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Internal Promotion, Intrafirm Wage Structure and Corporate Growth

by

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ABSTRACT

In a firm with two ranks where any vacancy in rank 2 is filled with internal promotion of rank 1 worker, three variables are important to employees and owners, the wage rates at the two ranks and the growth rate, where the latter is important because it affects an employee's chance of promotion. The decision on these variables is investigated under two behavioral hypotheses, stockholder-welfare maximization and employee-welfare maximization, with a worker's promotability dependent or independent of his work effort. The relevance to Japanese data, workers' incentive for seniority rule in promotion, and the implications to the growth-maximization hypothesis are also discussed.

1 INTRODUCTION

Consider a firm in which there are two ranks. Work at rank 1 requires no experience but work at rank 2 requires experience at rank 1 in the same firm; hence, any vacancy in rank 2 is filled only through internal promotion. Three variables are of importance to the employees of this firm as well as to the owner-stockholders, the wage rates at the two ranks and the rate of growth of the firm, where the latter variable is important to the employees because it affects the chance of promotion. This paper investigates how these variables are determined under alternative situations and corporate goals.

The model is given in the following section. Sections 3 and 4 investigate the decision under two alternative corporate goals, that is, stockholder-welfare maximization and employee-welfare maximization, respectively. These alternative goals are shown to result in different predictions on the relative flexibility between the levels of wages and the ratio of wages. Empirical application of this result is attempted in section 5 using Japanese data, though the result is not conclusive. Section 6 assumes that the probability of promotion is perceived by the worker to be dependent on his level of work effort. His decision on the optimal level of effort is analyzed and why workers seek a strict seniority rule in promotion is explained. The final section, after summarizing the major findings, discusses that other factors such as the difficulty of owners' monitoring and the conflict of interests among the employees may cause management and employees to seek a higher rate of growth more often than higher wage rates.

2 THE MODEL

Suppose that capital and labor are substitutable as in the usual

neoclassical model but labor at rank 1 and at rank 2 are not. That is, letting K denote the amount of capital and L_i, the amount of labor at rank i, the level of production is determined by $F(K, \min[L_1, L_2/c])$ with c constant. If we exemplify rank 2 by supervisorship and rank 1 by production labor, c is the inverse of control span, namely, of the number of subordinates a superior can supervise, which we may reasonably assume to be technologically fixed and less than one (see Simon, 1957). Presuming cost minimization, we have $L_2 = cL_1$ and the production function is $F(K, L_1)$. We follow the neoclassical assumptions that marginal products are positive but diminishing and the function is linearly homogeneous. Hence, $F(K, L_1) = Kf(\ell)$ with $\ell \equiv L_1/K$ and $f' > 0$ and $f'' < 0$. The output market is assumed competitive and without loss of generality we normalize the output price as unity.[1]

The net cash flow of the firm is $F(K, L_1) - wL_1 - bwL_2 - I$, where w is the rate of wage at rank 1 and bw, at rank 2; thus, b is the inter-rank wage ratio. Naturally, b is greater than one. I denotes the cost of investment and, following Uzawa's (1969) formulation of the cost of adjusting the stock of capital, we assume that $I = \psi(g)K$ where g is the rate of increase of capital, with $\psi' > 0$ and $\psi'' > 0$. Throughout this analysis, we assume that g is positive; that is, we only consider an expanding firm. Noting that $L_2 = cL_1$, the net cash flow above is rewritten as $[f(\ell) - (1 + bc)w\ell - \psi(g)]K$. If the competitive stock market has stationary expectation concerning w, ℓ and g as well as b, c, and the discount rate i, the market value of the firm equals the present value of its net cash flow; hence, provided $i > g$,[2]

$$v = [f(\ell) - (1 + bc)w\ell - \psi(g)]/(i - g) \qquad (1)$$

because K grows at rate g. v is the ratio of the market value to the book value of today's capital and is called the valuation ratio (Marris, 1964, and Odagiri, 1981). This ratio is equivalent to what Tobin (1969) has called q in a somewhat different context.

Suppose that every worker works for two periods. He/she is hired in rank 1 at the beginning of the first period and retires or dies at the end of the second period. At the beginning of the second period, he/she may be promoted to rank 2. In that only the seniors have a chance of promotion, this agrees with the seniority rule. Denote the probability of this promotion by π, which is assumed common to everyone; that is, promotion is a pure chance event not dependent on any personal characteristics (this assumption is relaxed in section 6). Then the number of rank 2 workers at time t, $L_2(t)$, equals $\pi N(t-1)$, where $N(t)$ is the number of new employees at time t, and the number of rank 1 workers, $L_1(t)$, equals $(1 - \pi)N(t-1) + N(t)$. From these equations and the definition of c, we have $\pi N(t-1) = c[(1 - \pi)N(t-1) + N(t)]$. If labor-capital ratio, ℓ, is constant, N increases at the same rate as capital; hence, $N(t)/N(t-1) = 1 + g$, and we have

$$\pi = (2 + g)c/(1 + c) = (2 + g)\tilde{c}, \qquad \text{where } \tilde{c} \equiv c/(1 + c) \tag{2}$$

Suppose that a worker's utility is intertemporally additive with the discount rate d (assumed greater than g) and that the level of utility at each time is determined by a von Neumann-Morgenstern utility function $u(y)$ when y is the income. Also assume that he expects the present corporate policy on w, b and g to continue until at least the next period. Then, if wages are paid at the end of each period, the expected lifetime utility of a new worker is

$$U = u(w)/(1 + d) + [\pi u(bw) + (1 - \pi)u(w)]/(1 + d)^2$$
$$= \{[2 + d - (2 + g)\tilde{c}]u(w) + (2 + g)\tilde{c}u(bw)\}/(1 + d)^2$$
$$= [(2 + d)u(w) + (2 + g)\tilde{c}\Delta u]/(1 + d)^2 \qquad (3)$$

using (2) where $\Delta u \equiv u(bw) - u(w) > 0$.

