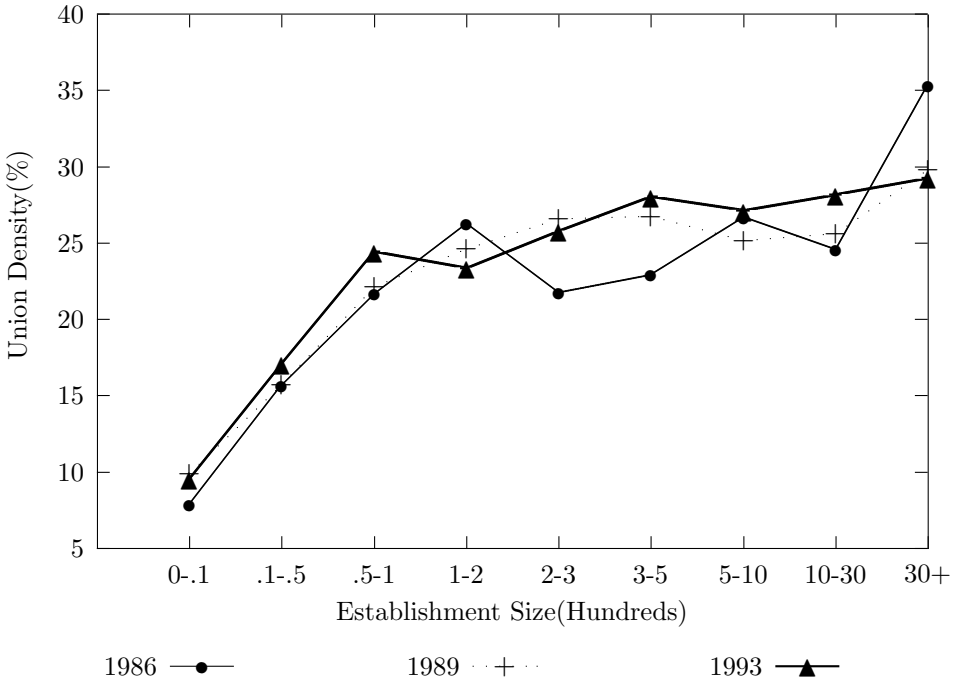

Table 1: Comparison between Original NLSY79 Data and Matched Data

Variable ＼ Data Set	Original NLSY Data	Matched Data
Log Real Hourly Wage	6.37	6.45
($ 1984)	(0.65)	(0.53)
Working Hours per Week	37.62	39.16
	(14.44)	(11.65)
Age	28.98	28.92
	(3.38)	(3.36)
Tenure (Year)	2.57	3.21
	(3.04)	(3.44)
Experience (Year)	8.50	8.73
	(3.72)	(3.71)
Establishment Size[1)]	574.7	1082.9
	(1778.2)	(2431.3)
Years of Schooling	12.94	13.03
	(2.40)	(2.19)
Union Worker	0.159	0.182
Married	0.468	0.483
Male	0.536	0.512
White	0.569	0.540
Full-time[2)]	0.760	0.823
Number of Observations	113,855	33,979
Number of Individuals	10,843	6,673

Note :
*) Standard deviations in parentheses.
1) I top-coded the employment size of the raw data at 10,000 in order to lower the effects of outliers.
2) Full-time worker is defined as a worker working at least 35 hours a week.

Table 2: Simplest Model with No Control of Unobservable Person Effects and Firm Effects

Explanatory Variables	Whole Sample	Male	Female
Intercept	4.7227***	4.8921***	4.7568***
	(0.0182)	(0.0268)	(0.0256)
Union Worker	0.1514***	0.1792***	0.1095***
	(0.0065)	(0.0087)	(0.0098)
Tenure	0.0864***	0.0850***	0.0870***
	(0.0022)	(0.0031)	(0.0032)
$\text{Tenure}^2/10$	-0.0467***	-0.0465***	-0.0469***
	(0.0019)	(0.0026)	(0.0028)
Experience	0.0339***	0.0351***	0.0322***
	(0.0030)	(0.0044)	(0.0042)
$\text{Experience}^2/10$	-0.0045***	-0.0062***	-0.0030
	(0.0016)	(0.0023)	(0.0024)
Married	0.0648***	0.1141***	0.0164**
	(0.0051)	(0.0075)	(0.0071)
Male	0.1819***		
	(0.0050)		
White	0.0923***	0.1124***	0.0734***
	(0.0051)	(0.0073)	(0.0071)
Years of Schooling	0.0841***	0.0826***	0.0845***
	(0.0012)	(0.0016)	(0.0018)
R-Square	0.3560	0.3335	0.3220
Number of Observations	29,801	15,316	14,485

Note :
1) Standard errors in parentheses.
2) *, ** and *** indicate that the estimate is significant at the 10%, 5% and 1% levels, respectively.

