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LABOUR ADJUSTMENT IN JAPANESE INCORPORATED ENTERPRISES: AN EMPIRICAL ANALYSIS FOR THE PERIOD 1965-1983

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Introduction

This paper was stimulated by the contradictory results obtained by some Japanese economists who have tried to evaluate the structural change in the pattern of labour adjustment in the Japanese manufacturing industry which has occurred since the first oil shock.

Labour adjustment patterns in Japan are related to the features and the evolution of Japanese labour relations, especially the so-called "lifetime employment" system; in many large Japanese companies, employment is a relatively fixed factor of production which is not adjusted as freely as in their American counterparts when fluctuations occur in the level of economic activity [see Ono (1981)].

However, the degree of fixity of labour does depend on the economic environment in the Japanese company, just as it does in the American, and it is therefore modified by relevant economic change. The analysis of eventual modifications is a necessary complement to often implemented international comparisons because it helps to achieve a more complete picture of the adjustment process itself.

Muramatsu (1983) has shown that the speed of labour adjustment has increased consistently after the oil shock, suggesting that labour has become a more flexible factor of production.

Shimada and associates (1982), on the other hand, have shown just the opposite result when considering less aggregate information. These findings stem from different versions of the standard partial adjustment model, which deals with labour as a quasi-fixed factor of production. Two main features of the model are:

1. A single equation approach, namely, no interrelation among different factors of production. A reasonable assumption, indeed, in the short term, but rather less reasonable when long time series are taken into account. In the second case, fixed factors such as capital cannot be considered to be fixed throughout [See Nadiri-Rosen for a critique (1973)].

2. A compact, "ad hoc" definition of the adjustment process given by the partial adjustment coefficient. When structural change is considered, however, a more explicit formulation of the process is required in order to understand why eventual changes have come about.

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The purpose of this paper is to drop both features 1. and 2. and replace them with the following.

3. Interrelated factor demands, which explicitly allow for either a stochastic or a deterministic interrelation among factors.

4. The introduction of a labour adjustment cost function which is related to changes in the economic environment. The speed of labour adjustment depends, among other things, on the cost of adjusting both labour and other related factors of production. In particular, an inverse relation between speed and cost of labour adjustment is to be expected in a given time span.

In order to do so, I first estimate a static model of interrelated factor demands and show that the structural change that occurred after the first oil shock not only involves the intensities of supply reactions to changes in relative prices but also introduces some variations in the properties of a standard three factor production function.

Next, I examine an "ad hoc" dynamic model which generalizes the standard partial adjustment framework and find that the limitations implicit in the model itself are such as to forbid definite statements about the patterns of labour adjustment.

Finally, I introduce a labour adjustment cost function and estimate it in a dynamic framework. The results suggest, with some qualifications, a structural reduction of the unit labour adjustment cost, which is generally related in an inverse fashion to the labour adjustment speed.

I then conclude that the speed of adjusting overall labour in the incorporated enterprises has tended to rise since the first oil shock, mainly as a consequence of the reduction in the relevance of "lifetime employees" with respect to more flexible labour contracts.

Higher speed of adjustment means that labour, again in an overall sense, has become more flexible a factor of production. This should not, however, be taken as a statement about the crisis of lifetime employment as such. Indeed, most lifetime employees before the shock have retained their status since the shock; it is the relative importance of the so called "good job opportunities" that has been steadily declining.

I. *The Static Model*

When expectations are assumed to be static and there is no adjustment cost so that factors may adjust instantaneously, a static environment is generated. If a production function with three factors of production, namely, labour, materials and capital is adopted, the associated cost function is from duality:

(1.1) $C=C(p_m, v, w, Y)$ where p_m is the real price of materials
v is the real user cost of capital
w is the real wage
Y is real output

The cost function (1.1) may be approximated by the translog formulation

$$(1.2)\quad lnC=a_0+a_y lnY+g_{yy}(lnY)^2+\frac{1}{2}\Sigma_i\Sigma_j g_{ij} lnP_i lnP_j+\Sigma_i b_i lnP_i+\Sigma_i g_{yi} lnY lnP_i$$

Homogeneity of degree *1* with respect to prices and the need for a well behaved production function imply the following restrictions on (1.2):

(1.3) $\Sigma_i b_i=1 \quad \Sigma_i g_{yi}=0 \quad g_{ij}=g_{ji} \quad \Sigma_i g_{ij}=\Sigma_j g_{ij}=0$

so that (1.2) becomes

$$(1.4)\quad lnC=a_o+a_y lnY+g_{yy}(lnY)^2+b_w lnw+b_m p_m+(1-b_w-b_m)lnv+\frac{1}{2}g_{ww}lnwlnw$$
$$+g_{wm}lnwlnp_m-(g_{ww}+g_{wm})lnwlnv+\frac{1}{2}g_{mm}lnp_m lnp_m-(g_{mm}+g_{wm})lnp_m lnv$$
$$+\frac{1}{2}(g_{ww}+g_{mm}+2g_{mw})lnvlnv+g_{yw}lnwlnY+g_{ym}lnp_m lnY$$
$$-(g_{yw}+g_{wm})lnvlnY+u_1$$