Suppose that the firm is to determine the policy relevant to the next period, namely, wages to be paid in the next period and the rate of growth from this period to the next. Then, among the present employees of the firm, this policy matters only to those currently in their first period because those in their second period will have retired by the next period. If we denote by U^* the expected future utility evaluated at the end of this period of the employees in their first period, we have

$$U^* = [\pi u(bw) + (1 - \pi)u(w)]/(1 + d)$$
$$= [u(w) + (2 + g)\tilde{c}\Delta u)]/(1 + d) \qquad (4)$$

We are now ready to proceed to the analysis of corporate decisions on w, b and g or, alternatively, w, Δu and g. A remark is in order here. To simplify the analysis, we employed a simple overlapping generation model presuming that workers work only for two periods. However, for most of the analysis that follows, this assumption is not essential. To verify this fact, the Appendix gives a sketch of a comparable model in which time is continuous and people may work for ever and yet gives essentially the same results.

3 A TRADITIONAL APPROACH: STOCKHOLDER-WELFARE MAXIMIZATION

We will start with the following proposition.

Proposition 1 If the firm maximizes v with respect to ℓ, w and b subject to the constraints that $U \geq \bar{U}$, $w \geq \bar{w}$, and $b \geq \bar{b}$, where $\bar{U}$, $\bar{w}$ and $\bar{b}$ are given constants, and if workers are risk averse or neutral, then at the optimal solution (i) $b = \bar{b}$ and (ii) $\partial w/\partial \bar{U} > 0$.[3]

The straightforward proof is of course obtainable by actually solving the maximization problem to obtain the Kuhn-Tucker condition. The basic idea, however, is this. Let MRS^U_{wb} stand for the marginal rate of substitution between w and b for the U function, namely, $MRS^U_{wb} \equiv (\partial U/\partial w)/(\partial U/\partial b)$. Then we find that

$$MRS^U_{wb} = \frac{u'(w)}{u'(bw)} \frac{2+d+c(d-g)}{cw(2+g)} + \frac{b}{w} \tag{5}$$

Similarly defining MRS^V_{wb}, we have

$$MRS^V_{wb} = \frac{1}{cw} + \frac{b}{w} \tag{6}$$

Noting that $b > 1$, $d > g$, and $u'(w) \geq u'(bw)$ due to the assumption of risk aversion or neutrality, we find that always

$$MRS^U_{wb} > MRS^V_{wb} \tag{7}$$

This implies that increasing U is made with a smaller reduction in v if w is increased than if b is increased; hence, the firm will opt to use w and not b to adjust the level of U, which is why we have (i) in Proposition 1. Since U is an increasing function of both w and b and b is fixed at $\bar{b}$, $\partial w/\partial \bar{U} > 0$ as in (ii).

Because (7) holds for all $g < d$, the proposition is valid whether g is endogenously chosen or exogenously given. Suppose now that it is a

policy variable to be determined endogenously. Then the internal solution requires that $MRS^U_{wg} = MRS^v_{wg}$ following the same notational method as before. Because $\partial u/\partial w > 0$, $\partial u/\partial g > 0$, and $\partial v/\partial w < 0$, we immediately find that $\partial v/\partial g$ should be negative, implying that the optimal growth rate is greater than the rate that maximizes v were it not for the constraint on U.

If b is fixed at $\bar{b}$, only w and g are variable as U or v changes and the locus of the optimal combination of w and g is interpreted as the contract curve between owners and workers. The equation for this contract curve is obtained from the above equality of MRS's, and is

$$[(2+d)u'(w) + (2+g)\tilde{c}(\partial\Delta u/\partial w)](v - \psi'(g)) + (1 + bc)\ell\tilde{c}\Delta u = 0 \quad (8)$$

If we differentiate the LHS with respect to w and g, we find that the coefficient for dg is negative and that for dw is

$$(1+d)^2(i-g)^2(\partial^2U/\partial w^2)(\partial v/\partial g) - (1+bc)\ell(2+d)u'(w) + (1+bc)\tilde{c}\ell(i-2-2g)(\partial\Delta u/\partial w) + (1+bc)\tilde{c}(i-g)\Delta u(\partial\ell/\partial w) \quad (9)$$

where $\partial\Delta u/\partial w = bu'(bw) - u'(w)$.

Suppose that workers are risk neutral. Then $\partial\Delta u/\partial w = (b - 1)u'(w)$ and $\partial^2U/\partial w^2 = 0$. Hence, the first term vanishes, the second and third terms are combined to get $(1+bc)\ell u'(w)[-(2+d) + (b-1)\tilde{c}(i-2-2g)]$, and the fourth term is negative. We may safely say that $(b-1)\tilde{c}$ is less than one, for b is, say, less than 6 (i.e., a boss is paid not more than six times his/her subordinates' salary) and $\tilde{c}$, 0.2 (i.e., a boss supervises more than four subordinates). Then the second and third terms combined are negative if $i < d+2g+4$. i is the stockholders' discount rate while d is the workers' discount rate. It is perhaps more usual that $i < d$ because stockholders have more opportunity to diversify their investment

to reduce risk. Even if i exceeds d, it is unlikely to be greater than $d+2g+4$ even for a, say, twenty-year period. (Since people work for two periods only, one period corresponds to a half of his work years.) We can thus conclude that the second and third terms together are negative and consequently so is (9), which implies that along the contract curve, $dw/dg < 0$, that is, as U increases w increases but g decreases.[4]

If workers are risk averse, the first term is positive, the second term is negative, and the sign of $\partial \Delta u/\partial w$ is ambiguous; thus, the sign of (9) is ambiguous. If they are risk loving, then (9) is negative. Hence $dw/dg < 0$. However, b may not be fixed at $\bar{b}$ and (8) may not be interpreted as the contract curve equation. Thus an unambiguous proposition is established only for the risk neutrality case.

Proposition 2 If the firm maximizes v with respect to ℓ, w, b and g subject to the constraints, $U \geq \bar{U}$, $w \geq \bar{w}$, and $b \geq \bar{b}$, then at the optimal solution, $\partial v/\partial g < 0$. Furthermore, if workers are risk neutral, $\partial w/\partial \bar{U} > 0$ and $\partial g/\partial \bar{U} < 0$.

Fig. 1 illustrates this result. The curves labeled v_i, $i = 1,\ldots,5$, are the loci of constant v with a larger i corresponding to a larger v, and those labeled U_i are the loci of constant U with a larger i corresponding to a larger U. Thus the former are the owners' and the latter, the workers' indifference curves. The owners' indifference curves reach their peak at the dotted line which corresponds to $\partial v/\partial g = (v - \psi'(g))/(i - g) = 0$. The workers' indifference curves are everywhere downward sloping. The bold line PQ gives the contract curve where the closer Q the happier the workers. This is to the right of the dotted line and the owners' indifference curves are always downward sloping at

the contract curve as proved in the first half of Proposition 2, and is downward sloping with $\partial w/\partial \bar{U} > 0$ and $\partial g/\partial \bar{U} < 0$ as proved in the latter part of the proposition.

