Reduced Hours of Work and Workers' Utility

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Introduction

This paper compares employees' utility in union firms with that in nonunion firms. The theoretical model assumes that labour and management negotiate a Pareto-optimal bargain over hours of work as well as annual wages. The empirical analysis specifies the shape of the trade union objective functions, assuming that observed wage-hours outcomes are on the "contract curve". We estimate employees' utility in union and nonunion firms, controlling for variables that influence wages and hours of work.

The statistical results suggest that union firm employees could have slightly higher utility than those in nonunion firms. However, union effects on hourly wages are insignificant except for female employees with senior high school diplomas. The results also indicate that union firms have significantly shorter hours of work than nonunion firms. Annual wages in union firms are significantly fewer than those in nonunion firms except for female employees with senior high diplomas. It is possible that the role and the power of trade unions have changed considerably under recent trends toward shorter working hours.

Reduction of working hours has been one of the major issues of the Japanese labour market since the Plaza Accord. Labour and management have tried hard to shorten hours of work. As a result, working time has been declining since the late 1980's. According to the White Paper on Labour 1994 [17], weekly scheduled working hours in the private sectors decreased about 4 hours in the period 1985-1992.

Theoretically, reduction of working hours could cause wage increase through the growth of labour productivity (Hayami [3], KEO Research group[4]). However, in our analysis, union firms do not necessarily pay higher wages because they have shorter hours of work.

Empirical analyses on Japanese unions so far have not reached the conclusion that Japanese unions significantly raise wages. The estimation by Tachibanaki [12] revealed that union wage effects were not significant for thirty-year-old male employees. According to his

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statistical results, trade unions raise employees' bargaining power. However, increased bargaining power does not necessarily lead to higher wages. Rebitzer and Tsuru [11], in their analysis of individual data, also found that union wage effects for full-time male employees were virtually zero. Their estimation suggested that union wage effects on female wages were positive. However, after controlling female wages for tenure, they could not find significant positive union effects. The research by Nakamura, Sato, and Kamiya [7] also suggested that unions did not increase the possibility that a wage rise took place. Our analysis differs from those of our predeccesors in the following two points. First, it yields a result that unions have significant positive effects on annual wages of female employees with high school diplomas. Second, it points out the possibility that male employees in union firms have higher utility than those in nonunion firms, although the former tends to be paid fewer annual wages than the latter.

In this study, we suppose that trade unions have quadratic objective functions defined over hours of work as well as wages. Objective functions basically describe the behavior of union firm employees. However, they could provide us with benchmarks for assessing the utility levels of nonunion as well as union firm employees. We estimate their parameters indirectly by fitting the "contract curve" to wage-hours outcomes. For calculating utility levels, we substitute theoretical wages and hours of work into the objective functions. For female employees with senior high diplomas, utility in union firms slightly exceeds that in nonunion firms. This result is not surprising, as unions have wage gains for this categories of employees. Unions also have positive effects on male employees' utility while giving negative effects on their annual wages. This is partly because unions have significant negative effects on working hours and partly because much weight is placed on leisure in trade unions' objective function.

Our results suggest that the Japanese unions still have the power to improve working conditions, particularly for employees who are not paid well or who have limited opportunities of promotion. The existence of Japanese unions could continue to have beneficial effects on the welfare of working people. However, the main objective of trade unions is to raise wages for all the members. It is possible that the fall in union density observed in almost all industrial sectors of Japan is related with the decrease of union rents caused by the recent moves toward shorter hours of work.

Section 1 posits a theoretical model in which labour and management bargain over contracted hours of work as well as annual wages. Section 2 controls wages and hours of work for various factors. Section 3 specifies trade union objective functions by estimating the "contract curves". This section also compares utility levels of union firm employees with those of nonunion firm employees. The data are from "Survey on Working Conditions and the Communication between Labour and Management"[14] by the JTUC Research Institute.

1 The Model

In the Western countries, economists have developed a wide variety of theoretical models on labour-management bargainings. Most of them assume that trade unions maximize well-defined objective functions while firms maximize profits. In our predecessors' analyses, unions' objective functions are defined over real wages and employment. This formulation is not suited for describing the industrial relations of Japan, where employment is rarely determined through labour-management bargaining. We assume that the Japanese unions' objective function is defined over wages and scheduled hours of work.

The form of the utility function has scarcely been examined in Japan. In empirical analyses carried out in the U.S. and the Scandinavian countries, the Stone-Geary type utility function is widely used because it is easy to handle (Macurdy and Pencavel [5], Pencavel [10]). However, its microeconomic foundations are weak, as pointed out by Ohashi [8]. The utilitarian utility function has a more solid foundation than the Stone-Geary type. Again, is is not necessarily appropriate to describe the labour-management bargaining in Japan, where union members are limited to employees who have jobs at present. The utility function formulated here is a generalized form that nests the Stone-Geary type and the "wage bill" functions as special cases. It is a quadratic function of annual wages and working time. From this model, we derive the Pareto-optimal combinations of wages and hours of work.