Shephard's Lemma then implies that $\partial C/\partial P_i=X_i$, where X_i is the demand for factor i. Observing that $\partial lnC/\partial lnP_i=P_i/C\cdot\partial C/\partial P_i=P_iX_i/C=M_i$, equations (1.5)–(1.7) may be derived by differentiating (1.4) with respect to prices:

(1.5) $M_w=b_w+g_{ww}lnw+g_{wm}lnP_m-(g_{mm}+g_{wm})lnv+g_{ym}lnY+u_2$

(1.6) $M_m=b_m+g_{mm}lnp_m+g_{wm}lnw-(g_{mm}+g_{wm})lnv+g_{ym}lnY+u_3$

(1.7) $M_k=1-M_w-M_m$

where M_i are the factor shares of cost C.

Equations (1.4)–(1.7) generate the static model of interrelated factor demands, which are implicitly related to the explicit factor shares. In order to estimate (1.4)–(1.7), some assumptions are needed about the error terms u_i. I henceforth assume that u_1 is a white noise; in the case of u_2 and u_3, however, the white noise hypothesis is tested against a simple autocorrelation structure following the methodology developed by Berndt and Savin (1975). Let us then write equations (1.5)–(1.7) in a compact form and introduce the autocorrelation hypothesis

(1.8) $M=AX+u$
$u=Ru_{-1}+\varepsilon$

where R is a diagonal matrix and $R_{ii}=R_{jj}$ for any i and j because of the unit restrictions implied by the use of shares. (1.8) may then be rewritten as

(1.9) $M=RM_{-1}+AX-RAX_{-1}+\varepsilon$ where ε is a vector of white noises

which is the alternative hypothesis for the error terms in the share equations.

The data used for estimation are derived from the Hojin Kigyo Chosa, a survey conducted on a quarterly basis by the Ministry of Finance of incorporated enterprises in the manufacturing industry with paid in capital equal to or larger than 10 million yen. Further details on the data, together with the definitions of relevant variables such as the capital stock, are to be found in the Appendix.

The model (1.4)–(1.7) has been estimated using a Full Information Maximum Likelihood technique. The existence of structural change between the subsamples 1965.1 – 1973.4 and 1974.1 – 1983.3 has been tested by a likelihood ratio test: if L_0, L_1 and L_2 are the values of maximum likelihood for the full sample 1965.1 – 1983.3 and the two subsamples respectively, the test is given by

(1.10) $2(L_1+L_2-L_0)\sim\chi_r{}^2$ with r being the number of restrictions

The asymptotic χ^2 has been found to be equal to 397.6, which is greater than 18.31, the critical value at 5% level of confidence. As a consequence structural change cannot be rejected and the two subsamples should be treated separately. Let us then call period 1965.1 - 1973.4 period I and period 1974.1 - 1983.3 period II.

The existence of simple autocorrelation patterns is tested by estimating equation (1.9) for both periods and applying a likelihood ratio test. Here the values of asymptotic χ^2 are given by 2.322 and 39.86 for periods I and II respectively. As the critical value at 5% level of confidence is now 3.8, autocorrelation is rejected only for period I; period II is henceforth considered with the simple pattern of autocorrelation included. Table 1 gives the Hicks-Allen elasticity values for both periods.

It is hard to conceal the fact that it is quite difficult to account for the positive value of ε_{Kv} and the negative value of ε_{Lv} in period II using the standard predictions of economic theory. In order to ascertain whether these undesirable results were due to my having specified the cost function in period II, I tested for weak separability in the production function $Q=Q(L,K,M)$, namely, for the possibility of writing it either as $Q=Q(G,M)$ where $G=G(K,L)$, or as $Q=Q(L,V)$ where $V=V(K,M)$. This was done by imposing the following restrictions:

$$(1.11)\quad M_m g_{wk}-M_k g_{wm}=0 \text{ for } Q=Q(V, L)$$

$$M_w g_{mk}-M_k g_{mw}=0 \text{ for } Q=Q(G, M)$$

which imply a set of linear restrictions given by $g_{wk}=g_{wm}=0$ in the $Q=Q(V, L)$ case and by $g_{mk}=g_{wm}=0$ in the $Q=Q(G, M)$ case. Table 2 lists the results.

The production function is thus found to be weakly separable in the form $Q=Q(V,L)$ for period II, the period in which the problems existed.

If separability restrictions are now imposed, the elasticities for the second period are as given in Table 3.