Table 3: Model with Unobservable Person Effects Only

	Fixed Effects Method		
Explanatory Variables	Whole Sample	Male	Female
Union Worker	0.0737***	0.0830***	0.0620***
	(0.0071)	(0.0096)	(0.0105)
Tenure	0.0443***	0.0441***	0.0444***
	(0.0021)	(0.0029)	(0.0031)
Tenure^2/10	-0.0234***	-0.0247***	-0.0216***
	(0.0018)	(0.0024)	(0.0027)
Experience	0.0452***	0.0499***	0.0401***
	(0.0034)	(0.0047)	(0.0048)
Experience^2/10	-0.0127***	-0.0143***	-0.0109***
	(0.0017)	(0.0023)	(0.0026)
R-Square	0.7717	0.7696	0.7505

	Random Effects Method[3)]		
Explanatory Variables	Whole Sample	Male	Female
Intercept	4.7744***	4.8530***	4.8683***
	(0.0276)	(0.0426)	(0.0403)
Union Worker	0.0741***	0.0829***	0.0627***
	(0.0072)	(0.0097)	(0.0106)
Tenure	0.0447***	0.0439***	0.0452***
	(0.0021)	(0.0029)	(0.0031)
Tenure^2/10	-0.0228***	-0.0238***	-0.0212***
	(0.0018)	(0.0025)	(0.0027)
Experience	0.0372***	0.0392***	0.0348***
	(0.0034)	(0.0048)	(0.0049)
Experience^2/10	-0.0109***	-0.0115***	-0.0102***
	(0.0017)	(0.0024)	(0.0026)
Married	0.0320***	0.0500***	0.0106
	(0.0055)	(0.0079)	(0.0075)
Male	0.1709***		
	(0.0085)		
White	0.0681***	0.1123***	0.0367***
	(0.0084)	(0.0126)	(0.0115)
Years of Schooling	0.0781***	0.0798***	0.0748***
	(0.0019)	(0.0027)	(0.0028)
Number of Observations	29,801	15,316	14,485
Number of Individuals	6,346	3,156	3,190

Note :
1) Standard errors in parentheses.
2) *, ** and *** indicate that the estimate is significant at the 10%, 5% and 1% levels, respectively.
3) The estimation results for person means of union status, tenure, experience, their higher terms, and variance components of unobservable person effect are suppressed. They are available from the author upon request.

Table 4: Model with Unobservable Person and Firm Effects - Fixed Effects Method

Explanatory Variables	Whole Sample			Male			Female		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Union Worker	0.0022	0.0015	0.0022	0.0088	0.0253*	0.0248*	-0.0052	-0.0226	-0.0208
	(0.0079)	(0.0103)	(0.0102)	(0.0110)	(0.0142)	(0.0142)	(0.0115)	(0.0148)	(0.0148)
Tenure	0.0278***	0.0272***	0.0273***	0.0269***	0.0257***	0.0268***	0.0292***	0.0289***	0.0289***
	(0.0028)	(0.0037)	(0.0037)	(0.0037)	(0.0048)	(0.0048)	(0.0044)	(0.0058)	(0.0058)
Tenure^2/10	-0.0150***	-0.0167***	-0.0166***	-0.0155***	-0.0178***	-0.0185***	-0.0146***	-0.0155***	-0.0154***
	(0.0018)	(0.0024)	(0.0024)	(0.0024)	(0.0032)	(0.0032)	(0.0026)	(0.0035)	(0.0035)
Experience	0.0255***	0.0177***	0.0167***	0.0283***	0.0205***	0.0191**	0.0211***	0.0119	0.0110
	(0.0043)	(0.0058)	(0.0058)	(0.0059)	(0.0079)	(0.0080)	(0.0063)	(0.0086)	(0.0086)
Experience^2/10	-0.0048**	0.0011	0.0014	-0.0060**	-0.0005	0.0000	-0.0028	0.0045	0.0047
	(0.0020)	(0.0027)	(0.0053)	(0.0027)	(0.0037)	(0.0037)	(0.0030)	(0.0040)	(0.0040)
Sales per Employee		-0.0138			0.0615**			-0.0175	
		(0.0123)			(0.0301)			(0.0166)	
Sales per Emp^2/10		0.0002			-0.0115***			0.0005	
		(0.0006)			(0.0040)			(0.0007)	
No. of Employees/10			0.0405			0.0454			0.0301
			(0.0258)			(0.0366)			(0.0372)
No. of Employees^2/100			-0.0347			-0.0470			-0.0152
			(0.0322)			(0.0428)			(0.0494)
R-Square	0.8698	0.8793	0.8795	0.8652	0.8774	0.8773	0.8616	0.8666	0.8668
No. of Observations	29,801	16,840	16,873	15,316	8,743	8,750	14,485	8,097	8,123
No. of Individuals	6,346	4,435	4,442	3,153	2,190	2,191	3,190	2,245	2,251
No. of Firms	3,825	1,586	1,593	2,527	1,111	1,112	2,287	1,013	1,019