Maximizing v subject to a minimum value of U is a neoclassical approach. That is, if the labor market is competitive and workers rank alternative job opportunities according to the lifetime utility expected from each job, every firm must offer at least the same expected utility as the market level $\bar{U}$ to attract a sufficient number of job applicants. Furthermore if the firm maximizes the welfare of its owners (stockholders) as the neoclassical theory presumes, then it necessarily maximizes v. Thus, Propositions 1 and 2 may be said to depict corporate decisions on growth and wage structure when the firm makes decisions as presumed by the neoclassical theory.

4 AN ALTERNATIVE APPROACH: EMPLOYEE-WELFARE MAXIMIZATION

Contrary to the analysis in the previous section, suppose that incumbent employees (those that have been already hired) possess a say in corporate decision making through, for instance, labor union or managerial discretion. The first example is orthodox and needs no explanation. The latter example follows the thinking of the so-called managerialist writers. These writers argue that the non-owner manager can sabotage value maximization because of the stockholders' lack of information to examine if the maximum value is in fact attained and/or because of the costs of removing incumbent management. They then argue that management only needs to achieve a certain level of valuation, $\bar{v}$, which is strictly smaller than its potential maximum, thus implying that it can afford to pursue other objectives. For such objectives, earlier writers stressed personal gains of top executives which depend on the size of the firm (Baumol, 1959), the rate of growth (Marris, 1964),

or the size of the management staffs and such (Williamson, 1963). More recent thinking, however, stresses that corporate objectives reflect the motivation of all those who are part of the corporate organization, particularly, those who in one way or another affect corporate decisions. This originates with Galbraith's (1967) concept of technostructure and seems most relevant in Japanese corporations where interfirm labor mobility is low, internal promotion is the basic rule, proxy fights and takeovers are virtually nonexistent, and great efforts are usually paid to avoid any conflict of interest within the firm. Thus in Japanese firms, it appears more appropriate to assume that the management makes decisions so as to maximize the welfare of the entire working members of the firm[5] than to assume value maximization which requires that "the individual member of the technostructure subordinate his personal pecuniary interest to that of the remote and unknown stockholder" (Galbraith, 1967, p. 174). In the present context, that is, the firm may well attempt to maximize the welfare of incumbent employees, U*, subject to the constraint that $v \geq \bar{v}$ with a given $\bar{v}$. This section explores the characteristics of the corporate policy under this behavioral hypothesis.

We first note that

$$MRS_{wb}^{U*} = \frac{1}{cw}\frac{u'(w)}{u'(bw)}\frac{1 - c - cg}{2 + g} + \frac{b}{w} \tag{10}$$

In comparison with (6), we have

$$MRS_{wb}^{U*} < MRS_{wb}^{V}$$

if and only if

$$u'(w)/u'(bw) < (2 + g)/(1 - c - cg) \tag{11}$$

Because the RHS in the last condition is greater than one, the following proposition is immediate.

Proposition 3 If the firm maximizes U^* with respect to ℓ, w and b subject to $v \geq \bar{v}$, $w \geq \bar{w}$, and $b \geq \bar{b}$, then at the optimal solution $w = \bar{w}$ if the condition (11) is satisfied, for instance, if workers are risk neutral or loving.

If u exhibits risk aversion, we cannot uniquely determine the ranking between the two MRS's, and both w and b possibly are greater than the corresponding minimum values. It is interesting to consider the case of constant relative risk aversion. Then following Pratt (1964, p. 134), we find that $u'(w)/u'(bw) = b^{-(1-r)}$ where r is the degree of relative risk aversion. Since $b > 1$, (11) is satisfied if $r \leq 1$. Hence we can generalize Proposition 3 as follows.

Corollary 1 If u exhibits constant relative risk aversion, Proposition 3 holds whenever the degree of relative risk aversion is less than or equal to one.

Let us now investigate the relation between b and g provided $w = \bar{w}$. The internal solution requires that $MRS_{bg}^{U^*} = MRS_{bg}^{v}$. This immediately implies that $\partial v/\partial g < 0$ because b and g affects U^* positively whereas b affects v negatively. The contract curve equation obtained from this equality between the two MRS's is

$$wu'(bw)(2+g)(i-g)(\partial v/\partial g) + cw\ell\Delta u = 0 \tag{12}$$

By differentiation with respect to b and g, we find that the coefficient for dg is negative and that for db is

$$w^2u''(bw)(2+g)(i-g)(\partial v/\partial g) + cw\Delta u(\partial \ell/\partial b) + w^2c\ell u'(bw)(i-2-2g)/(i-g) \tag{13}$$

The last two terms are negative if $i < 2 + 2g$ and the first term has the sign opposite to that of $u''(bw)$ because $\partial v/\partial g < 0$. Thus if $u'' \geq 0$, the whole expression is negative and $db/dg < 0$ along the contract curve; that is, if $\bar{v}$ can be decreased employees seek a larger U^* by increasing b but decreasing g. In sum,

Proposition 4 If the firm maximizes U^* with respect to ℓ, w, b and g subject to $v \geq \bar{v}$, $w \geq \bar{w}$, and $b \geq \bar{b}$, then at the optimal solution, $\partial v/\partial g < 0$. Furthermore, if workers are risk neutral or loving and $i < 2 + 2g$, $\partial b/\partial \bar{v} < 0$ and $\partial g/\partial \bar{v} > 0$.

A diagrammatic illustration of this result is analoguous to Fig. 1 and is not given here.

5 THE EARNINGS OF WORKERS AND SUPERVISORS IN JAPAN

It is interesting to compare the results between the two behavioral hypotheses -- stockholder-welfare maximization (SWM) that maximizes v subject to the labor market constraint, $U \geq \bar{U}$, and employee-welfare maximization (EWM) that maximizes incumbent employees' expected utility U^* subject to the capital market constraint, $v \geq \bar{v}$. If employees are risk neutral, $b = \bar{b}$ in SWM and $w = \bar{w}$ in EWM. If risk averse, $b = \bar{b}$ in SWM but w may or may not equal $\bar{w}$ in EWM. If risk loving, b may or may not equal $\bar{b}$ in SWM but $w = \bar{w}$ in EWM. This suggests that w is relatively more important if risk averse and b is relatively more important if risk loving, which is reasonable because w affects income irrespective of rank whereas b affects income at rank 2 only to which an employee may or may not be promoted.