Comparison of Tables 1 and 3 suggests the following implications:

a) The elasticities of labour demand with respect to any price increased in absolute value after the first oil shock.

b) The elasticity of labour demand with respect to output decreased marginally from 0.582 to 0.507 in the cross-over from period I to period II.

c) the own price elasticity of capital decreased after the first oil shock while the own elasticity of materials increased.

d) the structural change after the first oil shock did not involve only the parameters, but also the properties of the production function, as shown by the weak separability between labour and an aggregate of capital and materials.

Among the findings, point b) deserves particular attention because of its relation to labour adjustment and because it confirms existing evidence from different sources about labour management since the oil shock.[1]

[1] The point has been made quite clearly by the Economic Planning Agency:
"... given the downward shift in business expectations about economic growth ahead, business can hardly be expected to expand regular male employment as vigorously as they did even once they have wound up the post oil crisis employment adjustment program." EPA (1978/1979), p. 186.

TABLE 1. HICKS-ALLEN ELASTICITIES IN THE TWO PERIODS

	Period I	Period II
ε_{Lw}	−0.135	−0.428
ε_{Mm}	−0.051	−0.132
ε_{Kv}	−0.433	0.106
ε_{Lv}	0.088	−0.214
ε_{Mv}	0.043	0.024
ε_{Nw}	0.007	0.107
ε_{LY}	0.582	0.570

TABLE 2. TESTING WEAK SEPARABILITY
Values of the χ^2 with two restrictions

	Period I	Period II
$Q=Q(G,M)$	44.2	23.02
$Q=Q(V,L)$	92.8	0. *

* The value 0 stands for 2 (495.56–509.24) which is a negative number. How is it possible to justify such a result? A clue may, perhaps, be found in the phenomenon of multicollinearity. In order to investigate this, I have regressed each independent variable in the model on the set of all the other independent variables and then tested for orthogonality. All cases reject orthogonality but for the regression of *lnv* on all other independent variables of the share equations with the exception of *lnw;* note that this variable would be dropped in the case of weak separability $Q=Q(V,L)$. A simple look at the matrix of zero order correlations shows, moreover, that the elements containing *lnw* are generally highly collinear with other elements. Lastly, a look at the values of the estimated variances-covariances matrix shows that $Q=Q(V,L)$ separability reduces the variances of strategic parameters.

Multicollinearity may, thus, be behind the reduction in the value of maximum likelihood when separability is rejected.

TABLE 3. VALUES OF ELASTICITIES IN PERIOD II

ε_{Lw}	−0.869
ε_{Mm}	−0.129
ε_{Kv}	−0.117
ε_{Lv}	0.130
ε_{Mv}	−0.013
ε_{Mw}	0.130
ε_{MY}	0.507

Indeed, the reduction in the rate of growth after the Kippur War was accompanied by expectations of a reduction in the long term trend and an increase in the variability of performance around the trend. The consequence has been felt both in the adjustment of labour to the newly perceived trend and in the attitude of dealing with short term variations in output with the existing core of regular employees

II. *The "ad hoc" Dynamic Model*

Let S be the vector of factor shares of total cost and S^* the corresponding vector of desired shares described by (1.5) - (1.7); if L is a matrix of adjustment coefficients, Oi's partial adjustment model may be expressed as follows:

$$(2.1) \quad S-S_{-1}=L(S^*-S_{-1})+u$$

Matrix L has been estimated in two different versions by IV3SLS, with a set of instruments analogous to the one specified by Berndt and Wood (1975). The first version is given by

$$(2.2) \quad \begin{bmatrix} \lambda & 0 & 0 \\ 0 & \lambda & 0 \\ 0 & 0 & \lambda \end{bmatrix}$$

where all the elements in the diagonal are equal due to summing up restrictions implicit in the shares model. The estimated value of λ in period I has been found to be 0.634, while in period II it stands at 0.673. The difference between the coefficients in the two periods is, however, not significant. The estimated value of λ in the second period, for instance, cannot be considered significantly different from the value obtained in the first period.[2]

Moreover, if the diagonal model as a whole is tested against the hypothesis of instantaneous adjustment, diagonality is rejected in both subsamples.[3]

On the other hand, if diagonality is dropped and L is defined by

$$(2.3) \quad \begin{bmatrix} 1 & 0 & 0 \\ 0 & z_w & (1-z_k) \\ 0 & (1-z_w) & z_k \end{bmatrix}$$

where z_w is the adjustment coefficient for labour and z_k that for capital

namely, materials are assumed to adjust instantaneously while structural interrelation is introduced in the labour and capital adjustment paths, IV3SLS estimates generate the following L_{I} and L_{II} matrices,

$$L_{\text{I}} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1.048 & -0.018 \\ 0 & -0.048 & 1.018 \end{bmatrix} \qquad L_{\text{II}} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.997 & 0.087 \\ 0 & 0.003 & 0.902 \end{bmatrix}$$

each of them corresponding to one of the two subperiods. When stability is checked, however, the characteristic roots for periods I and II are found to be $b_1=1.06$, $b_2=0.98$ and $b_1=1.034$, $b_2=0.942$ respectively. In both cases, then, real roots are outside the unit circle so that model (2.3) is unstable. Moreover, if (2.3) is tested against (2.2), and (2.2) against the assumption of L being an Identity Matrix, diagonality is refused in both cases.