Suppose that a trade union's utility depends on both wages and leisure as (1).

(1) $U=U(wh,\ T-h)$

w, h, and T are hourly wages, hours of work, and total hours in a year respectively.
A firm has a production function as equation (2).

(2) $Y=f(hL)$

Y and L are value added and number of employees, respectively. In this model, the output elasticity for the number of employees is different from that for hours worked.
The firm's profit is defined as (3).

(3) $\Pi=f(hL)\ -whL$

Labour and management tries to maximize the weighted product defined as follows. denotes the trade union's relative bargaining power.

(4) $\Omega=U^{\alpha}\Pi^{1-\alpha}$

The first order conditions for maximizing are as (5), (6), and (7).

(5) $\partial\Omega/\partial w=0$

(6) $\partial\Omega/\partial h=0$

(7) $\partial\Omega/\partial L=0$

By substituting (1) and (3) into the first order conditions (5), (6), and (7), we get (8), (9), and (10).

(8) $U/U_1=\{\chi(1-\beta)/\beta(1-\chi)\}\ wh$

(9) $f_L=wh$

(10) $(U_1w-U_2)/U=-(1-\chi)(f_h-wL)/\chi\Pi$

U_1 and U_2 are the first order derivatives of the utility function.

$U_1=\partial U/\partial(wh)$

$U_2=\partial U/\partial(T-h)$

From (8) and (10), we get (11).

(11) $U_1/U_2=f_h/L$

We suppose that the union has a quadratic objective function as (12).

(12) $U=wh+\mu_1(T-h)+\mu_2(wh)(T-h)+\mu_3(wh)^2+\mu_4(T-h)^2$

μ_1 is the relative weight of leisure against wages in the union's objective. If the parameters μ_1 μ_2 μ_3, and μ_4 are jointly zero, then the unions objective is the "wage bill". If μ_1 μ_3, and μ_4 are jointly zero, then the unions objective is a kind of the Stone-Geary function. In the case where μ_1 is positive, the remaining parameters are expected to fulfill the following conditions.

(13) $U_1=1+\mu_2(T-h)+2\mu_3(wh)>0$

(14) $U_2=\mu_1+\mu_2(wh)+2\mu_4(T-h)>0$

(15) $U_{11}=2\mu_3<0$

(16) $U_{22}=2\mu_4<0$

(17) $U_{11}U_{22}-(U_{12})^2=4\mu_3\mu_4-(U_2)^2>0$

U_{11}, U_{22} and U_{12} are the second order derivatives of the utility function.

$U_{11}=\partial^2U/\partial(wh)^2$

$U_{22}=\partial^2U/\partial(T-h)^2$

$U_{12}=\partial^2U/\partial(wh)\partial(T-h)$

The firm's production function is as follows. Output elasticity of hours is different from that of number of employees (Ohashi [8]). This specification is based on the empirical findings, as discussed later.

(18) $f(hL)=h^{\alpha}L^{\beta},\ 0<\alpha<1,\ 0<\beta<1$

The firm's profit is then as (19).

(19) $\Pi=h^{\alpha}L^{\beta}-whL$

By substituting (13), (14), and (18) into (11), we get (20), which represents the Pareto-optimal combination of wages and hours of work in union firms.

(20) $$h=\frac{\alpha w(1+\mu_2 T)-\beta(\mu_1+2\mu_4 T)}{(\alpha+\beta)\mu_2 w-2(\alpha\mu_3 w^2+\beta\mu_4)}$$

Equation (20) is the "contract curve". Wages and hours of work in union firms are supposed to be on this curve.[1] In Section 3, we will estimate the parameters of this equation.

2 Statistical analysis

The purpose of this study is to compare employee utility in union firms with that in nonunion firms. In this section, we take the following procedures beforehand. First, we control both hourly wages and hours of work for firms' charateristics such as region, size, and industry. The term "hourly wages" here means annually scheduled wages divided by annually scheduled hours of work. Overtime premiums are not in the scope of our analysis. We first estimate hourly wages and hours of work on the basis of the simultaneous equations model. Then we predict hourly wages and hours of work for the following four categories of 30-year-old employees; male employees with senior high diplomas, male employees with college diplomas, female employees with senior high diplomas, and female employees with college diplomas. In section 3, we estimate "contract curve" to compare utility levels between union firm and nonunion firm employees, using the wages and hours of work after controls obtained in this section.

2-1 The Data

The data are from the "Survey on Working Conditions and the Communication between Labour and Management" [14] by the JTUC Research Institute for Advancing Living Standards. It is based on individual firm. The questionnaire was sent to firms with more than 100 employees. The variables covered in this survey are as follows; standard annual wages, bonuses, retirement allowances, scheduled hours of work, overtime hours, number of employees, labour force composition, tenure, industry, union status, and the firm's location. The survey also includes various indices for union performances. The number of observations is 689. About half of them are unionized (Tachibanaki [12]). The data was collected in 1991, when

[1] For nonunion firms, optimal combinations of wages and hours of work cannot be determined.

the reduction of working time was stressed by labour and management.