An interesting contrast occurs when risk neutral — only w is variable in SWM whereas only b is variable in EWM. This difference results from

the difference between U and U^*, namely, between the expected lifetime utility of a prospective employee and that of an incumbent employee. Because the latter has already served the firm for some time having received w and is now going to, say, draw a lottery that will award bw with probability π and w with probability $1 - \pi$, b is relatively more important to him than to a new worker who is going to receive w with probability one for some time before drawing the same lottery.

This suggests that we may be able to infer the behavioral rule of the firm from its wage policy. If b is fixed it is likely to be SWM whereas if w is fixed, EWM, although admittedly other possibilities remain depending on workers' risk attitudes. If b is fixed at $\bar{b}$, this will mostly depend on the social norm on how many times more a boss should receive than his subordinates, and this is likely common across firms. If w is fixed at $\bar{w}$, this will most importantly depend on the income that a worker can receive elsewhere, for example, by being hired at another firm or doing his own business. This may differ across firms if the extent that a worker's skill acquired during his employment at a firm is worth at another firm varies widely depending on which firm he has been employed by, for an alternative income a worker can get after quit will then depend on which firm he has been with. Otherwise, particularly if skills are mostly firm-specific that are of little value to other firms, the alternative wage level $\bar{w}$ is likely common across firms.

It seems, therefore, interesting to examine which of w and b varies more widely across firms or industries. For this purpose, data on earnings classified according to rank and industry were obtained for Japanese corporations[6] and the coefficients of variation across industries were calculated for the earnings in each rank and for inter-rank earnings ratios. This is summarized

in Table 1. It is noted that the data classifies industries only to five categories and hence the reliability of the coefficients of variation may be weak. It is found that (1) if aggregated regardless of age, earnings of supervisors (bucho or kacho) are more variant in terms of coefficients of variation than ordinaries (hishokukai), but the ratios of earnings between supervisors and ordinaries vary less than the earnings of ordinaries. (2) If we consider the earnings of each rank at the age class with the largest number of workers of that rank, we find that the earnings ratio vary more widely than the ordinaries' earnings. However, (3) if we compare the earnings at a common age class, 40 to 44, we find that the earnings ratios vary less compared to the ordinaries' earings. Therefore, the overall result is inconclusive and the effect of age appears important.

Also noted is that the data does not preclude the effects due to the differences in educational background and the length of service at the present company. It may be that hishokukai consists of workers of wider variation than bucho or kacho, for most of bucho and kacho are college graduates who entered the present company upon graduation and since stayed there, whereas hishokukai tends to consist of people of various educational background and include many who have changed companies. Therefore, bucho and kacho are likely more homogeneous than hishokukai. Thus, the coefficient of variation of hishokukai's earings may be relatively overstated. This also explains why the hishokukai's coefficient tends to increase with age. Particularly for age 40-44, therefore, the true difference in the variability between hishokukai's earnings and earnings ratios may be smaller than the data implies.

Even with this modification, however, it does not seem possible to determine if w or b is more variant across industries. Accordingly, it is not

possible either to determine if firms are maximizing stockholders' welfare or employees' welfare, which is disappointing but perhaps not surprising because many more factors than we have heretofore dealt with influence corporate decisions on wage structure. Some of them will be now discussed.

6 WORK EFFORT AND PROMOTABILITY[7]

So far promotion has been assumed to be a pure chance event that does not depend on a worker's behavior or personal characteristics. In a real firm, however, competition is severe on promotion and each worker expects his promotability to depend on his performance or effort. This consideration may result in the modification of our propositions. For instance, in spite of Proposition 1, a SWM firm may increase b to make promotion more attractive to workers and encourage their work efforts.

To investigate this problem, we define e as the level of one's work effort during his first period. This effort level we assume to be perfectly observable by the management without cost. In equation (2), one's chance of promotion π was shown to depend on the rate of corporate growth g. We now assume that it also depends on his work effort so that $\pi = \pi(g, e)$ where $\partial\pi/\partial g > 0$. The worker, we assume, expects π to be continuous in e and $\partial\pi/\partial e > 0$. Another possibility is that because promotion probably is determined only on the basis of ranking among candidates, he expects π discontinuous in e; for instance, $\pi = 1$ if $e > \bar{e}$ and $\pi = 0$ if $e \leq \bar{e}$ where $\bar{e}$ is what he believes to be his rivals' effort level. More likely, however, $\bar{e}$ is uncertain to him and he expects his π continuously increasing in e for the relevant range. Thus the assumption of continuity will be maintained.

Also assumed is that during one's second period his effort level is

exogenously fixed at e_j for rank $j = 1$ and 2. For instance, a worker expects to be fired with probability one if his work effort is less than this level. Then, presuming a utility function of the form, $u = u(y, e)$ with y denoting income and $\partial u/\partial y > 0$ and $\partial u/\partial e < 0$, we have as his expected lifetime utility $U_{expected}$

$$U_{expected} = u(w, e)/(1 + d) + [\pi(g, e)u(bw, e_2) + (1-\pi(g, e))u(w, e_1)]/(1 + d)^2 \tag{14}$$

When hired, a worker will determine his effort level to maximize (14); hence,

$$\partial U_{expected}/\partial e = (\partial u/\partial e)/(1 + d) + \Delta u(\partial \pi/\partial e)/(1 + d)^2 = 0 \tag{15}$$

where $\Delta u \equiv u(bw, e_2) - u(w, e_1)$. Given d, therefore, a worker's effort level is determined depending on the wage rate at rank 1, the utility difference between the ranks, and the responsiveness of promotability on work effort as perceived by the worker. Presuming that $\partial^2 u/\partial e^2 < 0$ we write this relation as follows

$$e = e(w, \Delta u, \alpha) \tag{16}$$

where α is individual worker's estimate of $\partial \pi/\partial e$, with $\partial e/\partial \Delta u > 0$ and $\partial e/\partial \alpha > 0$.

