An Analysis of Fringe Benefits Costs in Japanese Large Firms*

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I. Introduction

The economic analysis that has dealt with labor turnover has mostly concentrated its attention upon the relationships between wages and labor turnover. For instance, the investigations by Stoikov and Raimon [9], and Burton and Parker [1] provide us with detailed descriptions of decision making on the part of the employee to whom the most important inducement to quit his job is a higher paying job elsewhere. On the other hand, Pencavel [6] presents a model of the employer's strategy who has to balance the advantages of operating with a low turnover rate against the costs of higher wage rate. These studies, however, neglect the effects of fringe (nonwage) benefits on the labor turnover. Ehrenberg [2] and Garbarino [3], on the other hand, analyze fringe benefits in its relations to the employment-hours decisions of employers. According to Ehrenberg [2], fringe benefits are one of the "quasi-fixed" costs which are employee rather than man-hour related, and influence the optimal division of a firm's required labor input between a stock of employees and the average number of hours per week that each employee works.

The primary purpose of this paper is to construct a model of a Japanese large firm, which has monopsony power in labor market and has to bear higher fringe benefits costs as well as higher wage costs to increase its stock of employees. We will also present the results of our empirical investigations of variations in observed fringe benefits costs among Japanese manufacturing industries.

In fact, Japanese employees receive fairly large biannual bonuses and various kinds of allowances, such as family allowance, regional allowance, commuting allowance, and housing allowance in addition to regular earnings. However, at least from the point of view of the workers, these fringe benefits as well as overtime and other pecuniary payments have essentially the same effects as those of regular earnings. Indeed, not only regular earnings but also these fringe benefits are important subjects of collective bargaining in current Japanese large firms.

Aside from them, Japanese employees are entitled to various "welfare services," some of them are obligatory on employers(such as contributions to social insurances)and others are voluntary. The latter category, which is characteristically Japanese, contains expenditures on maintenance of dormitories for unmarried employees, apartments for families, and recreational facilities. In this paper, we will focus our attention to these voluntary fringe benefits which are simply called "fringe benefits" in the sequel.

II. The Model

Recently several authors have constructed models of a neoclassical firm facing an imperfectly competitive labor market(Mortensen [5], Pencavel [6], and Salop [8]). The firm is a monopsonist in a dynamic sense only and is assumed to be able to vary the net rate of change in its employment level by appropriate choices of its own wage relative to the market average. As Phelps [7] pointed out, these models are quite plausible as descriptions of behavior in the labor market, because trade unions represent a relatively small proportion of the labor force in the United States. However, in order to build a realistic model to serve as the basis for our empirical work, we believe that it is more appropriate to include a few institutional features of the labor market in Japan.

Firstly, since almost 70 percent of the employees of large firms are currently organized, it seems more realistic to assume that wages are determined through collective bargaining. Stated another way, relative wages are one of the parameters to the firm's decision problem and should not be treated as a control variable. On the other hand, the level of voluntary

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fringe benefits is determined unilaterally by the employer. And here is the most significant difference in specification between our model and those of Mortensen [5] and Pencavel [6].

Secondly, the nature of employment system is quite different between male employees and female employees in Japan. Women workers are excluded from the system of so-called "permanent commitment," and it is customary for them to quit at the age of marriage or childbirth. In fact, as pointed out in Matsukawa [4], there is no significant relationship between the quit rate of women workers and their wages and fringe benefits. Hence, female workers are far younger than male workers on the average and their quit rate is so high to enable the employer to reduce the number of them in a relatively brief period of time. Evidence also indicates that female participants exhibit a stronger preference of working in large firms to working in middle or small size firms than male participants. This means that the employer could also increase the number of the female employees without delay. Therefore we could assume that the stock of female employees is perfectly variable, while the stock of male employees is imperfectly variable. In other words, the employer has to bear higher fringe benefits costs only when he intends to increase his *male* employees. However, since exclusion principle does not hold for the "welfare services," he cannot prevent female employees from receiving the benefits resulting from such services, possibly with some exceptions such as dormitories for unmarried *male* employees.