We analyze union effects on standard wages and scheduled hours of work of 30-year-old employees. The data are available for the following four categories of employees.

male employees with senior high school diplomas
male employees with college diplomas
female employees with senior high school diplomas
female employees with college diplomas

The data for 45-year-old employees are also available. However, we do not analyze them, as union coverage of male employees of this age is low.

2-2 Controls for Labour Quality

Both hourly wages and hours of work are affected by a variety of factors such as labour quality, firm size, and region. We control for such factors through the estimation of wages and hours functions as (21).

(21) $w_j = a_0 + a_1 X_j + a_2 U_j + e_j$
$h_j = b_0 + b_1 X_j + b_2 U_j + \varepsilon_j$

w_j and h_j are hourly wages and hours of work of the j-th firm, respectively. X_j is the matrix of firm characteristics that affect both wages and hours of work. U_j is the dummy variable for whether the j-th firm is organized or not. e_j, and ε_j, are the error terms. For union firms, predicted wage per hour and hours of work (w_{uj} and h_{uj}) are defined by the pair of equations (23). For nonunion firms, on the other hand, the corresponding predicted values (w_{ni} and h_{ni}) are given by the pair of equations (24).

Union wages and hours of work

(23) $w_{uj} = a_0 + a_1 X_{uj} + a_2$
$h_{uj} = b_0 + b_1 X_{uj} + b_2$

Nonunion wages and hours of work

(24) $w_{ni} = a_0 + a_1 X_{ni}$
$h_{ni} = b_0 + b_1 X_{ni}$

We first estimate equations (21) and then predict hourly wages and hours of work for each group[ii] using the equations (23) and (24). The explanatory variables included in the matrix X are as follows.

[ii] We assume that both union and nonunion firms have the common returns to firm characteristics. Controls for the union-nonunion differences in the returns do not seriously affect our statistical results.

Region1: dummy variable for Tokyo and the surrounding regions
Region2: dummy variable for Osaka, Kyoto, and the surrounding regions
Region3: dummy variable for Nagoya and the surrounding regions
Manu: dummy variable for the manufacturing industry
Trans: dummy variable for the transportation sector
Size1: dummy variable for firms with more than 1,000 employees
Size2: dummy variable for firms with 300 to 999 employees

The reasons why we control wages and hours of work for these variables are as follows. It is a well known fact that in Japan, wage differentials between different sized firms are significant. It is also known that employees in small and medium firms tend to have longer hours of work than those in large firms. Thus we bring the variables representing firm size such as Size1 and Size2 in the regression model. Regions also influence wages, as pointed out by Tachibanaki [12]. We also add dummies for manufacturing industry and the transportation sector to the explanatory variables, as these sectors have more manual employees than other sectors.

As hourly wages and hours of work could be related with each other[iii], we estimate them simultaneously using the two-stage least squares method. The regression results are in Tables 1-1, 1-2, 1-3, and 1-4[iv]. Region dummies give significant positive effects on wage per hour, while giving significant negative effects on hours worked. Firm size dummies also have significant positive effects on wage per hour while significantly reducing hours of work. For all the four categories of employees, union effects on hours worked are negative. For female employees with high school diploma, unions have significant positive impacts on hourly wages. However, for the remaining three categories of employees, union wage effects are insignificant.

For predicting wages and hours of work, we use observations with no missing values. The theoretical wages and hours of work obtained from equations (23) and (24) are in Table 3 and in Figures 1-1, 1-2, and 1-3. We test whether union-nonunion differences in predicted hourly wage (w), hours of work (h), and annual wages (wh) are significant or not. The term "annual wages" here means the product of the predicted hourly wage and the predicted hours of work. For all the four categoreis of employees, unions have significant negative effects on hours worked. Annual hours of work in union firms are, on the average, 80 hours shorter than the corresponding values in nonunion firms. On hourly wage rate, unions have significant positive effects except for female employees with college diplomas. However, union gains on hourly wages are only 30 yen and 22 yen for male employees with senior high school diplomas and those with college diplomas, respectively. On the other hand, for female employees with senior high school diplomas, unions raise hourly wage rate as much as 70 yen. Union effects on annual wages are mixed. For female employees with senior high diplomas, average union gains on wage income are about 50,000 yen. For other categories of employees, union firms have

[iii] In Tachibanaki [12], hourly wages are negatively related with scheduled hours of work.

[iv] Number of observations for female employees with college diplomas is the smallest. This is because some firms do not have standard wages for them.