Actually, however, who to promote depends on relative ranking of workers concerning effort and not on the absolute level. In a simple case where workers are all identical, everyone chooses the same effort level and the probability of promotion reduces to a value common to all the workers, which of course should equal that given in equation (2). Hence, the actual expected lifetime utility,[8] U_{actual}, for a worker is

$$U_{actual} = u(w, e)/(1+d) + \{(2+g)\tilde{c}u(bw, e_2) + [1 - (2+g)\tilde{c}]u(w, e_1)\}/(1+d)^2$$
$$= u(w, e)/(1+d) + [(2+g)\tilde{c}\Delta u + u(w, e_1)]/(1+d)^2 \qquad (17)$$

where e is as determined by (16). This expression is similar to that of U in equation (3); however, U_{actual} now depends on e and as a consequence on not only w, g and b but also α, the individual worker's estimate of the sensitivity of his probability of promotion to his work effort. Differentiating, we have

$$\partial U_{actual}/\partial w = (\partial u(w,e)/\partial w)/(1+d) + (2+g)\tilde{c}(\partial \Delta u/\partial w)/(1+d)^2 + (\partial u(w,e_1)/\partial w)/(1+d)^2 \qquad (18)$$

$$\partial U_{actual}/\partial b = (2+g)\tilde{c}(\partial \Delta u/\partial b)/(1+d)^2 + (\partial u(w,e)/\partial e)(\partial e/\partial \Delta u)(\partial \Delta u/\partial b)/(1+d)$$
$$< (2+g)\tilde{c}(\partial \Delta u/\partial b)/(1+d)^2 \qquad (19)$$

$$\partial U_{actual}/\partial \alpha = (\partial u(w,e)/\partial e)(\partial e/\partial \alpha)/(1+d) < 0 \qquad (20)$$

It seems realistic to suppose that workers are aware of this actual utility level. They are aware that after all the level of utility is U_{actual}; still, however, in the Cournot-Nash situation they have to determine the level of e so as to maximize $U_{expected}$ given the subjective probability distribution of his rivals' levels of e. Here is a prisonners' dilemma situation. If employees can collude, their utility will be maximized by setting e very low; however, because such collusion is impossible due to the largeness in number of employees and/or the employer's monitoring, their utility has to settle on a smaller level.

It remains to examine if the equilibrium exists stably. This seems to depend on how accurately every employee estimates his rivals' effort levels. If he accurately knows the rivals' effort levels, then the marginal benefit of his increasing e must be large at the equilibrium (because π

will jump to one) likely exceeding its disutility at whatever feasible level of e. This incentive to outperform rivals should be keen to every rank 1 worker and as a consequence there will exist an upward spiral of the employees' effort levels. It is thus conceivable that e reaches the feasible maximum (e.g., working from 9 to 5 with full energy). However, once this point is reached and every worker finds that after all his π is not different from others' and less than one, he may rather choose to reduce e even if this means zero π. Thus this situation may not be stable either. On the contrary, if an employee has only limited knowledge concerning the others' levels of effort, he will estimate that an increase in e increases π only continuously and does not push it to one; hence, his estimated marginal benefit of increasing e is limited and there will be an optimal level of e below its maximum. Accordingly, there will be an equilibrium as discussed above, to which we confine our analysis.

We can now derive several interesting propositions.

Proposition 5 Ceteris paribus the employees are happier the smaller α, namely, the less dependent the decision on who to promote is on individual workers' effort levels.

This is immediate from (20) and is consistent with the finding by Freeman and Medoff (1979, p.77) that "under unionism, promotions and other rewards tend to be less dependent in any precise way on individual performance and more dependent on seniority," for the unions must be aware of the above prisonners' dilemma problem.

The level of work effort should of course affect productivity; hence, it is reasonable to assume that the rate of production per unit of capital is determined by $f(\ell, e)$ with $\partial f/\partial e > 0$. (1) is thus rewritten as

$$v = [f(\ell, e) - (1 + bc)w\ell - \psi(g)]/(i - g) \tag{21}$$

It is obvious that α only affects v through e and $\partial v/\partial\alpha > 0$. Hence,

Proposition 6 To increase the value of the firm, α should be as large as possible.

Propositions 5 and 6 imply that concerning promotional rule, owners and workers are completely against each other. No wonder, therefore, the extent of employer discretion in promotion is one of the most important and heated issues in collective bargainings (see Freeman and Medoff, 1979, and Koike, 1977).

In order to examine if Proposition 1 is still valid, assume that the utility function is separable in income and effort, namely, $\partial^2 u(y, e)/\partial y\partial e = 0$. From (17) and (21) we get

$$MRS^U_{wb} = \frac{(2+d) + c(d-g) - (1+c)(1+d)u_2(w,e)(\partial e/\partial\Delta u)}{(2+g) + (1+c)(1+d)u_2(w,e)(\partial e/\partial\Delta u)/c} \frac{u_1(w,e)}{cwu_1(bw,e_2)} + \frac{b}{w} \tag{22}$$

$$MRS^V_{wb} = \frac{\ell + f_2(\ell,e)(\partial e/\partial\Delta u)u_1(w,e)}{\ell - f_2(\ell,e)(\partial e/\partial\Delta u)u_1(bw,e_2)/c} \frac{1}{cw} + \frac{b}{w} \tag{23}$$

where u_i or f_i denotes the partial derivative with respect to the i-th argument. Suppose that workers are risk neutral and hence $u_1(w,e) = u_1(bw,e_2)$. Then the difference between the two MRS's is only with respect to the first fraction in each equation. Obviously, if $\partial e/\partial\Delta u = 0$, $MRS^U_{wb} > MRS^V_{wb}$ as proved in Proposition 1. As $\partial e/\partial\Delta u$ increases so do MRS^U_{wb} and MRS^V_{wb} because $u_1 > 0$, $u_2 < 0$, and $f_2 > 0$. If $\partial e/\partial\Delta u$ is small, we naturally expect MRS^U_{wb} to keep dominating MRS^V_{wb}; however, as $\partial e/\partial\Delta u$ becomes large, MRS^V_{wb} may exceed MRS^U_{wb} or not, and the comparison is inconclusive. Hence, we have

Proposition 6 If the firm maximizes v subject to given minimum values of U_{actual}, w and b, then at the optimal solution b is likely to be kept constant at its minimum level $\bar{b}$ if $\partial e/\partial \Delta u$ is small, but if $\partial e/\partial \Delta u$ is large b may or may not be larger than $\bar{b}$.