The findings quite clearly limit the appeal of the ad hoc dynamic model and compel careful use of its results. It is worth noting that an equivalent outcome was produced by Berndt and his associates [see Berndt-Wavermann-Fuss (1978)] when testing the same model on American data. The exposure to different data sets from different countries and different periods should further confirm the pitfalls of the model.

[2] The t-value of the difference (0.673–0.634) in the second period is 0.532, not significantly different from zero.

[3] For instance, in period I, if L_0 is the value of maximum likelihood when the model is diagonal and L_1 the same value for instantaneous adjustment, the test gives $2(L_0-L_1)\sim\chi^2_1=0.46$, which is less than 3.8.

III. *The Labour Adjustment Cost Function*

As previously mentioned, the speed of labour adjustment in a given time interval depends, coeteris paribus, on the cost of adjusting labour and other related factors of production. Given the cost of adjusting these other factors, the higher the cost of varying the amount of labour in a given time period, the lower the speed of labour adjustment may be expected to be. An inverse relation then exists between the speed itself and an appropriately defined labour adjustment cost function c_L. As a consequence, changes in the adjustment speed over time may be properly described by analysing the dynamics of the function c_L.

The cost of adjusting labour depends, among other things, on the quality of labour being considered and on the general conditions of the labour market, as the latter interacts with the highly structured features of firm-related internal markets.

If "lifetime employment" implicit contracts are considered [see Aoki (1984); Nakatani (1984); Koike (1977) and Ohashi (1983)], for instance, it is often remarked that Japanese companies tend to use more a "flex-wage fix-employment" model to deal with fluctuations in the level of economic activity than do their American counterparts.

On the other hand, contracts for part-time and temporary workers do entail relatively low costs of adjusting the quality of these workers both upwards and downwards. As a consequence, the expectation is that an increase in the actual and desired numbers of part-timers as a percentage of total employees in the incorporated enterprises will imply lower overall labour adjustment cost.

There are indeed several indications that, since the first oil shock, "low adjustment cost" employment opportinuties, filled mainly by female part-timers, have risen at the expense of shrinking "good job opportunities" taken by lifetime employees.[4]

As for the impact of labour market conditions, a tight labour market, such as that seen in the late sixties and the early seventies, increases the range of attractive alternative job opportunities available to specifically trained employees and thus their incentive to quit. This situation is closely paralleled by tough competition for new workers, which raises hiring costs and generates raiding behaviour. As Gary Becker has pointed out in his famed research on human capital, the cost of losing a specifically trained employee and the related potential revenues in the wake of a temporary reduction in the level of economic activity are generally a function of how the competitors and the market as a whole are faring [see Cole (1979) and Dore (1973)].

In all these circumstances, the tighter the labour market, the higher the actual and expected cost of both increasing and decreasing the number of employees.

On the other hand, both hiring costs and expected revenues from specific training are lower in a loose labour market, as in the case of the situation associated with the low growth performance after the first oil shock. Consequently, both actual and future costs of increasing or decreasing labour are expected to be lower.

To sum up, the structural change in the economic environment after the first oil shock

[4] "From around 1975, Japanese business definitely turned to manpower of relatively low adjustment cost in the face of a lowering in the expected rate of economic growth. That is why demand increased for part-time workers, most of them being females," E.P.A. (1978–79), pp. 171–172. Moreover, see Odaka (1980), Rohlen (1979) and Koshiro (1983).

has generally changed the conditions of the labour market from tight to loose, with a consequent expected reduction in the cost of adjusting the amount of employees.

In order to derive an explicit formulation of the labour adjustment cost function, some assumptions are required. First of all, I assume that only employment and capital have non-zero adjustment costs. Both materials and working hours are, for simplicity sake, assumed to adjust instantaneously. The functional forms of both labour and capital as·justment costs are given respectively by:

$$(3.1) \quad c_L=\frac{1}{2}b(L_t-L_{t-1})^2+g_1(L_t-L_{t-1})(K_t-K_{t-1})$$

$$(3.2) \quad c_k=\frac{1}{2}a(K_t-K_{t-1})^2+g_2(L_t-L_{t-1})(K_t-K_{t-1})$$

The total adjustment cost function is then described by the following quadratic form [see for instance Meese (1980) and Sargent-Hansen (1981)].

