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Fringe Benefits in a Dynamic Theory of the Firm

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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[10], and Burton and Parker[2] 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[7] 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[3] and Garbarino[4], on the other hand, analyze fringe benefits in its relations to the employment-hours decisions of employers. According to Ehrenberg[3], fringe benefits are one of the "quasi-fixed" costs which are employee rather than man-hour related, and influence the optimal devision 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 profit-maximizing 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 the United States, many of the social benefits have been adopted privately by unions and employers in collective bargaining agreement.

And employers, even in the absence of unions, have been adopting many of these benefits voluntarily (Allen[1]). This movement for fringe benefits took place in a number of industrialized countries mainly through the governments' wartime economic policy of limiting wage increases. However, the relative importance of fringe benefits has not declined since the end of the war. For example, in 1976 the ratio of voluntary fringe benefits costs to total labor costs amounted, on the average, to 4.6 percent in Japanese manufacturing firms with 5000 or more employees and 3.4 percent in those with 1000 to 4999 employees. As of pulp, paper and allied products industry, this ratio amounted to 6.0 percent.

Unfortunately, there is no generally accepted definition of fringe benefits and the interpretations of the word differ in different countries. For example, 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 leasr from the poin t 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, 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 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.

Although the lack of a clear meaning for the term contributed great confusion to the effort to understand the nature of fringe benefits, the economic effects of these welfare services have long been discussed by labor economists and various hypotheses have been presented. In the first place, these benefits enhance the attractiveness of the job and lower the turnover rate. Secondly, since the benefits resulting from such services will accrue to all who work in the firm, they are similar in economic effects to public goods.[1/]

II. The Model

Recently several authors have constructed models of a neoclassical firm facing an imperfectly competitive labor market (Mortensen[6], Pencavel[7], and Salop[9]). 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[8] 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 economy of industrialized countries.

Firstly, since a considerable proportion of the employees are organized in those firms which have monopsony power in a labor market, 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 fringe benefits is determined unilaterally by the employer. And here is the most significant difference in specification between our model and those of Mortensen[6] and Pencavel[7].

Secondly, labor is not homogeneous and the workers within a firm are widely different from each other in such aspects as productivity and propensity to quit. For example, 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[5], 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.

To cope with this problem, we consider a model with two different groups of employees, "primary" employees and "secondary" employees. Primary employees' quit rate is assumed to be relatively low and a non-increasing function of both the firm's relative wage offer and fringe benefits per employee. From the point of view of the employers, this means that the stock of primary employees is imperfectly variable. On the other hand, "secondary" employees have unstable working patterns and relatively high propensity to quit. Therefore, the stock of them may be thought of as being perfectly variable.

Now, let us consider the firm's flow supply of primary 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, we have;

$$(1) \qquad H = h(W)S$$

$$h' > 0, \quad h'' < 0,$$

where H is the number of new hires, W is the wage of primary employees which is given to the firm by collective bargaining, and S is a proxy for the size of the firm which is assumed to be invariant with respect to time. In Mortensen[6] it is assumed that the number of applicants for a firm is proportional to the number of employees. Whilst this may be a suitable approach for answering many questions, the number of male employees is not the only proxy for the size of the firm. Furthermore, the short-run variations in the number of male employees should have little influence on the firm's share of the participants who do make a contact, because participants' understanding of the firm size depends on such intertemporal factors as the firm's reputation and the cumulative effects of advertising.

On the other hand, since new workers learn the relevant characteristics of his job as they work for the firm, quits of primary employees (Q) are assumed to be a function of both the firm's relative wage offer and fringe benefits per employee (B);

$$(2) \qquad Q = q(B, W)M$$

$$q_1 < 0, \quad q_2 < 0, \quad q_{11} > 0, \quad q_{22} > 0,$$

where M is the number of primary employees.

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

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

where a dot indicates a time derivative.

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

$$Y = F[\min \{M, \frac{1}{\mu} L \}],$$

where Y is output, L is the number of secondary employees, μ is a constant, and F is assumed to be concave and homogeneous of degree 1 in labor and other inputs. 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;

$$(4) \qquad R = (1 - t)(pF[\min\{M, \frac{1}{\mu}L\}] - WM - W'L) - (1 - t\varepsilon)B(M + L),$$

where W' is the wage rate of secondary employees, which is also given to the firm by collective bargaining, t is tax rate on profits, and ε is the proportion of the fringe benefits costs permitted to be tax-free expenditure.