Table 1-1 Wages and Hours of Work, 30-Year-Old Male Employees with Senior High Diplomas

Method of Estimation: Two-Stage Least Squares Method

	w_j	h_j
Intercept	1.147 (55.293)	2127.026 (173.926)
$(Region1)_j$	0.201 (7.807)	-100.494 (-6.608)
$(Region2)_j$	0.119 (4.136)	-60.670 (-3.565)
$(Region3)_j$	0.114 (3.849)	-20.493 (1.174)
$(Manu)_j$	-0.075 (-3.469)	20.976 (1.642)
$(Trans)_j$	-0.028 (-0.764)	80.515 (3.746)
$(Size1)_j$	0.138 (3.002)	-59.202 (-2.183)
$(Size2)_j$	0.074 (2.986)	-54.689 (-3.732)
U_j	0.024 (1.115)	-78.888 (-6.295)
$\bar{R}^2$	0.1458	0.1828
Number of observations	561	561

Figures in parentheses are t-values.
Manu: manufaturing industries Trans: transportation sector
Size1: Firms with more than 1,000 employees
Size2: Firms with 300 to 999 employees
Region1: Tokyo and the surrounding regions
Region2: Osaka , Kyoto and the surrounding regions
Region3: Nagoya and the surrounding regions

wage losses instead of wage gains about 30,000 yen[v] a year. Except for female employees with senior high school diplomas, union gains on hourly wage rate is not enough to compensate for shorter hours of work.

[v] A simple descriptive analysis reveals that union wage effects vary with industry and firm size. For male employees with senior high diplomas in the manufacturing sector, union wage losses are 130,000 yen and 45,000 yen for "Size1" and "Size2" firms, respectively. For those in the wholesale and retail sector, union wage gain is about 86,000 yen for "Size2" firms, while that for "Size1" firms is minus 138,000 yen per year.

Table 1-2 Wages and Hours of Work, 30-Year-Old Male Employees with College Diplomas

Method of estimation: Two-Stage Least Squares Method

	w_j	h_j
Intercept	1.260 (49.689)	2115.962 (157.874)
$(Region1)_j$	0.224 (7.369)	-112.757 (-7.036)
$(Region2)_j$	0.126 (3.560)	-69.639 (-3.738)
$(Region3)_j$	0.080 (2.255)	-21.193 (-1.136)
$(Manu)_j$	-0.037 (-1.453)	28.523 (2.093)
$(Trans)_j$	-0.034 (-0.728)	102.192 (4.155)
$(Size1)_j$	0.151 (2.962)	-48.374 (-1.792)
$(Size2)_j$	0.062 (2.092)	-29.878 (-2.093)
U_j	0.007 (0.272)	-83.388 (-6.193)
$\bar{R}^2$	0.1236	0.1927
Number of observations	504	504

Figures in parentheses are t-values.

Do union firm employees other than female with senior high diplomas have lower utility than their nonunion counterparts because of lower wages? The next section will compare utility levels between union and nonunion firm employees on the basis of the theoretical wages and hours of work obtained in this section.

Table 1-3 Wages and Hours of Work, 30-Year-Old Female Employees with Senior High Diplomas

Method of estimation: Two-Stage Least Squares Method

	w_i	h_i
Intercept	0.948 (47.119)	2125.738 (154.591)
$(Region1)_i$	0.232 (9.420)	-108.759 (-6.459)
$(Region2)_i$	0.157 (5.531)	-75.866 (-3.902)
$(Region3)_i$	0.065 -33.408	(2.247) (-1.679)
$(Manu)_i$	-0.094 (-4.452)	26.075 (1.813)
$(Trans)_i$	-0.068 (-1.950)	85.817 (3.593)
$(Size1)_i$	0.096 (2.212)	-49.600 (-1.678)
$(Size2)_i$	0.109 (4.539)	-46.572 (-2.847)
U_i	0.070 (3.353)	-76.097 (-5.342)
$\overline{R}^2$	0.2522	0.1733
Number of observations	479	479

Figures in parentheses are t-values.

Table 1-4 Wages and Hours of Work, 30-Year-Old Female Employees with College Diplomas

Method of estimation: Two-Stage Least Squares Method

	w_j	h_j
Intercept	1.071 (30.800)	2103.482 (106.096)
$(Region1)_j$	0.239 (5.951)	-105.754 (-4.615)
$(Region2)_j$	0.115 (2.491)	-60.756 (-2.301)
$(Region3)_j$	0.013 (0.236)	-12.264 (-0.406)
$(Manu)_j$	-0.039 (-1.101)	1.199 (0.059)
$(Trans)_j$	-0.069 (-1.157)	130.879 (3.823)
$(Size1)_j$	0.044 (0.670)	-9.237 (-0.249)
$(Size2)_j$	0.076 (1.999)	0.175 (0.008)
U_j	0.026 (0.759)	-90.862 (-4.702)
$\bar{R}^2$	0.1637	0.2011
Number of observations	239	239

Figures in parentheses are t-values.