Note :
1) Standard errors in parentheses.
2) *, ** and *** indicate that the estimate is significant at the 10%, 5% and 1% levels, respectively.

Table 5: Model with Unobservable Person and Firm Effects - Random Effects Method

Explanatory Variables	Whole Sample			Male			Female		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intercept	6.5090***	6.5130***	6.5180***	6.6200***	6.6230***	6.6220***	6.3760***	6.3800***	6.3890***
	(0.0076)	(0.0077)	(0.0094)	(0.0101)	(0.0102)	(0.0115)	(0.0096)	(0.0097)	(0.0116)
Union Worker	0.0312***	0.0312***	0.0316***	0.0456***	0.0457***	0.0473***	0.0090	0.0097	0.0087
	(0.0093)	(0.0094)	(0.0093)	(0.0126)	(0.0126)	(0.0126)	(0.0137)	(0.0139)	(0.0137)
Tenure	0.0394***	0.0397***	0.0394***	0.0318***	0.0319***	0.0325***	0.0467***	0.0484***	0.0469***
	(0.0028)	(0.0029)	(0.0028)	(0.0038)	(0.0038)	(0.0038)	(0.0042)	(0.0043)	(0.0042)
Tenure^2/10	-0.0212***	-0.0215***	-0.0210***	-0.0197***	-0.0198***	-0.0200***	-0.0226***	-0.0238***	-0.0225***
	(0.0023)	(0.0023)	(0.0023)	(0.0031)	(0.0031)	(0.0031)	(0.0034)	(0.0035)	(0.0034)
Experience	0.0221***	0.0211***	0.0227***	0.0334***	0.0324***	0.0348***	0.0049	0.0045	0.0056
	(0.0046)	(0.0046)	(0.0046)	(0.0063)	(0.0064)	(0.0063)	(0.0068)	(0.0069)	(0.0067)
Experience^2/10	-0.0041*	-0.0036	-0.0043*	-0.0083***	-0.0078**	-0.0088***	0.0034	0.0036	0.0030
	(0.0023)	(0.0024)	(0.0023)	(0.0032)	(0.0032)	(0.0032)	(0.0035)	(0.0036)	(0.0035)
Married	0.0219***	0.0217***	0.0218***	0.0379***	0.0388***	0.0382***	-0.0040	-0.0046	-0.0044
	(0.0068)	(0.0069)	(0.0068)	(0.0099)	(0.0099)	(0.0099)	(0.0094)	(0.0096)	(0.0094)
Male	0.1260***	0.1274***	0.1266***						
	(0.0102)	(0.0103)	(0.0102)						
White	0.0737***	0.0735***	0.0732***	0.0822***	0.0832***	0.0819***	0.0605***	0.0599***	0.0593***
	(0.0099)	(0.0110)	(0.0099)	(0.0152)	(0.0153)	(0.0153)	(0.0131)	(0.0132)	(0.0131)
Years of Schooling	0.0621***	0.0625***	0.0624***	0.0686***	0.0684***	0.0696***	0.0562***	0.0580***	0.0565***
	(0.0023)	(0.0023)	(0.0023)	(0.0034)	(0.0035)	(0.0034)	(0.0031)	(0.0032)	(0.0032)
Full-time	0.0680***	0.0620***	0.0684***	0.0778***	0.0655***	0.0794***	0.0642***	0.0632***	0.0653***
	(0.0083)	(0.0084)	(0.0082)	(0.0137)	(0.0139)	(0.0137)	(0.0104)	(0.0106)	(0.0104)
Sales per Employee	0.0345***			0.0865***			0.0432***		
	(0.0067)			(0.0149)			(0.0088)		
Sales per Emp^2/10	-0.0010***			-0.0102***			-0.0011***		
	(0.0004)			(0.0021)			(0.0004)		
Operating Income		0.0341***			0.0240			0.0589***	
per Employee		(0.0121)			(0.0153)			(0.0188)	
No. of Employees/10			0.0142			-0.0084			0.0204
			(0.0152)			(0.0184)			(0.0196)
No. of Employees^2/100			-0.0067			0.0208			-0.0062
			(0.0225)			(0.0280)			(0.0306)
Variance Components :									
Person Effect	0.0626***	0.0627***	0.0629***	0.0778***	0.0786***	0.0786***	0.0470***	0.0466***	0.0473***
	(0.0021)	(0.0021)	(0.0021)	(0.0036)	(0.0036)	(0.0036)	(0.0026)	(0.0026)	(0.0026)
Firm Effect	0.0026***	0.0380***	0.0383***	0.0352***	0.0376***	0.0373***	0.0385***	0.0400***	0.0417***
	(0.0019)	(0.0027)	(0.0026)	(0.0033)	(0.0034)	(0.0034)	(0.0034)	(0.0035)	(0.0036)
No. of Observations	15,983	15,679	16,015	8,321	8,210	8,328	7,662	7,469	7,687
No. of Individuals	4,324	4,292	4,331	2,136	2,121	2,137	2,188	2,171	2,194
No. of Firms	1,562	1,560	1,569	1,087	1,084	1,088	1,000	999	1,006