Now, let us consider the firm's flow supply of male workers. Since information is imperfect in labor market, we assume that the number of applicants for a firm is not affected by the firm's offer, but proportional to the size of the firm. When the applicants come in immediate contact with the firm, they decide to accept the offer or not with consideration of the relevant characteristics of the job such as wages and fringe benefits. Thus, the proportion of the number of those who accept the offer to the number of total applicants, and in consequence to the size of the firm is a function of these characteristics. However, the applicants are not fully aware of the relevant characteristics of his job when they contact the firm. Especially, since available information on the fringe benefits is strongly limited, it is appropriate to assume that this proportion is a function of the firm's wage offer alone. Ignoring time notation and using the output of the firm as a proxy for the size of the firm, we have:

(1) $H=h(W)Y, \ h'>0, \ h''<0,$

where H is the number of new hires, W is the wage of male employees which is given to the firm by collective bargaining, and Y is output.

On the other hand, since new workers learn the relevant characteristics of his jobs as they work for the firm, the quit rate of male employees (q) is assumed to be a function of both the firm's relative wage offer and fringe benefits per employee (B):

(2) $q=q(B, W) \quad q_1<0, q_2<0, q_{11}>0, q_{22}>0.$

Combining (1) and (2), we obtain the flow supply of male workers:

(3) $\dot{M}=h(W)Y-q(B, W)M,$

where a dot indicates a time derivative, and M is the number of male employees.

Suppose the production conditions of the firm are defined by the expression:

$$Y=F\left(\min\left\{M, \frac{1}{\mu}L\right\}\right) \quad F'>0, \ F''<0,$$

where L is the number of female employees, and μ is a constant. Now, by assuming that the firm produces a single product and sells it in a perfectly competitive market at a price p, the net cash flow of the firm (R) can be written:

(4) $$R=pF\left(\min\left\{M, \frac{1}{\mu}L\right\}\right)-WM-W'L-B(M+L),$$

where W' is the wage rate of female employees, which is also given to the firm by collective bargaining.

Then, since the stock of female employees is perfectly variable, it is adjusted to the stock of male employees instantaneously, if marginal value product of labor exceeds the wage rate of female employees over the relevant range. That is:

(5) $L=\mu M.$

Substitution into (3) and (4) yields:

(6) $\dot{M}=h(W)F(M)-q(B, W)M,$

(7) $R=pF(M)-(1+\mu\delta)WM-(1+\mu)BM,$

where $\delta=W'/W.$

If the firm can borrow or lend in a competitive capital market at an interest rate ρ, which is expected to prevail in the future we can compute the present value of the firm (V):

$$V=\int_0^\infty Re^{-\rho\tau}d\tau.$$

Now the problem that the firm is posturated to solve can be stated as follows:
Maximize

$$(8)\qquad \int_0^\infty \{pF(M)-(1+\mu\delta)\,WM-(1+\mu)\,BM\}\,e^{-\rho\tau}d\tau,$$

subject to (3) and an initial condition on the state variable M, where B is the control variable.

Since q is monotonic in B, we can solve (3) for B as:

$$(9)\qquad B=\beta\left(\frac{\dot{M}-h(W)F(M)}{M},\ W\right),$$

$$\beta_1=-\frac{1}{q_1}>0,\quad \beta_2=-\frac{1}{q_2}>0,$$

$$\beta_{11}=-\frac{q_{11}}{q_1{}^3}>0.$$

Substitute into (8) to obtatin:

$$(10)\qquad \int_0^\infty \left\{pF(M)-(1+\mu\delta)\,WM-(1+\mu)\,\beta\left(\frac{\dot{M}-h(W)F(M)}{M},\ W\right)M\right\}e^{-\rho\tau}d\tau$$