Table 2 Predicted Wages and Hours of Work, Union and Nonunion Firms

		Male, Senior High School	Male, College	Female, Senior High School	Female, College
Hourly Wage(1,000 yen)	Union	1.257	1.381	1.103	1.200
	Nonunion	1.228	1.360	1.035	1.183
	t-value	-3.458*	-2.236*	-6.052*	-1.114
Annual Wage(1,000 yen)	Union	2520.52	2749.06	2209.64	2369.05
	Nonunion	2558.03	2818.29	2148.12	2432.24
	t-value	2.9557*	5.3627*	-3.5092*	2.7404*
Annual Hours of Work	Union	2008.93	1995.14	2009.60	1980.67
	Nonunion	2087.60	2076.34	2081.75	2061.66
	t-value	16.344*	15.202*	13.214*	9.824*

*Significant at the 5% significance level.

Table 3 Production function of manufacturing industries, 1979-1988.

Estimated formula; $\log\left(\frac{Y_{tj}}{P_t}\right) = \alpha\log(h_{tj}) + \beta\log(L_{tj}) + e_{tj}$

Number of Employees	α	β	$\bar{R}^2$	Number of Observations
From 100 to 999	0.135 (1.826)	1.260 (10.784)	0.420	135
More than 1,000	0.315 (5,225)	1.044 (14.243)	0.658	104

Figures in parentheses are t-values.

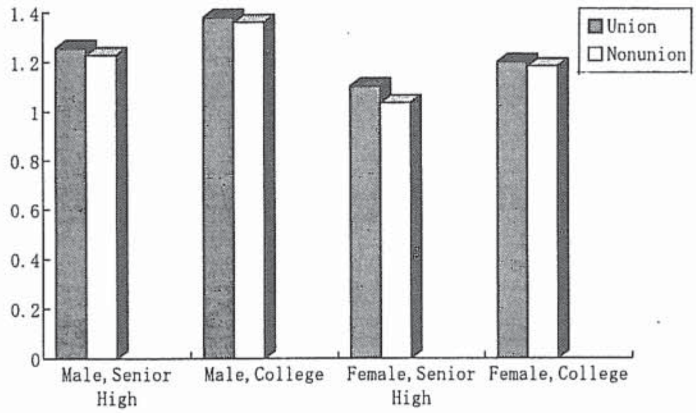

Figure 1-1 Predicted Hourly Wage, Union and Nonunion Firms (1,000 yen)

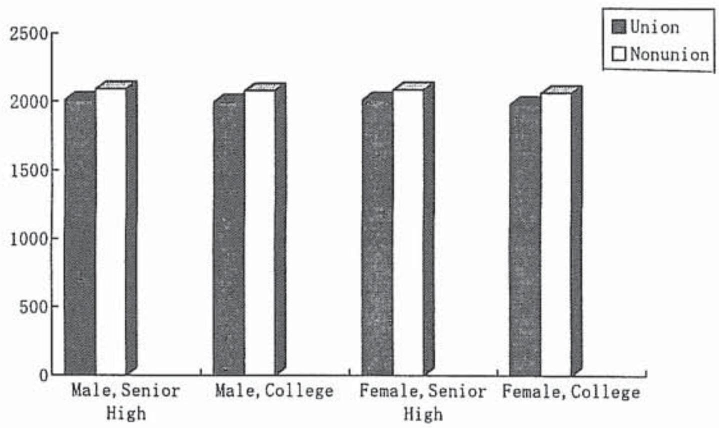

Figure 1-2 Predicted Hours of Work, Union and Nonunion Firms

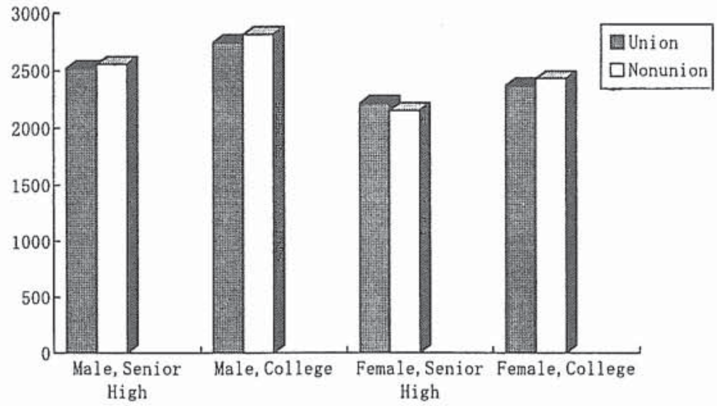

Figure 1-3 Predicted Annual Wage, Union and Nonunion Firms, (1,000 yen)

3 Estimation of the utility function

This section compares employees' utility between union and nonunion firms. We get union objective function paramters for the four categories of employees. Basically, objective functions are for union firm employees. However, we use them to evaluate the utility levels of nonunion as well as union firm employees. We cannot estimate objective functions directly. Instead, we regress the "contract curve" on wage-hours outcomes of union firms. Section 3-1 estimates the production function parameters. Section 3-2 estimates the "contract curve" and Section 3-3 compares employees' utility in union firms with that in nonunion firms.