Note : 1) Standard errors in parentheses. *, ** and *** indicate that the estimate is significant at the 10%, 5% and 1% levels, respectively.
2) The estimation results for occupation dummies and person means of union status, tenure, experience, and their higher terms are suppressed. They are available from the author upon request.

Table 6: Model with Unobservable Person and Job Effects - Random Effects Method

Explanatory Variables	Whole Sample			Male			Female		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intercept	6.4790***	6.4800***	6.4780***	6.6040***	6.6040***	6.6030***	6.3460***	6.3460***	6.3440***
	(0.0055)	(0.0056)	(0.0055)	(0.0082)	(0.0083)	(0.0083)	(0.0072)	(0.0073)	(0.0073)
Union Worker	0.0272***	0.0285***	0.0289***	0.0438***	0.0467***	0.0480***	0.0079	0.0093	0.0086
	(0.0093)	(0.0094)	(0.0093)	(0.0127)	(0.0127)	(0.0127)	(0.0137)	(0.0139)	(0.0136)
Tenure	0.0245***	0.0252***	0.0246***	0.0221***	0.0236***	0.0229***	0.0275***	0.0282***	0.0278***
	(0.0038)	(0.0039)	(0.0038)	(0.0048)	(0.0049)	(0.0048)	(0.0062)	(0.0063)	(0.0061)
Tenure^2/10	-0.0174***	-0.0179***	-0.0174***	-0.0167***	-0.0173***	-0.0172***	-0.0182***	-0.0195***	-0.0182***
	(0.0024)	(0.0024)	(0.0024)	(0.0032)	(0.0032)	(0.0032)	(0.0036)	(0.0037)	(0.0036)
Experience	0.0149**	0.0147***	0.0167***	0.0160**	0.0152*	0.0182**	0.0093	0.0105	0.0114
	(0.0059)	(0.0060)	(0.0059)	(0.0079)	(0.0080)	(0.0080)	(0.0090)	(0.0092)	(0.0089)
Experience^2/10	0.0024	0.0025	0.0018	0.0006	0.0008	-0.0001	0.0063	0.0064	0.0056
	(0.0027)	(0.0028)	(0.0027)	(0.0037)	(0.0037)	(0.0037)	(0.0042)	(0.0042)	(0.0041)
Married	0.0190***	0.0197***	0.0196***	0.0413***	0.0421***	0.0421***	-0.0076	-0.0069	-0.0073
	(0.0070)	(0.0071)	(0.0070)	(0.0099)	(0.0100)	(0.0100)	(0.0097)	(0.0099)	(0.0098)
Male	0.1436***	0.1475***	0.1461***						
	(0.0108)	(0.0110)	(0.0109)						
White	0.0801***	0.0809***	0.0784***	0.0904***	0.0930***	0.0904***	0.0681***	0.0681***	0.0657***