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

$$(5) \qquad L = \mu M.$$

Substitution into (4) yields;

$$(6) \qquad R = (1 - t)(pF(M) - (1 + \mu\delta)WM) - (1 - t\varepsilon)(1 + \mu)BM,$$

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 postulated to solve can be stated as follows;

$$\text{Maximize (7)} \int_0^\infty \{(1 - t)(pF(M) - (1 + \mu\delta)WM) - (1 - t\varepsilon)(1 + \mu)BM\}e^{-\rho\tau}d\tau$$

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;

$$(8) \qquad B = \beta(\frac{\dot{M} - h(W)S}{M}, W)$$

$$\beta_1 = -\frac{1}{q_1} > 0, \quad \beta_{11} = -\frac{q_{11}}{q_1^3} > 0.$$

Substitute into (7) to obtain;

$$(9) \qquad \int_0^\infty \{(1 - t)(pF(M) - (1 + \mu\delta)WM) - (1 - t\varepsilon)(1 + \mu)\beta(\frac{\dot{M} - h(W)S}{M}, W)M\}e^{-\rho\tau}d\tau.$$

This is a classical calculus of variations problem. It is convenient to rewrite (9) with the aid of homogeneity of F;

(10) $$S\int_0^\infty \{(1-t)(pF(m)-(1+\mu\delta)(Wm)-(1-t\varepsilon)(1+\mu)\beta(\frac{\dot{m}-h(W)}{M}, W)m\}e^{-\rho\tau}d\tau.$$

where $m = M/S$. Define;

(11) $$\lambda = \beta_1(\frac{\dot{m}-h(W)}{m}, W).$$

Then, the necessary conditions for the problem (10) are;

(12) $$\dot{\lambda} = (\rho - \frac{\dot{m}-h(W)}{m})\lambda + \beta(\frac{\dot{m}-h(W)}{m}, W) - \frac{1-t}{(1-t\varepsilon)(1+\mu)}\{pf'(m) - (1+\mu\delta)W\}$$

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

(14) $$\frac{\partial\lambda}{\partial\dot{m}} = \frac{\beta_{11}(\frac{\dot{m}-h(W)}{m}, W)}{m} \geq 0.$$

The equations (11) and (12) constitute an autonomous system of differential equations in λ and m. This problem can be solved using phase diagrams in the (m, λ) plane, where the $\dot{\lambda} = 0$ singular curve is negatively sloped while the $\dot{m} = 0$ singular curve is upward sloping. Then, by the same consideration as that of Mortensen[6], it is clear that there are only two trajectries, which converge to the singular point. In other words, for any given initial stock of primary 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 solution. Further, we have;

(15) $$\lim_{\tau\to\infty} e^{-\rho\tau} \lambda m = 0$$

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

The long-run equilibrium of the system (m^*, λ^*) is represented by the intersection of the two singular curves. Their values will differ for different values of the parameters ρ, t, ε, p, W, δ, and μ. 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 the changes in these parameters.

From (12) we have;

$$\frac{\partial m}{\partial \rho}\Big|_{\dot{\lambda}=0} = \frac{(1 - t\varepsilon)(1 + \mu)\lambda}{(1 - t)pf''} < 0$$

$$\frac{\partial m}{\partial t}\Big|_{\dot{\lambda}=0} = \frac{(1 - \varepsilon)\{pf' - (1 + \mu\delta)W\}}{(1 - t)(1 - t\varepsilon)pf''} < 0$$

$$\frac{\partial m}{\partial \varepsilon}\Big|_{\dot{\lambda}=0} = -\frac{pf' - (1 + \mu\delta)W}{(1 - t\varepsilon)pf''} > 0$$

$$\frac{\partial m}{\partial p}\Big|_{\dot{\lambda}=0} = -\frac{f'}{pf''} > 0$$

$$\frac{\partial m}{\partial W}\Big|_{\dot{\lambda}=0} = \frac{\beta_2(1 - t\varepsilon)(1 + \mu) + (1 - t)(1 + \mu\delta)}{(1 - t)pf''}$$

$$\frac{\partial m}{\partial \delta}\Big|_{\dot{\lambda}=0} = \frac{\mu W}{pf''} < 0$$

$$\frac{\partial m}{\partial \mu}\Big|_{\dot{\lambda}=0} = \frac{1-\delta}{(1+\mu)pf''} < 0.$$

with respect to the shifts of the $\dot{m} = 0$ singular curve, we have;

$$\frac{\partial m}{\partial W}\Big|_{\dot{m}=0} = \frac{h'(W)m}{h(W)} - \frac{\beta_{12}m^2}{\beta_{11}h(W)} \; ?.$$

while this curve is independent of the changes in other parameters. Then it is clear from Figure 1;