3-1 Estimation of the production function

The "contract curve" derived from the theoretical model is as equation (20).

$$h=\frac{\alpha w(1+\mu_2 T)-\beta(\mu_1+2\mu_4 T)}{(\alpha+\beta)\mu_2 w-2(\alpha\mu_3 w^2+\beta\mu_4)}$$

(20)

$$T=8760(hours)$$

μ_1, μ_2, μ_3, and μ_4 are the parameters of the union objective function. On the other hand, α and β are the parameters of the production function. We estimate α and β using the data other than "Survey on Working Conditions and the Communication between Labour and Management". For manufacturing industries, we regress production function (18)', the logarithmic form of equation (18) in the previous section.

(18)' $$\log\left(\frac{Y_{tj}}{P_t}\right)=\alpha\log(h_{tj})+\beta\log(L_{tj})+e_{tj}$$

Y_{tj} is the annual value added for the j-th firm size class in the t-th year. P_t is the GDP deflator for the t-th year. h_{tj} is the annually scheduled hours of work. L_{tj} is the number of employees. e_{tj} is the error term. The suffixes t and j denote the t-th year and the j-th firm size category, respectively.

The data are from the two official statistics; Census of Manufacturers [15] and Monthly Labour Survey [16]. The former lists both value added and the number of employees for 9 firm size classes for each 2-digit industry. The latter reports monthly scheduled hours of work for four firm size classes for each 2-digit industry. We connect these two series of data for the following five industrial sectors; steel, transportation machinery, chemicals, paper and pulp, and petroleum. This makes 45 observations a year. Then we stack the data for the period 1979 through 1988. We delete the data for firms with less than 100 employees, as they are not in the JTUC data. Then we divide the remaining data into two groups; firms with more than 1,000 employees and those with 300 to 999 employees. This classification is consistent with that of the previous section. We apply equation (16)' to each size group. The OLS results are in Table 3. The null hypothesis that the estimated parameters $\hat{\alpha}$ and $\hat{\beta}$ are the same is rejected. Output elasticity of hours of work is different from that of number of employees. For nonmanufacturing industries, production functions cannot be easily measured. We assume that the same production function applies for nonmanufacturing firms.

3-2 Estimation of the Utility Function

In this subsection, we estimate the "contract curve" (20).

$$h=\frac{\alpha w(1+\mu_2 T)-\beta(\mu_1+2\mu_4 T)}{(\alpha+\beta)\mu_2 w-2(\alpha\mu_3 w^2+\beta\mu_4)} \quad (20)$$

$$T=8760(hours)$$

We cannot use this equation itself, as the number of parameters exceeds that of explanatory variables (w and w^2). Thus we assume $\mu_2=0$ and estimate the remaining three parameters ,μ_1, μ_3, and μ_4. This assumption does not violate the second-order condition for maximizing utility if μ_3 and μ_4 are both negative. We substitute production function parameters α and β obtained in the previous subsection into equation (20). The formula actually fitted is as (20)'.

$$(20)' \quad h=-\frac{\hat{\alpha}w-\hat{\beta}(\mu_1+2\mu_4 T)}{2(\hat{\alpha}\mu_3 w^2+\hat{\beta}\mu_4)}$$

We apply equation (20)' to the four categories of employees separately, as it is plausible that unions have different indifference curves for different groups of employees. Three-stage least squares estimation method is used. The exogenous variables are w, w^2, α and β here. The estimated results are in Table 4. Estimated parameters μ_3 and μ_4 are both negative for all the four categories of employees. This means that the second-order conditions for maximizing utility are fulfilled. We also check whether wages and hours worked in union firms are in the thoretically expected ranges (inequalities (13) and (14) in Section 1).[vi] For female employees with high school diplomas, 69 observations out of 212 are in the range consistent with the theory.

Table 4 Estimation of the Utility Function

Estimated Formula: $h=\frac{\hat{\alpha}w-\hat{\beta}(\mu_1+2\mu_4 T)}{2(\hat{\alpha}\mu_3 w^2+\hat{\beta}\mu_4)}$

	Male Employees with Senior High Diploma	Male Employees with College Diploma	Female Employees with Senior High Diploma	Female Employees with College Diploma
μ_1	4.1988 (1.2558)	8.4000 (3.9162)	2.0224 (0.4326)	2.5863 (0.8143)
μ_3	-0.0002 (0.000018)	-0.0002 (0.000036)	-0.0002 (0.000013)	-0.0002 (0.000018)
μ_4	-0.00031 (0.00009)	-0.00062 (0.00029)	-0.00015 (0.000033)	-0.00019 (0.000061)
R^2	0.1343	0.1145	0.2809	0.3033
Mean actual value	2008.9	1995.1	2009.6	1980.7
Mean Predicted Value	1954.6	1964.4	2013.1	1960.7
RMS error	137.27	137.0	123.75	119.47
Number of Observations	255	236	212	112
Number of Observations within the theoretical range	71	39	69	37

Figures in parentheses are standard errors.