	(0.0107)	(0.0108)	(0.0108)	(0.0160)	(0.0163)	(0.0162)	(0.0141)	(0.0144)	(0.0143)
Years of Schooling	0.0710***	0.0725***	0.0726***	0.0760***	0.0783***	0.0787***	0.0635***	0.0653***	0.0648***
	(0.0024)	(0.0025)	(0.0025)	(0.0035)	(0.0036)	(0.0035)	(0.0034)	(0.0035)	(0.0034)
Full-time	0.0541***	0.0552***	0.0536***	0.0409***	0.0421***	0.0434***	0.0619***	0.0647***	0.0614***
	(0.0086)	(0.0087)	(0.0086)	(0.0143)	(0.0144)	(0.0143)	(0.0107)	(0.0109)	(0.0107)
Sales per Employee	0.0506***			0.1102***			0.0645***		
	(0.0052)			(0.0126)			(0.0071)		
Sales per Emp^2/10	-0.0019***			-0.0142***			-0.0019***		
	(0.0004)			(0.0019)			(0.0004)		
Operating Income		0.0546***			0.0310**			0.0883***	
per Employee		(0.0111)			(0.0143)			(0.0176)	
No. of Employees/10			-0.0455***			-0.0461***			-0.0469***
			(0.0076)			(0.0108)			(0.0107)
No. of Employees^2/100			0.0745***			0.0741***			0.0786***
			(0.0123)			(0.0167)			(0.0184)
Variance Components :									
Person Effect	0.0593***	0.0612***	0.0616***	0.0719***	0.0761***	0.0757***	0.0445***	0.0468***	0.0474***
	(0.0029)	(0.0030)	(0.0030)	(0.0046)	(0.0047)	(0.0046)	(0.0037)	(0.0038)	(0.0038)
Job Effect	0.0424***	0.0422***	0.0425***	0.0429***	0.0417***	0.0422***	0.0409***	0.0414***	0.0421***
	(0.0024)	(0.0024)	(0.0024)	(0.0034)	(0.0034)	(0.0033)	(0.0033)	(0.0034)	(0.0034)
No. of Observations	15,983	15,679	16,015	8,321	8,210	8,328	7,662	7,469	7,687
No. of Individuals	4,324	4,292	4,331	2,136	2,121	2,137	2,188	2,171	2,194
No. of Jobs	6,313	6,236	6,331	3,127	3,088	3,131	3,186	3,148	3,200

Note : 1) Standard errors in parentheses. *, ** and *** indicate that the estimate is significant at the 10%, 5% and 1% levels, respectively.
2) The estimation results for occupation dummies, person and job means of union status, tenure, experience, and their higher terms are suppressed. They are available from the author upon request.

Table 7: Union Wage Effect with Corrections of Measurement Errors of Union Status