This obviously implies that

Corollary 2 If workers perceive the probability of promotion as dependent on their work effort, then a SWM firm more likely sets b above its required minimum value than otherwise.

This result is reasonable. As e is more dependent on Δu, a SWM firm has an incentive to increase Δu by increasing b so that workers choose a larger e which contributes productivity and hence profits. Thus to increase b rather than w to achieve a market level of U becomes relatively more advantageous to the firm. We note that by differentiating (15)

$$\left.\frac{\partial e}{\partial \Delta u}\right|_{dw=dg=0} = -\frac{\partial \pi}{\partial e} \Big/ \left[(1 + d)u_{22}(w, e) + \Delta u \frac{\partial^2 \pi}{\partial e^2} \right] \tag{24}$$

Therefore, as the marginal disutility of effort is less increasing in effort level and promotability is perceived by the workers to be more sensitive to effort level, $\partial e/\partial \Delta u$ is larger. If such conditions are met, the firm will use a larger inter-rank wage differential so as to entice workers into working harder seeking promotion.

More difficult is the analysis of employee-welfare maximization, because incumbent employees may be for or against the effort-promotion linkage. If the decision is made after the announcement of who are to be promoted, the employees are certain about their lifetime utility that is independent of

α. If the decision is made before tha announcement of who are to be promoted but after having been observed their effort levels, then their expected lifetime utility is again independent of α. Hence, in maximizing the employees' utility subject to a given minimum value of v, they will prefer to increase α so that e (of the workers yet to be employed) and productivity are increased,in order to increase w, Δu and g as much as possible. In this respect, they have common interests with the stockholders. Corporate executives at the table of collective bargaining identifying their interests with the stockholders' against the labor union may be an example of this situation.

On the contrary, if the interests of those employees whose work efforts are yet to be observed are important, then the story is essentially similar to Proposition 5; thus, α has an adverse effect to the actual level of expected lifetime utility and they will surely demand less employer discretion on promotion.

Therefore, the interests may not be common across different generations of employees and agreement may not be easy among employees, although this problem cannot be formally analyzed with our simple two-period model. It is expected that the older employees will be more tolerant to the dependence of promotion on observed effort levels and rather prefer wage increase, whereas the younger will be more eager to reduce the dependence because they have a larger time that the effort levels matter for promotability. It is thus expected that the seniority rule concerning promotion to reduce employer discretion is more eagerly demanded by the younger low-rank employees.

7 SUMMARY AND SOME ADDITIONAL REMARKS

Using an overlapping generation model in which every worker works for two periods with a positive probability of promotion at the beginning of their second period, we have investigated the firm's decision on the wage rate at the lowest rank, w; inter-rank wage ratio, b; and the rate of corporate growth, g. Two behavioral hypotheses were considered: the stockholder-welfare maximization (SWM) in which the value of the firm is maximized subject to a labor market constraint, that is, a minimum level of expected lifetime utility for a prospective employee; and the employee-welfare maximization (EWM) in which the expected utility of an incumbent employee is maximized subject to a capital market constraint, that is, a minimum valuation of the firm.

Among the major findings were that (1) the relative effectiveness of w and b as policy variables depends on corporate objectives, workers' risk attitudes, and the sensitivity of promotion to each worker's work effort as perceived by workers, (2) as the utility level of workers increases and the value of the firm decreases the rate of corporate growth tends to decrease in either SWM or EWM if workers are risk neutral, (3) despite (2) $\partial v/\partial g < 0$, that is, the growth rate is greater than the rate which alone maximizes the value, (4) if each worker perceives that his/her probability of promotion depends on the level of his/her work effort, he/she will work harder the larger the utility difference between the two ranks and the more sensitive the perceived probability is to effort, and finally (5) workers will demand that the decision on who is to be promoted depends less on individual worker's performance and effort but more on a standardized procedure, such as the seniority rule, which is against the stockholders' interests.

As shown in section 5, the available evidences are inconclusive as to the relative variability of w and b predicted in (1) thus failing to predict if Japanese firms behave in accordance with SWM or EWM. (4) is intuitively quite reasonable and (5) is consistent with the fact that firms with powerful trade unions tend to have strict seniority rule in promotion.[9] The remaining two findings, (2) and (3), have interesting and somewhat puzzling implications in relation to the growth-maximization hypothesis advocated by Marris (1964) and Galbraith (1967). (See also Odagiri, 1981.) Their argument that management pursues faster growth of the firm to create more positions to promote is consistent with our finding (3). For instance, Marris (1964, p. 101) argued that "there can be no doubt at all that this fundamental characteristic of the interaction between salary system, organisational structure and poor transfer market provides a real and powerful motive for inducing internal expansion in every modern business," where the transfer market refers to the external market (as opposed to internal within the firm) for transferring management staffs and other workers. which has been assumed perfectly smooth in the traditional theory. Interestingly, we have shown that if workers are aware of his chance of promotion increasing with the rate of corporate growth, even a stockholder-welfare maximizing firm should seek to grow faster than otherwise, let alone an employee-welfare maximizing firm.

On the other hand, the result (2) which suggests that the growth rate decreases as owner control weakens may appear contradictory to the argument of the managerialists.[10] To do more justice to the managerial theory, however, it is necessary to give considerations to some other factors that affect the firm's choice on wages and growth rate.

In the above analysis, stockholders are solely concerned with the

value of the firm and not with the way the value is achieved. That is, whether a value lower than its potential maximum results from too rapid growth and too large investment or from too generous wage payments to employees, the stockholders were assumed unconcerned or indifferent. This is not realistic, however. In the managerial theory, two reasons have been raised to why the management can sabotage value maximization without jeopardizing its position. One is the cost of ousting the incumbent management through proxy fights and/or takeovers as discussed by Marris (1964, Chapter 1), Manne (1965), and Odagiri (1981, Chapter 2). The other is the disadvantage of stockholders to management with respect to the amount of information on actual and potential business environment. That is, "since owners are remote from the firm's actual decision-making, they learn about the firm's performance only ex post, and then only through 'official' reports from top management. As a result, owners have no reliable way of determining whether the firm is maximizing its profits and the growth of its stock prices or not" (Monsen and Downs, 1965, p. 225).