On the other hand, for male employees with college diplomas, only 39 out of 236 are in the theoretically expected range. The simulation fits also differ among four categories of employees. Mean simulation error is the lowest for female employees with senior high school diplomas. For other categories of employees, mean errors are rather high. This is because actual hours of work are significantly longer than fitted hours of work.

Utility functions thus obtained for four categories of employees are as (25), (26), (27), and (28), respectively.

For male employees with senior high diplomas:

[vi] The theoretical ranges for w and h for the four categories of employees are as follows. They are derived from the inequalities (13) and (14).

$h<1989.67$ for male employees with senior high diplomas,

$h<1985.81$ for male employees with college diplomas,

$h<2026.67$ for female employees with senior high diplomas,

$h<1954.74$ for female employees with college diplomas,

$w<2500/h$ for all employees.

(25) $U_j = w_j h_j + 4.1988(T - h_j) - 0.0002(w_j h_j)^2 - 0.00031(T - h_j)^2$

For male employees with college diplomas:

(26) $U_j = w_j h_j + 8.4000(T - h_j) - 0.0002(w_j h_j)^2 - 0.00062(T - h_j)^2$

For female employees with senior high diplomas:

(27) $U_j = w_j h_j + 2.0224(T - h_j) - 0.0002(w_j h_j)^2 - 0.00015(T - h_j)^2$

For female employees with college diplomas:

(28) $U_j = w_j h_j + 2.5863(T - h_j) - 0.0002(w_j h_j)^2 - 0.00019(T - h_j)^2$

We compare utility levels of union employees with those of nonunion employees by substituting predicted wages and hours of work obtained in the previous section into objective functions (25), (26), (27), and (28). Objective functions are basically for union firms. However, in this analysis, they will provide common benchmarks for evaluating utility for both union and nonunion employees. The formulas used for the estimation of utility levels are as follows. $\widehat{U}_u$ and $\widehat{U}_n$ are the expected levels of utility for union and nonunion firm employees, respectively. w_u, w_n, h_u, and h_n are the predicted values of wages and hours of work.

(For male employees with senior high diplomas)

(29) $\widehat{U}_u = \widehat{w}_u \widehat{h}_u + 4.1988(T - \widehat{h}_u) - 0.0002(\widehat{w}_u \widehat{h}_u)^2 - 0.00031(T - \widehat{h}_u)^2$

$\widehat{U}_n = \widehat{w}_n \widehat{h}_n + 4.1988(T - \widehat{h}_n) - 0.0002(\widehat{w}_n \widehat{h}_n)^2 - 0.00031(T - \widehat{h}_n)^2$

(For male employees with college diplomas)

(30) $\widehat{U}_u = \widehat{w}_u \widehat{h}_u + 8.4000(T - \widehat{h}_u) - 0.0002(\widehat{w}_u \widehat{h}_u)^2 - 0.00062(T - \widehat{h}_u)^2$

$\widehat{U}_n = \widehat{w}_n \widehat{h}_n + 8.4000(T - \widehat{h}_n) - 0.0002(\widehat{w}_n \widehat{h}_n)^2 - 0.00062(T - \widehat{h}_n)^2$

(For female employees with senior high diplomas)

(31) $\widehat{U}_u = \widehat{w}_u \widehat{h}_u + 2.0224(T - \widehat{h}_u) - 0.0002(\widehat{w}_u \widehat{h}_u)^2 - 0.00015(T - \widehat{h}_u)^2$

$\widehat{U}_n = \widehat{w}_n \widehat{h}_n + 2.0224(T - \widehat{h}_n) - 0.0002(\widehat{w}_n \widehat{h}_n)^2 - 0.00015(T - \widehat{h}_n)^2$

(For female employees with college diplomas)

(32) $\widehat{U}_u = \widehat{w}_u \widehat{h}_u + 2.5863(T - \widehat{h}_u) - 0.0002(\widehat{w}_u \widehat{h}_u)^2 - 0.00019(T - \widehat{h}_u)^2$

$\widehat{U}_n = \widehat{w}_n \widehat{h}_n + 2.5863(T - \widehat{h}_n) - 0.0002(\widehat{w}_n \widehat{h}_n)^2 - 0.00019(T - \widehat{h}_n)^2$

Utility levels obtained from equations (29), (30), (31), and (32) are presented in Table 5. Except for female employees with college diplomas, unions significantly raise employee utility.