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

(17) $\frac{\partial m^*}{\partial\rho} < 0, \quad \frac{\partial m^*}{\partial t} < 0, \quad \frac{\partial m^*}{\partial\varepsilon} > 0, \quad \frac{\partial m^*}{\partial p} > 0, \quad \frac{\partial m^*}{\partial\delta} < 0, \quad \frac{\partial m^*}{\partial\mu} < 0,$

while the effects on the long-run equilibrium values of variations in W remain unsolved.

Further, from (8) and (11);

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

where B^* is the long-run equilibrium value of fringe benefits costs per employee. Differentiate with respect to a parameter (2);

(19) $$\frac{\partial B^*}{\partial Z} = \frac{\frac{\partial\lambda^*}{\partial Z}}{q_{11}(\lambda^*)^2}$$

Substitution from (16) yields;

(20) $$\frac{\partial B^*}{\partial \rho} < 0, \quad \frac{\partial B^*}{\partial t} < 0, \quad \frac{\partial B^*}{\partial \varepsilon} > 0, \quad \frac{\partial B^*}{\partial p} > 0, \quad \frac{\partial B^*}{\partial \delta} < 0, \quad \frac{\partial B^*}{\partial \mu} < 0.$$

The results in (17) and (20) are quite plausible. In particular, the result that fringe benefits costs per employee decrease as μ increases is consistent with the observation that fringe benefits costs are lower in those industries where the proportion of secondary employees is high. On the other hand, the effects of variations in the extent of the wage difference between primary and secondary workers have been overlooked in literatures.

In the present model, the differentials in fringe benefits costs among firms still exist in the long-run equilibrium. It should be noted that this result is a consequence of the assumption that the number of applicants for a firm is proportional to S which is assumed to be independent of labor input. On the other hand, if the number of applicants is assumed to be proportional to M, that is the number of primary employees, fringe benefits costs do not vary across firms in the long-run equilibrium, because the $\dot{m} = 0$ singular curve becomes horizontal under this alternative assumption.

We now procced to the comparative dynamics of this system. Since λ decreases as m increases along the optimal path, we have;

(21) $$\frac{\partial \lambda^\circ}{\partial m} < 0,$$

where λ° is the λ-coordinate of the optimal path. The optimal path also depends on the values of ρ, t, ε, p, W, δ and μ. The effects of variations in these parameters on $\lambda°$ is the same as those on λ^*, at least near equilibrium. However, by the same consideration as those of Treadway [11] and Mortensen [6], it dan be shown that these results hold everywhere[2/].

$$(22) \quad \frac{\partial\lambda°}{\partial\rho} < 0, \quad \frac{\partial\lambda°}{\partial t} < 0, \quad \frac{\partial\lambda°}{\partial\varepsilon} > 0, \quad \frac{\partial\lambda°}{\partial p} > 0, \quad \frac{\partial\lambda°}{\partial\delta} < 0, \quad \frac{\partial\lambda°}{\partial\mu} < 0,$$

Then the same calculation as in (18) and (19) yields;

$$(23) \quad \frac{\partial B°}{\partial\rho} < 0, \quad \frac{\partial B°}{\partial t} < 0, \quad \frac{\partial B°}{\partial\varepsilon} > 0, \quad \frac{\partial B°}{\partial p} > 0, \quad \frac{\partial B°}{\partial\delta} < 0, \quad \frac{\partial B°}{\partial\mu} < 0,$$

where $B°$ denotes the optimal fringe benefits costs per employee.

In summary the fringe benefits costs per employee in the long-run equilibrium and those along the optimal path can be written;

$$(24) \quad B^* = B^*(\rho,\ t,\ \varepsilon,\ p,\ W,\ \delta,\ \mu)$$

and

$$(25) \quad B° = B°(m,\ \rho,\ t,\ \varepsilon,\ p,\ W,\ \delta,\ \mu).$$

These are essentially the cross-section regression equations which are estimated in the next section.