$$(3.3) \quad c_{LK}=\begin{bmatrix} L_t-L_{t-1} \\ K_t-K_{t-1} \end{bmatrix}' D \begin{bmatrix} L_t-L_{t-1} \\ K_t-K_{t-1} \end{bmatrix}$$

where D is a full matrix given by

$$(3.4) \quad D=\begin{bmatrix} b/2 & g_1 \\ g_2 & a/2 \end{bmatrix}$$

Given that the purpose here is to study the dynamic of the function c_L as it relates to the dynamics of labour market conditions and the quality of labour being employed, (3.1) has to be suitably modified as follows. Let V be the ratio of job offers to job seekers (*kyujin-bairitsu*); V is an appropriate index of the conditions prevailing in the labour market, and can be used here as a proxy for this purpose. On the other hand, let *COMP* be the ratio of female to male employees in manufacturing. Female workers are generally on a type of contract that implies lower adjustment costs than does that of their male counterparts. Most part-time work is done by females, while male employees are to a larger extent entitled to the lifetime employment privileges. *COMP* may then be used as a proxy for the quality of labour being employed, and (3.1) may thus be rewritten as

$$(3.5) \quad c_{Lt}=\frac{1}{2}[b_0-b_1COMP_{t-\tau}+b_2V_{t-\tau}][L_t-L_{t-1}]^2+g_1(L_t-L_{t-1})(K_t-K_{t-1})$$

where the fixed coefficient b in (3.1) has been replaced by the time related function

$$(3.6) \quad b=b_0-b_1COMP_{t-\tau}+b_2V_{t-\tau}$$

where τ is a lag operator.

In other words, the unit adjustment cost for labour has been related to two different economic variables, both theoretically sensible to changes in the economic environment.

While b_1 is expected to be negative because higher percentages of female workers are assumed to reduce the overall cost of adjusting labour, b_2 is expected to be positive, given that higher values for V stand for tighter labour market conditions and thus higher costs of labour adjustment.

An alternative version of (3.1) may be tested. The cost of adjusting labour, especially downwards, is in fact related to union resistance and control, so that union strength has a bearing on variations in employment. If the rate of unionization in manufacturing is taken as a proxy of union strength, (3.1) may be replaced by

$$(3.1.1)\quad c_{Lt}=\frac{1}{2}[c_0+c_1UNION_{t-\tau}](L_t-L_{t-1})^2+g_1(L_t-L_{t-1})(K_t-K_{t-1})$$

where c_1 is expected to be positive, since actual and prospective costs of adjustment are directly related to union strength.

IV. *The Dynamic Model*

Let us now assume that companies determine their factor demands by solving a dynamic control problem subject to rational expectations about the future values of output and relative prices:

$$(4.1)\quad \min_{K,L} E_t\sum_{t=\tau}^{\infty} R_{t,\tau}[C(p_{m\tau},_{K\tau},\ L_\tau,\ Y_t)+v_\tau K_\tau+w_\tau L_\tau+c_{LK\tau}]$$

$K,L\ t=\tau$ where R is the discount factor, E the rational expectations operator and K the capital stock.

Materials are assumed to adjust instantaneously, so that the restricted cost function [see Pindyck-Rotemberg (1983); also Sargent (1981) and Bertsekas (1976)] is given by:

$$(4.3)\quad lnC=a_0+lnp_m+a_2lnK+a_3lnL+a_4lnY+d_{13}lnLlnY+\frac{1}{2}d_{22}(lnK)^2$$
$$+d_{32}lnKlnY+\frac{1}{2}d_{11}(lnL)^2+d_{12}lnLlnK+\frac{1}{2}d_{33}(lnY)^2+ft$$

where t stands for Hicks neutral technical progress
MA is the quantity of materials
$C=p_mMA$ is the short-term cost

If lag τ is now assumed to be equal to 1 and $g=g_1+g_2$, Euler equations may be derived from (4.1) as follows:

$$(4.4)\quad \frac{C_t}{L_t}[a_3+d_{11}lnL+d_{12}lnK+d_{13}lnY]+w_t=E_t[R_t(b_0-b_1COMP_t+b_2V_t)$$
$$*(L_{t+1}-L_t)+R_tg(K_{t+1}-K_t)]$$
$$-(b_0-b_1COMP_{t-1}+b_2V_{t-1})(L_t-L_{t-1})-g(K_t-K_{t-1})$$

$$(4.5)\quad \frac{C_t}{K_t}[a_2+d_{22}lnK+d_{12}lnL+d_{32}lnY]+v_t=E_t[R_ta(K_{t+1}-K_t)+R_tg(L_{t+1}-L_t)]$$
$$-a(K_t-K_{t-1})-g(L_t-L_{t-1})$$

As Pindyck and Rotemberg have shown, model (4.3) – (4.5) may be conveniently estimated if expectations of future variables are assumed to be equal to the future variables themselves but for an expectational error. Under some conditions specified by the authors, IV3SLS is the appropriate estimator,[5] with the list of instruments including all the variables belonging to the information set used to infer expectations, namely, the lagged values of both quantities and relative prices included in the model. Model (4.3) – (4.5) has been estimated both for the full sample and for the two subsamples. Given, however, that results for the second subsample are rather unsatisfactory, an alternative second subsample has been used for the period between the two oil shocks, i.e. 1974.1 – 1978.4. Table 4 gives the estimated values of the two adjustment cost functions c_L and c_K under the assumption of D being diagonal, namely, of no structural interrelation (g=0).