Utility gaps between union and nonunion firm employees have the four components as follows.

$$\widehat{U}_u-\widehat{U}_n=(\widehat{w}_u\widehat{h}_u-\widehat{w}_n\widehat{h}_n)+\widehat{\mu}_1(\widehat{h}_n-\widehat{h}_u)+\widehat{\mu}_3\ \{(\widehat{w}_u\widehat{h}_u)^2-(\widehat{w}_n\widehat{h}_n)^2\}$$
$$+\widehat{\mu}_4\ \{(T-\widehat{h}_u)^2-(T-\widehat{h}_n)^2\}$$

The first term on the right hand side of this equation corresponds to the union-nonunion wage gap. This term is negative except for female employees with senior high diplomas. The second term is a parameter multiplied by union-nonunion differentials in working hours. This term is positive for all the four categories. The third and the fourth terms are by turns positive and negative. Table 6 lists the four components of union-nonunion utility differentials. Union effects on utility levels are positive for female employees with high school diplomas, as the sum of the first, the second, and the third terms has the larger absolute value than the fourth term. Union gains on utility levels are also positive for male employees, for whom union wage effects are negative, as the second term is large enough to cancel out the negative values of the first and the fourth terms. This is because for male employees, the values of μ_1, the parameter representing the weight on leisure is much higher than those for female employees.

Table 5 Utility Levels, Union and Nonunion Firms

	Union	Nonunion	t-value
Male Employees with Senior High Diploma	15463.29	15459.88	-6.718*
Male Employees with College Diploma	29682.12	29670.63	-7.617*
Female Employees with Senior Hign Diploma	7955.17	7950.96	-4.022*
Female Employees with College Diploma	10039.02	10038.71	-0.273

*: Significant at the 5 percent significance level.

To sum up, utility levels of union firm employees are equal to, or even higher than those of nonunion firm employees. This is partly because union firms have shorter hours of work than nonunion firms and partly because much weight is placed on leisure in union objective function. Shorter hours of work and fewer wages observed in union firms could be a result of unions' preferences for longer leisure. However, different formulation of objective functions could yield different results. As for employees' utility, further analysis will be required.

Table 6 Decomposition of Union-Nonunion Utility Differentials

	$\hat{w}_u\hat{h}_u-\hat{w}_n\hat{h}_n$	$\hat{\mu}_1(\hat{h}_n-\hat{h}_u)$	$\hat{\mu}_3\ \{(\hat{w}_u-\hat{h}_u)^2-(\hat{w}_n-\hat{h}_n)^2\}$	$\hat{\mu}_4\ \{(T-\hat{h}_u)^2-(T-\hat{h}_n)^2\}$
Male, Senior High Diploma	-37.51	330.32	38.16	-327.37
Male, College Diploma	-69.23	682.08	77.09	-677.05
Female, Senior High Diploma	61.52	145.91	-53.62	-145.33
Female, College Diploma	-63.19	209.46	60.68	-207.40

$\hat{w}_u$: predicted hourly wage of union firms
$\hat{w}_n$: predicted hourly wage of nonunion firms
$\hat{h}_u$: predicted hours of work of union firms
$\hat{h}_n$: predicted hours of work of nonunion firms

4 Concluding Remarks

The purpose of this paper was to estimate union effects on employees' utility. The model assumed that labour and management bargained over hours of work as well as over wages. The "contract curve" was derived from this model. In the first stage of the empirical analysis, we controlled wage per hour and hours worked for firm characteristics and other factors. Then we compared wages and hours of work in union firms with those in nonunion firms. For all categories of employees under investigation in this paper, hours worked in union firms were significantly shorter than those in nonunion firms. On the other hand, wage per hour in union firms was significantly higher than that in nonunion counterparts, except for female employees with college diplomas. Union effects on annual wage income were mixed. For female employees with senior high school diplomas, unions had significant positive effects on annual wage income. On the other hand, for other categories of employees, unions had significant negative effects on annual wages. This was because union gains on hourly wage rate were offset by shorter hours of work. This result suggested that it was difficult for trade unions to attain shorter hours of work and wage rise at the same time. Union wage gains for female employees with senior high school diplomas indicated that unions could exert beneficial effects on employees who were not necessarily paid well or who had limited probability of promotion.

In the second stage of the statistical analysis, we fitted the "contract curve" derived from the theoretical analysis to the firm data. This was to specify the shape of the trade union objective functions. The estimated parameters fulfilled the theoretically expected sign conditions. The simulation fit of the contract curve was the best for female employees with high school diplomas. For other categories of employees, actual hours of work were significantly longer than simulated hours of work. We then compared utility levels between union and nonunion firm employees, substituting predicted wages and hours of work into the objective functions. Except for female employees with college diplomas, utility in union firms slightly exceeded that in nonuion firms. For male employees, union firms exhibited higher utility than nonunion firms in spite of the negative union wage effects. This was partly because union firms had much shorter hours of work than nonunion firms and partly because much weight was placed on leisure in trade union objective function. In plain words, male employees in union firms might have higher utility than those in nonunion firms because they prefer longer leisure to higher wages.

The most important findings in this paper are as follows. 1)Unions have significant positive effects on wage income received by 30-year-old female employees with high school diplomas. 2)For 30-year-old employees both male and female, utility in union firms is almost equal to, or slightly higher than that in nonunion firms. These findings suggest that the Japanese unions nowadays still have the power to enhance the quality of life of working people. However, the major objective of trade unions is to raise wages for all the members. Our results indicates that the role and the raison d'etre of trade unions have fundamentally changed under the recent trends towards shorter hours of work.

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