It should be noted here that not all corporate policies are equal in terms of the easiness for the stockholders to evaluate their appropriateness. In our present model, it must be more difficult for the stockholders to examine if the growth rate chosen by the management is too high than if the wage rates are too large, because stockholders usually do not know the list of all the available investment projects and their costs and returns, and consequently which growth rate or which amount of investment maximizes their interests. On the contrary, the market wage rate for each rank and type of job is relatively easily known by anyone; hence, the stockholders will easily find it aginst their interests if the wage rates are too generous compared to the market rates. Of course, since firm-specific skills are

important in today's businesses, it may not be easy to determine the appropriate rates of wage. Nonetheless, one can compare the wage rates at a comparable rank, say, kacho, among companies and conclude if the present wage policy of the firm is appropriate and fair. Thus, when the management or employees pursue their interests, they find it with less stockholder objection and interference to increase the growth rate and as a result promotability than to increase wage rates. Therefore, in spite of our finding (2), it may well be the case that as the owners lose more control and as the workers gain more power, the rate of corporate growth increases with constant or slightly increasing wage rates. The result then is perfectly consistent with the managerialist position.

We also note another force that reinforces this argument. In the latter half of section 6, it was suggested that concerning promotional policy, employees of different ranks or generations may possess conflicting interests. Such conflict of interests may well be observed on other problems as well. (See Monsen and Downs, 1965.) In particular, because the decision on wage rates at various ranks immediately affects the income distribution among employees, an agreement among entire employees on the optimal intrafirm wage structure may be more difficult than an agreement on the optimal growth rate. In the present two-rank model, this fact is rather obscure because workers in their second period will not be benefited by growth at all. However, if there are many ranks as in real firms, all the employees (except the top manager) have some chance of promotion which depends on the rate of corporate growth. Even the top executive who has no higher rank to promote will be happier by growth because as Marris (1964, p. 102) has argued the manager's fame, prestige and power tend to depend on how successful he/she has been in expanding the firm. Such psychological and sociological satisfaction with growth tends to be shared by every other employee

as well, because to be in an expanding firm will bring him more job security and more prestige in every aspect of his life -- even in finding a spouse! Thus it is expected that achieving faster growth of the company is more easily agreed by the entire employees than determining or altering the intrafirm wage structure. In view of this relative easiness of agreement and compromise among employees, it is likely that when employees gain more power they opt for faster growth in spite of our result (2), again in agreement with the managerialist stand.

Admittedly the results of this paper are not easily testable, for we have to compare an observed growth rate to an unknown value-maximizing rate. However, in that they clarified several forces that determine intrafirm wage structure and the rate of corporate growth, we believe that they further deepen our understanding of corporate decision making in a hierarchical firm.

APPENDIX

This appendix discusses how the analysis can be extended to the case in which time is continuous and workers may work for ever. In addition to the notation in the text, we use the following:

$Q(t)$: the cumulative probability that a worker retires or quits after service with the firm of length t.

$H(t)$: the cumulative probability that a worker has been promoted to rank 2 after the service of length t.

Then

$$q(t) = (dQ(t)/dt)/(1 - Q(t)) \tag{A1}$$

is the conditional probability that a worker quits at time t given that he has not quit before. We assume this constant. Then, solving (A1) given $Q(0) = 0$, we have

$$Q(t) = 1 - e^{-qt} \tag{A2}$$

Similarly,

$$h(t) = (dH(t)/dt)/(1 - H(t)) \tag{A2}$$

is the conditional probability that a worker is promoted at time t given that he has not been promoted before. If h is constant and $H(0) = 0$, we have[11]

$$H(t) = 1 - e^{-ht} \tag{A3}$$

The expected lifetime utility U of a prospective worker is now

$$U = \int_0^{\infty}(1 - Q(t))[H(t)u(bw) + (1 - H(t))u(w)]e^{-dt}dt \tag{A4}$$

if u depends only on income and utility after quit is not dependent on any variable of our concern and thus can be neglected. If h, w, and b are constant, substituting (A2) and (A4),

$$U = u(bw)/(d + q) - (u(bw) - u(w))/(d + q + h) \tag{A6}$$

In the present model, we define U^* as the level of expected lifetime utility averaged over entire employees; that is, letting U^i denote the expected lifetime utility of a worker in i-th rank,

$$U^* = (U^1 + cU^2)/(1 + c) \tag{A7}$$

because $L_2 = cL_1$. In this model of infinite time horizon and constant variables, U^1 obviously equals U defined in (A6). That is, a worker who has worked for several years but remains at rank 1 has exactly the same level of expected lifetime utility as a new employee. On the other hand, an employee at rank 2 keeps staying at the rank until he retires and

$$U^2 = \int_0^\infty (1 - Q(t))u(bw)e^{-dt}dt = u(bw)/(d + q) \tag{A8}$$

Hence by (A7)

$$U^* = u(bw)/(d + q) - (u(bw) - u(w))/(1 + c)(d + q + h) \tag{A9}$$

The value of the firm is exactly identical to that given in the text, for

$$\begin{aligned} v &= (1/K(0)) \int_0^\infty [F(K(t),L_1(t)) - wL_1(t) - bwL_2(t) - \psi(g)K(t)]e^{-it}dt \\ &= [f(\ell) - (1 + bc)w\ell - \psi(g)]/(i - g) \end{aligned} \tag{A10}$$

Finally we have to investigate how h is determined. As in the text, let us denote by $N(t)$ the number of new employees at time t. Then

$$L_2(t) = \int_{-\infty}^{t} (1 - Q(t-s))H(t-s)N(s)ds \tag{A11}$$

$$L_1(t) = \int_{-\infty}^{t} (1 - Q(t-s))(1 - H(t-s))N(s)ds \tag{A12}$$

If $N(s)$ grows at rate g, and h and q are constant

$$L_2(t) = N(t)[1/(q + g) - 1/(q + h + g)] \tag{A13}$$

$$L_1(t) = N(t)/(q + h + g) \tag{A14}$$

Combining with $c = L_2(t)/L_1(t)$, we have

$$h = c(q + g) \tag{A15}$$

Thus h is an increasing function of g as was in the discrete model dicussed in the text. A remark is in order here, however. We have assumed that the rate of increase of the number of new employees is constant at g in the past and in the future. However, at the time of decision, the growth rate in the past is a given datum whereas the rate in the future is a policy variable. Thus, the probability of promotion today depends on $L_2(0)$ and $L_1(0)$ which in turn depend on the rate of growth in the past but not on the rate g to be determined now, whereas the probability of promotion at the distant future ($t \to \infty$) depends on the limits as $t \to \infty$ of $L_2(t)$ and $L_1(t)$ which depend mostly on g, the rate to be determined now. Hence, the probability is not constant unless the growth rate chosen today happens to equal that in the past. To take into account this variability of the probability turned out to be very difficult, and we have to assume that decision makers approximate the probability by the value to which it approaches asymptotically as time goes on, namely, that determined in (A15).