The signs of the estimated coefficients are as expected in the first subsample and the full sample, namely positive for a and b_2 and negative for b_1. The parameter a is significant at the 5% level both in the first subsample and in the full sample. Parameters b_1 and b_2 are significant at the 10% level in the first subsample. In the second subsample, b_1 is quite close to significance at the 10% level. However, t values deteriorate significantly whenever the period after the second oil shock is included, as in the case of the full sample case.

Table 5 gives the estimated values of the adjustment cost functions for the two subsamples when allowance is made for structural interrelation (g nonzero).

While there is no significant variation in the other estimated parameters, it is interesting to observe how structural interrelation has become a significant phenomenon in the period between the two oil shocks. This result should, however, come as little surprise when one

TABLE 4. ESTIMATED PARAMETERS OF THE ADJUSTMENT COST FUNCTIONS*

	1965.1–1973.4	1974.1–1978.4	1965.1–1983.3
a	0.1902E-04	−0.340E-05	0.1665E-04
	(4.01)[a]	(−0.74)	(2.099)[a]
b_0	0.6509E-03	0.8690E-03	0.779E-03
	(1.65)	(1.96)	(0.926)
b_1	0.150E-02	0.1731E-02	0.1630E-02
	(1.85)[b]	(1.90)	(0.963)
b_2	0.838E-04	−0.203E-04	0.278E-04
	(2.00)[b]	(−0.58)	(0.302)

* t values are in brackets; a stays for significance at the 5% level of confidence, while b stays for a 10% level.

TABLE 5. INTERRELATION BETWEEN CAPITAL AND LABOUR

	1965.1–1973.4	1974.1–1978.4
a	0.1951E-04	−0.323E-06
	(4.15)[a]	(−0.07)
g	0.202E-05	0.524E-05
	(0.569)	(2.87)[a]
b_0	0.497E-03	0.841E-03
	(1.12)	(1.912)
b_1	0.115E-02	0.1796E-02
	(1.31)	(1.886)
b_2	0.659E-04	−0.930E-05
	(2.98)[a]	(−0.26)

[5] Solving for stochastic equilibria instead of estimating the Euler equations is computationally more difficult but yields estimators that are asymptotically more efficient.

TABLE 6. COMPARISON IN THE SCALE OF ADJUSTMENT COEFFICIENTS

	Japanese case		American case	
a	0.1821*E*-04	*ratio a/b*	0.18779	*ratio a/b*
b	0.2310*E*-04	=0.78	0.326*E*-03	=576

TABLE 7. LABOUR UNION STRENGTH IN THE ADJUSTMENT COST FUNCTION

	1965.1–1973.4		1965.1–1983.3
c_0	−0.530*E*-03	−0.713*E*-03	−0.378*E*-03
	(1.42)	(−1.74)[b]	(0.34)
c_1	0.135*E*-02	0.1853*E*-02	0.962*E*-03
	(1.37)	(1.73)[b]	(0.38)
g		0.330*E*-05	
		(0.88)	

thinks of the relevant changes in the amount and composition of the capital stock of many Japanese manufacturing companies which occurred in the years following the Kippur War.

Even though the findings obtained so far are not exactly comparable with the ones estimated by Pindyck and Rotemberg, it can be noted that when the scale of capital and labour adjustment parameters are considered the American case shows capital adjustment costs that are considerably larger than those of labour; the Japanese case, on the other hand, presents no relevant difference in the scale itself. Indeed, if (3.5) is replaced by

$$(3.1.2)\quad c(L_t - L_{t-1}) = \frac{b}{2}(L_t - L_{t-1})^2$$

as in Pindyck-Rotemberg, and the absolute values of the estimated parameters a and b are compared, Table 6 may be obtained.

Table 6 seems to suggest that while capital is a much more fixed factor than labour in the American case illustrated by Pindyck and Rotemberg, in the Japanese case the degree of fixity is about the same for the two production factors.

Version (3.1.1) of the labour adjustment cost function has also been estimated for the first subperiod, both for $g=0$ and g nonzero, and for the full sample for $g=0$. Table 7 shows the results. As in the case of (3.5), signs are as expected but significance declines whenever the period after the first oil shock is fully included in the sample.

Keeping in mind this rather important limitation of the results obtained so far, some general considerations about the dynamics of the labour adjustment cost may be advanced as follow. Throughout the latter half of the sixties and the beginning of the seventies, the unit labour adjustment cost was kept at a relatively high level by increasingly high values of V, a situation which is typical of a labour shortage economy.