III. Testing the Model

The discussion contained in the previous section suggested that observed variations in fringe benefits costs per employee among firms are attributable to variations in m, ρ, t, ε, p, W, δ, and μ. This section presents the results of an empirical analysis of interindustry variations in fringe benefits costs in Japanese manufacturing industries. The primary and secondary workers are defined here as male employees and femal employees. Since these parameters are assumed to vary across firms in the previous section, 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 as the units of observation.

First, we consider equation (25) which describes firm's dynamic adjustment processes. Since we use cross section data, deleting ρ, p, t, and ε from (25), we have;

$$(26) \qquad B = B(m, W, \delta, \mu).$$

where for notational simplicity we omit the "0" superscript which refers to the optimal path. However, firms are located in short-run equilibrium along the adjustment path and hence even if two firms in a given industry face identical parameters, they might be at different points on the path. Then, the aggregation of the data will distort our estimates of equation (26). On the other hand, if the actual values of m and B are distributed around their long-run equilibrium m^* and B^*, then by the law of large numbers the observed average values of m and B may be assumed to be not so different from m^* and B^*. Therefore under this assumption we can estimate the equation (24) instead of (26). Hence the second equation which we will estimate is;

$$(27) \quad B = B(W, \delta, \mu),$$

where we also omit the "*" superscript.

In estimation of equation (26), one further complication still exists with regard to the choice of the variable which stands for the size of the firm. We somewhat arbitrarily decide to use "capital" as this variable but the estimates of equation (26) in the following should be viewed as preliminary rather than conclusive because capital as well as other proxies for the size of the firm is not prefectly independent of labor input.

The linear stochastic forms of equation (26) and (27) can be written as follows;

$$(28) \quad \ell og\ B_i = a + b\ell og\ m_i + c\ell og W_i + d\delta_i + e\ell og\ \mu_i + u_i$$

$$(29) \quad \ell og\ B_i = a + c\ell og\ W_i + d\delta_i + e\ell og\ \mu_i + v_i,$$

where u_i and v_i are stochastic disturbance terms.

The data utilized in this study are derived from <u>1976 Survey on</u>

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 and number of workers 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 estimates of equations (28) and (29) by ordinary least squares methods are as follows;

$$(30) \qquad \ell og\ B = \underset{(1.45)}{4.456} - \underset{(3.68)}{0.256}\ \ell og\ m + \underset{(0.37)}{0.141}\ \ell og\ W - \underset{(3.63)}{2.663}\,\delta - \underset{(5.17)}{0.599}\ \ell og\ \mu$$

$$\bar{R} = .861 \qquad SEE = 0.147,$$

$$(31) \qquad \ell og\ B = \underset{(0.13)}{-0.477} + \underset{(1.25)}{0.615}\ \ell og\ W - \underset{(5.65)}{4.389}\,\delta - \underset{(6.05)}{0.823}\ \ell og\ \mu$$

$$\bar{R} = .737 \qquad SEE = 0.202,$$

where numbers inside parenthes under estimated coefficients show t-statistics. The fact that the coefficient of $\ell og\ m$ in equation (30) is significant may be considered to indicate that the data set is not of long-run equilibrium observations and should not be used to estimate directly long-run equilibrium values. However, as we have already noted, the estimates presented in equation (30) is subject to certain constraints imposed by the limitations of the data. Therefore, it is not appropriate to test whether the data set represents the long-run equilibrium observations or the optimal level of benefits during adjustment, using the coefficients of $\ell og\ m$ in equation (30).

The coefficients of $\ell og\ W$ are not significant in both equations, but the effects of $\ell og\ W$ on fringe benefits costs could not be solved in the theoretical model. Other variables are significant and have expected signs in both equations. Threfore, 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 (primary workers) and female participants (secondary workers).

IV. Conclusions

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 Japnese 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 secondary employees to the number of primary employees and the secondary/primary 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 is responsive to fringe benefits, while that of secondary workers is not. (2) The same level of benefits will accrue to all who work in the firm. Although in the empirical parts of the study we have forcused our attention to the "welfare service" 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.

Notes

1/ There are, of course, some exceptions. For example, female employees are not entitled to dormitories for unmarried male employees, while single employees are not entitled to apartments for families.

2/ See Treadway [11], pp.237 - 8 and Mortensen [6], pp.188 - 9.

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