This is a classical calculus of variations problem. Define:

$$(11)\qquad \lambda=\beta_1\left(\frac{\dot{M}-h(W)F(M)}{M},\ W\right)$$

Then, the necessary conditions for the problem are:

$$(12)\qquad \dot{\lambda}=\left(\rho-\frac{\dot{M}-h(W)F(M)}{M}\right)\lambda-\frac{p}{1+\mu}F'(M)+\frac{1+\mu\delta}{1+\mu}W+\beta\left(\frac{\dot{M}-h(W)F(M)}{M},\ W\right)$$

$$(13)\qquad \lim_{\tau\to 0}\lambda e^{-\rho\tau}=0$$

$$(14)\qquad \frac{\partial\lambda}{\partial\dot{M}}=\frac{\beta_{11}\left(\dfrac{\dot{M}-h(W)F(M)}{M},\ W\right)}{M}\geq 0$$

Since the equations (11) and (12) constitute an autonomous system of differential equations in M and λ, this problem can be solved using phase diagrams in the (M, λ) plane. The slope of the $\dot{\lambda}=0$ singular curve falls as M increases, while the $\dot{M}=0$ singular curve is positively sloped. Then, by the same consideration as that of Mortensen [5], it is clear that there are only two trajectories, which converge to the singular point. In other words, for any given initial stock of male employees, there is one and only one value of λ, for which the solution of the system converges to the stationary point.

Since λ approaches positive finite limits, the transversality condition (13) as well as the other necessary conditions are satisfied by these solutions. Further, we have:

$$(15)\qquad \lim_{\tau\to 0}e^{-\rho\tau}\lambda M=0,$$

and together with concavity assumptions, the sufficient condition for these solutions to be optimal is also satisfied.

The long-run equilibrium of the system is represented by the intersection of the two singular curves in the (M, λ) plane. Its λ-coordinate (λ^*) and M-coordinate (M^*) will differ for different values of the parameters, ρ, p, δ, μ, and W. To obtain qualitative implications as to the effects of changes in these parameters, we first consider the shifts of the $\dot{\lambda}=0$ singular curve according to changes in these parameters. From (12) we have:

$$\left.\frac{\partial M}{\partial\rho}\right|_{\dot{\lambda}=0}=\frac{\lambda(1+\mu)}{pF''(M)}<0$$

$$\left.\frac{\partial M}{\partial p}\right|_{\dot{\lambda}=0}=\frac{-F'(M)}{F''(M)}>0$$

$$\left.\frac{\partial M}{\partial\delta}\right|_{\dot{\lambda}=0}=\frac{\mu W}{pF''(M)}<0$$

$$\left.\frac{\partial M}{\partial\mu}\right|_{\dot{\lambda}=0}=\frac{pF'(M)-(1-\delta)\,W}{(1+\mu)\,pF''(M)}<0$$

$$\left.\frac{\partial M}{\partial W}\right|_{\dot{\lambda}=0}=\frac{1+\mu\delta+\beta_2(1+\mu)}{pF''(M)}<0.$$

With respect to the shifts of the $\dot{M}=0$ singular curve, we have:

$$\left.\frac{\partial M}{\partial W}\right|_{\dot{M}=0}=\frac{h'(W)F(M)M-\beta_{12}M^2}{h(W)\{F(M)-F'(M)M\}}?,$$

while this curve is independent of the changes in other parameters.

Then it is clear from the phase diagram:

$$(16)\qquad \frac{\partial\lambda^*}{\partial\rho}<0,\ \frac{\partial\lambda^*}{\partial p}>0,\ \frac{\partial\lambda^*}{\partial\delta}<0,\ \frac{\partial\lambda^*}{\partial\mu}<0,$$

while the effects of variations in W on the long-run equilibrium values remains unsolved[1].