Reaching its peak shortly after the first oil shock, when the percentage of labour at relatively low adjustment cost fell abruptly, the cost dropped strongly in the following years in response to both a shattering reduction of V and the consistent growth of more flexible labour as a percentage of the total number of employees. It is, indeed, a well known fact that women, who took the brunt of the adjustment just after the recession, started to find their way back into the labour market when the economy began to grow again in a different and more uncertain environment.

The trough is to be found towards the end of 1978, a date generally considered by both

OECD and E.P.A. reports [see OECD and EPA (1974–1984)] as the turning point in the complex adjustment process endured by the Japanese economy as a consequence of the first oil shock.

Since this turning point, the unit labour adjustment cost has risen again as economic conditions have improved. The current level is, however, structurally lower than that which prevailed before the shock because of the structurally lower level of V and the increasing role being played by part-timers.

Moreover, the relevant decline in the degree of unionization after the upsurge associated with the first oil shock and the immediate danger of layoffs has not only generated poor Shunto performances but has also contributed to keeping the labour adjustment cost at relatively lower levels.

If the inverse relation between labour adjustment speed and labour adjustment cost is recalled, some evidence seems to exist, albeit within the previously stated limitations, to support the conclusion that the speed of labour adjustment has risen structurally in the low growth environment following the first oil shock, a conclusion which supports the results obtained by Muramatsu with a simpler partial adjustment model.

At this stage, the effect of the relaxation of the assumptions implicit in the static model on the elasticities of factor demands with respect to changes in relative prices remains to be investigated. In order to check findings a), b), and c) from the static model, then, I have dropped a further assumption from the dynamic framework (4.3)–(4.5) so as to approximate reality in a better way; namely, I allow for adjustment of working hours to be taken into account when computing short and long term elasticities. To do so, I use the simplifying assumption that while labour inputs are adjusted in the short term only by changing working hours per employee, adjustment in the long term is performed only by varying the number of employees.

Let us define the total wage bill W as

(4.6) $W=w_H HL$ where w_H is the wage per hour paid to an average employee, H the number of hours per employee, L the number of employees and $w=w_H H$ the wage per employee.

(4.3) then becomes

$$(4.7)\quad lnC=a_0+lnw_H+a_1ln(p_m/w_H)+a_2lnL+a_3lnK+a_4lnY+1/2e_{11}(lnp_m/w_H)^2 +e_{13}ln(p_m/w_H)lnL+e_{14}ln(p_m/w_H)lnK+e_{15}ln(p_m/w_H)lnY+1/2d_{11}(lnL)^2 +ft+d_{12}lnKlnL+d_{13}lnLlnY+1/2d_{22}(lnK)^2+d_{32}lnKlnY+1/2(lnY)^2$$

where $C=p_mMA+w_HHL$

The Euler equations are now:

$$(4.8)\quad S_m=a_{11}+e_1(lnp_m/w_H)+e_{13}lnL+e_{14}lnK+e_{15}lnY$$

where $S_m=p_HMA/C$

(4.9) is equivalent to (4.4) but for the addition of the term $e_{13}ln(p_m/w_H)$ inside the brackets on the left side.

(4.10) as well is equivalent to (4.5) but for the addition of the term $e_{14}ln(p_m/w_H)$ inside the brackets on the left side.

TABLE 8. SHORT AND LONG TERM ELASTICITIES

	1965.1–1983.4		1974.1–1983.3	
	Short term	Long term	Short term	Long term
ε_{Mm}	−0.255		−0.349	
ε_{Lm}		0.619		0.777
ε_{Km}		0.411		0.323
ε_{Hw}	−0.132		0.380	
ε_{Hm}	0.132		−0.380	
ε_{LY}		0.726		0.460
ε_{KY}		0.712		0.645
ε_{MY}	1.150		0.904	
ε_{HY}	1.024		1.367	
ε_{Kv}		−0.642		−0.413
ε_{Lw}		−0.418		−1.398
ε_{Kw}		0.231		0.090

The estimation of (4.7) - (4.10) leads to a set of short and long term elasticities, the latter being computed by setting $a=b_0=b_1=b_2=0$.[6]

Tabel 8 presents these elasticities both for the full sample and for period II.

If the findings from the full sample are compared with those from period II, all the results listed in a), d) and c) from the static model are confirmed. In fact, all the elasticities of labour to price variations rise after the shock, as does the own price elasticity of materials. Instead, the own elasticity of capital falls, as in the static model. Finally, a decrease in the elasticity of employment to output is now coupled with an increase in the elasticity of working hours, which shows how incorporated enterprises have generally reacted to changes in output since the oil shock by a larger utilization of flexible inputs which require smaller costs of adjustment and can be easily disposed of in an uncertain environment. Lastly, the elasticity of capital to output has also fallen, in a fashion which seems similar to that followed by labour. However, a better understanding of the case of capital stock would require the introduction to the model of an index of capital utilization and a symmetric treatment of production factors. This is, unfortunately, quite a difficult task to pursue with the available data resources.