Using this analytical framework, we can solve the problems as in the text. The analysis and results are essentially analogous to those in the text and will not be given here.

NOTES

1. Assuming a given downward-sloping demand curve in place of a given price does not change the results essentailly but makes the analysis more tedious.

2. Note that this is the present value of net cash flow stream up to infinite future even though individual stockholders are mortal, because they can always sell their stocks at the price reflecting this stream.

3. Maximizing with respect to ℓ yields the condition that the marginal product $f'(\ell)$ should equal the marginal cost $(1 + bc)w$ which consists costs of not only the additional rank 1 worker but also the additional rank 2 worker necessitated by the increase in the number of rank 1 workers. Since $f'' < 0$, b, c and w affects ℓ negatively. This result stands also under the alternative approach taken in the next section.

4. The other possibility, an increase in g and a decrease in w with an increase in U, is rejected because $\partial MRS^{U}_{wg}/\partial g > 0$ but $\partial MRS^{V}_{wb}/\partial g' < 0$ so that the MRS's diverge as g increases with fixed or decreasing w.

5. Aoki has written several articles along this thinking; for example, Aoki (1980a) and (1980b). The latter partly discusses the problems addressed in the present analysis.

6. The author does not know of similar data sources for other countries.

7. For related literature, see Lazear and Rosen and Ishikawa (1981).

8. Pardon me for the awkward naming, the "actual expected utility." It is actual because it is evaluated at the actual probability of promotion; however, it is an expected value because promotion still is a random event.

9. Koike's (1977) finding that in some industries at least, promotion is under larger employer discretion in Japanese firms than in American firms may suggest that unions in Japan are less powerful in these industries.

10. This result resembles the argument that a labor-managed firm will grow less rapidly than a capitalist firm (Atkinson, 1973) or a profit-sharing worker-participatory firm (Odagiri, 1980).

11. The concept similar to h and q has been used to analyze the optimal pricing of a monopolist under uncertain threat of entry into the industry, with h called the "hazard rate." See Kamien and Schwartz (1971). Odagiri (1981, Chapter 2) used the concept to analyze takeovers.

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TABLE 1. ANNUAL EARNINGS ACCORING TO RANK[a]

Rank	All age	Typical age class[b]	Age 40-44
(1) Bucho (Director)	6796[c] .1351	7027 .1532	6154 .1208
(2) Kacho (Division Head)	5391 .1734	5587 .1633	5587 .1633
(3) Hishokukai (Ordinary)	3082 .0968	2759 .0672	4091 .1622
(1)/(3)	2.20 .0554	2.54 .0911	1.51 .0480
(2)/(3)	1.74 .0820	2.02 .0970	1.37 .0653

Source: Japan, Ministry of Labor, Basic Survey of Wage Structure, 1979.

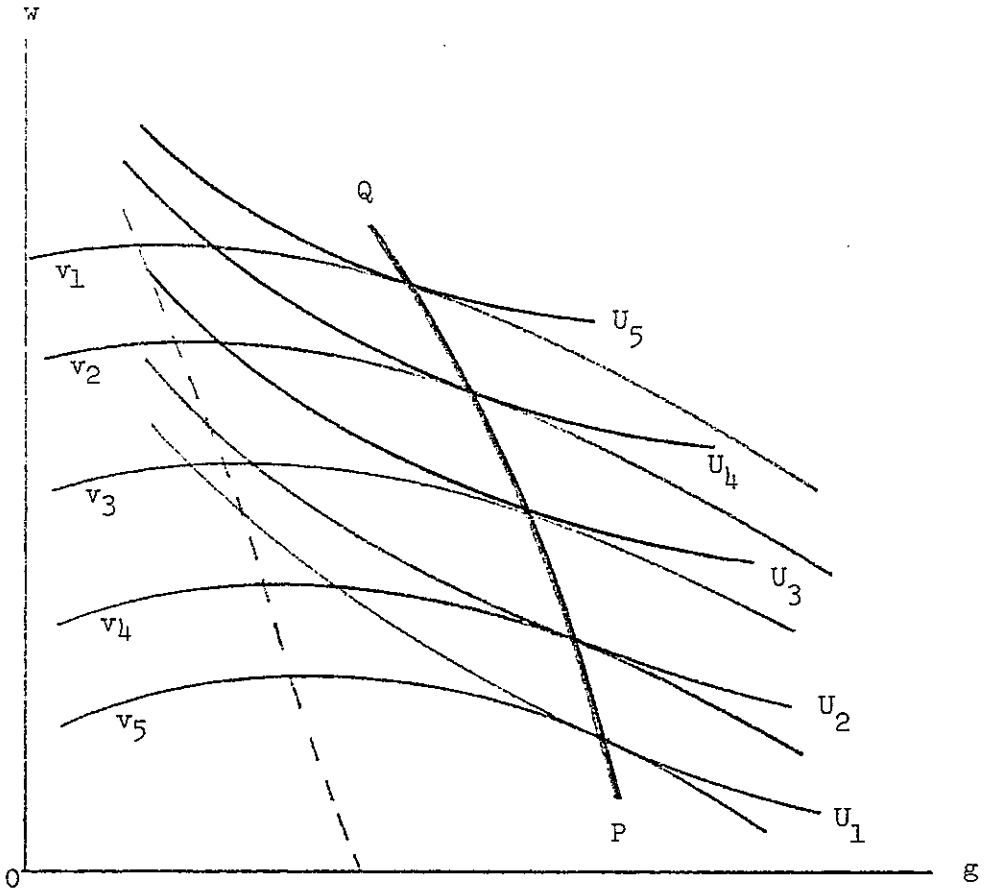
Notes:

a. Male workers in Japanese companies with 100 or more employees.

b. Age 45-49 for Bucho, 40-44 for Kacho, and 25-29 for Hishokukai.

c. The upper figure (in thousand yen except for ratios) shows the arithmetic mean over five industries -- construction, manufacturing, wholesale and retail, financial and insurance, and service -- and the lower figure shows the coefficient of variation.

FIG. 1



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