Estimation Methods:	Whole Sample							
Fixed Effects	0.1587***	0.0887***	0.0016	0.0067	0.0076	0.0016	0.0067	0.0076
	(0.0067)	(0.0077)	(0.0093)	(0.0121)	(0.0121)	(0.0093)	(0.0121)	(0.0121)
Random Effects		0.0950***		0.0425***	0.0432***		0.0380***	0.0405***
		(0.0110)		(0.0103)	(0.0103)		(0.0105)	(0.0105)
Control of Person and Firm Effect								
Unobservable Person Effect		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unobservable Firm Effect			Yes	Yes	Yes			
Unobservable Job Effect						Yes	Yes	Yes
Other Observable Controls								
(1) Sales per Employee				Yes			Yes	
(2) Number of Employees					Yes			Yes
Estimation Methods:	Male							
Fixed Effects	0.1838***	0.0966***	0.0092	0.0435***	0.0430**	0.0092	0.0435***	0.0430**
	(0.0089)	(0.0105)	(0.0129)	(0.0168)	(0.0168)	(0.0129)	(0.0168)	(0.0168)
Random Effects		0.0997***		0.0594***	0.0619***		0.0596***	0.0653***
		(0.0152)		(0.0141)	(0.0141)		(0.0143)	(0.0143)
Control of Person and Firm Effect								
Unobservable Person Effect		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unobservable Firm Effect			Yes	Yes	Yes			
Unobservable Job Effect						Yes	Yes	Yes
Other Observable Controls								
(1) Sales per Employee				Yes			Yes	
(2) Number of Employees					Yes			Yes
Estimation Methods:	Female							
Fixed Effects	0.1192***	0.0783***	-0.0071	-0.0314*	-0.0292*	-0.0071	-0.0314*	-0.0292*
	(0.0101)	(0.0114)	(0.0134)	(0.0174)	(0.0173)	(0.0134)	(0.0174)	(0.0173)
Random Effects		0.0859***		0.0162	0.0162		0.0122	0.0140
		(0.0159)		(0.0153)	(0.0152)		(0.0154)	(0.0154)
Control of Person and Firm Effect								
Unobservable Person Effect		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unobservable Firm Effect			Yes	Yes	Yes			
Unobservable Job Effect						Yes	Yes	Yes
Other Observable Controls								
(1) Sales per Employee				Yes			Yes	
(2) Number of Employees					Yes			Yes

Note :
1) Standard errors in parentheses.
2) *, ** and *** indicate that the estimate is significant at the 10%, 5% and 1% levels, respectively.
3) The estimates for variables other than union status are suppressed. They are available from the author upon request.

Table 8: Union Wage Effects with Control of Establishment Effects

Estimation Methods:	Whole Sample					
Fixed Effects	-0.0075	-0.0119	-0.0111	-0.0075	-0.0119	-0.0111
	(0.0088)	(0.0114)	(0.0113)	(0.0088)	(0.0114)	(0.0113)
Random Effects		0.0143	0.0148		0.0088	0.0102
		(0.0103)	(0.0103)		(0.0103)	(0.0093)
Control of Person and Firm Effect						
Unobservable Person Effect	Yes	Yes	Yes	Yes	Yes	Yes
Unobservable Firm Effect	Yes	Yes	Yes			
Unobservable Job Effect				Yes	Yes	Yes
Other Observable Controls						
(1) Sales per Employee		Yes			Yes	
(2) Number of Employees			Yes			Yes
Estimation Methods:	Male					
Fixed Effects	0.0009	0.0146	0.0142	0.0009	0.0146	0.0142
	(0.0121)	(0.0156)	(0.0156)	(0.0121)	(0.0156)	(0.0156)
Random Effects		0.0292**	0.0314**		0.0267*	0.0310**
		(0.0141)	(0.0141)		(0.0141)	(0.0141)
Control of Person and Firm Effect						
Unobservable Person Effect	Yes	Yes	Yes	Yes	Yes	Yes
Unobservable Firm Effect	Yes	Yes	Yes			
Unobservable Job Effect				Yes	Yes	Yes
Other Observable Controls						
(1) Sales per Employee		Yes			Yes	
(2) Number of Employees			Yes			Yes
Estimation Methods:	Female					
Fixed Effects	-0.0166	-0.0364**	-0.0342**	-0.0166	-0.0364**	-0.0342**
	(0.0128)	(0.0166)	(0.0165)	(0.0128)	(0.0166)	(0.0165)
Random Effects		-0.0113	-0.0108		-0.0119	-0.0112
		(0.0151)	(0.0151)		(0.0151)	(0.0151)
Control of Person and Firm Effect						
Unobservable Person Effect	Yes	Yes	Yes	Yes	Yes	Yes
Unobservable Firm Effect	Yes	Yes	Yes			
Unobservable Job Effect				Yes	Yes	Yes
Other Observable Controls						
(1) Sales per Employee		Yes			Yes	
(2) Number of Employees			Yes			Yes

Note :
1) Standard errors in parentheses.
2) *, ** and *** indicate that the estimate is significant at the 10%, 5% and 1% levels, respectively.
3) The estimates for variables other than union status are suppressed. They are available from the author upon request.