V. *Conclusions*

This paper has attempted an estimation of the patterns of labour adjustment in the Japanese incorporated enterprises before and after the first oil shock by using an interrelated factor demands approach and by developing a more explicit labour adjustment cost function so as to overcome the pitfalls inplicit in a single "ad hoc" partial adjustment model. The response of the production structure to changes in the economic environment has been investigated first in a static framework, revealing that structural change has involved not only some parameters but also the properties of a three factor production function. The characteristics of an "ad hoc" dynamic model have been briefly considered, showing that some

[6] Formulae for the elasticities may be obtained on request.

qualifications need to be added and a careful interpretation is needed when stating that the speed of labour adjustment has risen since the first oil shock.

In order to avoid these problems, an explicit labour adjustment cost function has been inserted in a dynamic framework a la Pindyck-Rotemberg.

Estimation shows that the cost of adjustment is significanlty related, at least in a time interval, to the quality of the labour force employed and the general conditions prevailing in the labour market. About as convincing is the evidence on the relevance of union strength, when this is proxied by the degree of unionization in manufacturing. The results are interpreted as a sign of the existence of a structural reduction in the cost of adjusting employees after the first oil shock. Associated with the cost by an inverse relation, the speed of labour adjustment is then perceived to have increased, a fact which supports the conclusion that overall labour has become more flexible a factor of production since the crisis. Needless to say, all this confirms the results obtained by Muramatsu with a simple partial adjustment model.

Coupled with the perceived increase in the speed of labour adjustment is the structural reduction of the elasticity of employment with respect to changes in the level of output and the parallel increase of the elasticity of working hours. The increased uncertainty about the future values of output in a low growth environment such as that prevailing after the first oil shock seems to have induced many incorporated enterprises in Japan to use flexible inputs like working hours more extensively than in the past to deal with cyclical fluctuations in the level of economic activity. At the same time, the sensibility of employment to variations in any relative price has increased.

APPENDIX

The data come from the Hojin Kigyo Tokei Kiho, a quarterly publication by the Ministry of Finance, and are limited to a sample of incorporated enterprises with more than 10 million yen in paid in capital. Being aggregate data, they necessarily approximate the actual pattern of labour adjustment and to a certain degree underestimate it, because flows of employees among firms do cancel out.

As there is no time series of the real gross capital stock for incorporated enterprises, I have estimated it using the following methodology. The available data include a time series of gross investments and a time series of gross capital stock in manufacturing, the latter covering a much larger sample. The assumption I make here is that the dynamics of the capital stock series, both in manufacturing and in the incorporated enterprises, are almost equivalent when compared at certain benchmarks; in 1975, I assume, the ratio investment/capital is the same in both cases. The last assumption allows me to obtain the needed bemchmark in the formula

$K_t = I_t + (1-d)K_{t-1}$ where K=capital stock
I=investment
d=depreciation rate

I then establish the two following benchmarks:

$r_1 = K_{1973\cdot 4}/K_{1965\cdot 1}$ $r_2 = K_{1983\cdot 3}/K_{1973\cdot 4}$

If r_{1m} and r_{2m} then stand for the ratios in total manufacturing and r_{1c} and r_{2c} for the same ratios in the incorporated enterprises, I choose among the feasible values of d those which get a closer equivalence among the ratios. As it worked out, I got $d=0.009$ for the first subperiod corresponding to r_1 and $d=0.0115$ for the second subperiod corresponding to r_2. If the dynamics of the constructed series is compared with the movement of the existing series in manufacturing equivalence is obtained.

Given that I do not separate intermediate goods from raw materials, I had to compute a composite price index of which the ingredients are the index of prices of raw materials and the index of prices of semi-finished goods, using as a weight the index of consumption of both raw materials and intermediate goods in manufacturing.

The user cost of capital has been obtained from the following formula:

$$v=\frac{DEFLINV}{DEFLP}(r+d)/(1-t)$$

where *DEFLINV* is the price index of investment goods, *DEFLP* is the wholesale price index, $r=(PROF-TAXES+INR)/K$, *PROF* is the level of current gross profits; *TAXES* is the amount of corporate tax payments, *INR* is the amount of interests paid, and t is the corporate tax rate. The methodology is then quite similar to the one used by Jorgenson and Stevenson.

The *UNION* variable has been calculated using the Survey on Union Organization by the Ministry of Labour.

The number of employees includes temporary employment, while remunerations are gross of welfare provisions.

All data in the sample 1965.2 – 1983.3 have been filtered using *TSP* procedures. Estimation has been conducted with the *TSP* package.

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