Further, from (9) and (11);

$$(17)\qquad \lambda^*=-\frac{1}{q_1(B^*,\ W)},$$

where B^* is the long-run equilibrium value of fringe benefits costs per employee. Differentiate with respect to the parameters and substitute from (16) yields:

$$(18)\qquad \frac{\partial B^*}{\partial\rho}<0,\ \frac{\partial B^*}{\partial p}>0,\ \frac{\partial B^*}{\partial\delta}<0,\ \frac{\partial B^*}{\partial\mu}<0.$$

These results are quite plausible. In particular, the result that fringe benefits costs per em-

1) We could also proceed to the comparative dynamics of this system.

ployee decrease as μ increases is consistent with the observation that fringe benefits costs are lower in those firms where the proportion of female employees is high. On the other hand, the effects of variations in the female-male wage differential have been overlooked in literatures.

III. Testing the Model

We now proceed to an empirical analysis of interindustry variations in fringe benefits costs. Since the parameters are assumed to vary across firms in (18), the empirical studies call for individual firm data. But information about voluntary fringe benefits costs is available at the industry level only. Thus, there is no alternative to postulate that these parameters do not vary across the firms within a given industry and to use mean values of the variables for each two-digit manufacturing industry as the units of observation. Since we use cross section data, deleting p and ρ from (18), form the first order logarithmic approximation as follows:

$$\text{(19)} \quad \log B_i = a + b \log W_i + c\delta_i + d \log \mu_i + u_i,$$

where for notational simplicity we omit the "*" superscript and u_i is a stochastic disturbance term.

The data utilized in this study are derived from *1976 Survey on Labor Cost (Ministry of Labor)* and *1976 Basic Survey of Wage Structure (Ministry of Labor)*. Only the data for firms with 1000 and more workers are considered and eighteen two-digit manufacturing industries are included in our sample. The data for cost of non-obligatory welfare services have been taken from "Average monthly labor cost per regular employee by industry, size of enterprise and item of labor cost" in *Survey on Labor Cost*. We calculated the weighted averages of cost of non-obligated welfare services in firms with 5000 or more employees and firms with 1000 to 4999 employees. The weight is the number of employees, the data on which are obtained from *Census of Manufactures*. The data on wages have been taken from "Average monthly total cash earnings and estimated number of employees by type of regular employees, sex, educational attainment, age and size of enterprise" in *Basic Survey of Wage Structure*.

The results obtained by a ordinary least squares estimation process is:

$$\text{(20)} \quad \log B = \underset{(-0.13)}{-0.477} + \underset{(1.25)}{0.615} \log W - \underset{(5.65)}{4.389}\,\delta - \underset{(6.05)}{0.823} \log \mu$$

$$\bar{R} = 0.737 \qquad SEE = 0.202,$$

where numbers inside parenthes under estimated coefficients show t-statistics.

The coefficient of $\log W$ is not significant, but the effects of $\log W$ on fringe benefits costs could not be solved in the theoretical model. Other variables are significant and have expected signs in equation (20). Therefore, these estimates may be considered to be consistent with our theoretical model. Particularly, observed fringe benefits costs per employee are significantly negatively related to the ratio of the number of female employees to the number of male employees. Our theoretical model suggests that this result is caused by the difference in the elasticity of labor supply curves between male participants and female participants.

IV. Conclusion

In this paper we have built a theoretical model of the profit-maximizing firm which is able to vary the net rate of change in its employment level by appropriate choices of its fringe benefits costs per employee. Based on this theoretical model, we have presented empirical investigations of the determinants of interindustry variations in observed fringe benefits costs per employee in Japanese manufacturing industries. Although the unavailability of data at the firm level as distinct from the industry level imposed several limitations on the statistical analysis presented above, the empirical results found in this paper are consistent with our theoretical model. That is, observed fringe benefits costs per employee have been shown to be significantly negatively related to the ratio of the number of female employees to the number of male employees and the female-male wage differential.

The firm analyzed in this paper is assumed to have monopsony power in the dual labor market. The basic assumptions of the model are: (1) The turnover rate of primary workers or male employees is responsive to fringe benefits, while that of secondary workers or female employees is not. (2) The same level of benefits will accrue to all who work in the firm. Although we have forcused our attention to the "welfare services" supplied by Japanese large firms, the extention of our analysis to the labor economy of any industrialized country involves no difficulty in principle, as long as these two assumptions are satisfied.

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