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Corporate Hierarchy, Promotion, and Firm Growth: Japanese Internal Labor Market in Transition*

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This paper investigates the incentive systems and the hierarchical design of the Japanese firms as integral parts of employment structure. Using the survey cross-

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section data on job ranks and wages, we analyze the promotion policy and compensations system as the key incentive mechanism in these firms with highly developed internal labor markets. We find that the incentive as well as hierarchical structures of the large Japanese firms are highly sensitive to the longrun growth rates of these firms. This finding is supported by a prediction of a model of internal promotions developed in the paper. We also find that the span of control, incentive effects of promotion, and wage–age profile at each job rank are all increasing in the longrun growth rates of these firms. These findings are jointly consistent with and in support of the hypothesis that the expected gains from the promotion is the key incentive in inducing efforts of the employees. *J Japan. Int. Econ.*, December 1992, **6** (4), pp. 440–471. Kyoto University, Kyoto 606, Japan; University of Venice, Venice, Italy; Osaka University, Osaka 565, Japan; and Kyoto University, Kyoto 606, Japan.

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1. Introduction

Economic growth is no doubt a multifaceted phenomenon. Our modest aim in this paper is to investigate rather closely the interactions between the growth deceleration and changes in hierarchical structure and promotion policies which started in the mid-1970s and continued throughout the 1980s among the Japanese firms.

Our basic premise in investigating the interactions is that management of those firms faced a serious dilemma. The dilemma was between the need to maintain proper incentives by keeping stable promotion policy, and the cost and potential inefficiency that might arise by adjusting hierarchical structure to the rapid increase in the necessary amount of vacancies.

With an eye on the key interactions above, we examine various aspects of the Japanese internal labor markets and the hierarchical structure. In this paper they are referred categorically as *employment structure*.

Employment structure can be analyzed from two broader perspectives. First of all, employment structure can be viewed as the optimal design of the work organization and matching of employees to the best suited jobs. Employment structure can be analyzed as the one that achieves production efficiency.[1] On the other hand, employment structure can be analyzed from its incentive effects.[2] Promotion to a higher rank is the most important means to give proper incentive for employees to work hard and to work efficiently. In short, employment structure viewed in this way is

[1] See for example, Rosen (1982) and Waldman (1984).

[2] The third alternative is to focus on the cooperative aspects and informational efficiency of the firm organizations. Although these *team* aspects of corporate hierarchy are no doubt important, they are not the main focus of this paper. Itoh (1991) offers a through survey on the related literature. See also Aoki (1988).

the optimal design of ranks and promotion policy that minimizes agency cost. On a priori ground, there is no reason to believe that a production efficient organization achieves the minimization of the agency costs.[3]

Our major objective of the paper is to investigate the interactions between longrun growth and employment structure by focusing upon the potential trade-off between production efficiency and the minimization of the agency costs. In Section 2, we investigate the broad characteristics of employment structure of the Japanese firms. In Section 3, we develop a simple model of hierarchically organized firms which encompasses the following aspects: the degree of internal labor market development, hierarchical structure, and promotion and payment policy. We derive several empirically testable predictions from the analysis. In Section 4, we incorporate these predictions in interpreting the facts collected in Section 2.

2. Evolution of Employment Structure: 1976–1989

In this section, we document and analyze the data concerning employment structure of firms. Our primary objective in this section is to select and investigate a few key variables which are important in defining broader characteristics of the employment structure.

2.1. *Data*

The data is taken from Volume 3 of the Wage Census [The Basic Survey of the Wage Structure] published annually by Ministry of Labor, Japan. The data consists of annual cross-section tables for wages of male workers classified by job ranks. The two major variables available are annual compensations and the number of workers in each cohort. Available cross-section attributes are average age and tenure for each rank, each firm scale, each industry, and year. The industries chosen here are manufacturing, finance, and distribution. Firms in each industry are divided into three categories: large (1000 employees or more), medium (500–999), and small (100–499).[4] Job ranks are: nonsupervisors (rank 1),

[3] See Baker *et al.* (1988) for a similar argument. During the late 1970s and the early 1980s, many economists voiced grave concerns over the potentially devastating impacts of growth deceleration on the "lifetime" employment system. Although the impact on the employment structure of the large Japanese firms was substantially less than what they feared, the growth deceleration prompted firms to adjust their employment structure in several important ways. Related to these issues is a paper by Mincer and Higuchi (1989) that analyzes the effect of growth on the wage–tenure profile.

[4] For manufacturing industry, the Census divides the firm size into large (5000 or more), medium (1000 ~ 4999), and small (100 ~ 1000) between 1976 and 1979. Because of the changes in these categories, we use in most of the tables the following classifications: larger firms with more than 1000 employees and smaller firms with less than 1000 employees. The

foreman (*Shokucho,* rank 2), section chief (*Kakaricho,* rank 3), subdivision director (*Kacho,* rank 4), and division director (*Bucho,* rank 5). Rank 2 applies only for manufacturing in our data and thus is not used here. The sample period is between 1976 and 1989, the maximum size currently available. Denote by t, i, s, j, and a, respectively, year, industry, firm scale, job rank, and age. We computed relative wage (RW) and the span of control (SPC) from the data on wage (W) and the number of employees (n) in each cohort in the following manner:

$$\mathrm{RW}(t, i, s, j, a) = \mathrm{W}(t, i, s, j, a)/\mathrm{W}(t, i, s, 1, a) \qquad \text{for } i = 2, 3, 4.$$
$$j = 3, 4, 5; \qquad t = 1976\text{–}1989; \quad s = 1, 2, 3;$$
$$\text{and } a = 1, 2, \ldots, 13.$$[5]

$$\mathrm{SPC}(t, i, s, j) = \sum_{k=1}^{j-1} \sum_{a=1}^{12} n(t, i, s, k, a) / \sum_{a=1}^{12} n(t, i, s, j, a).$$

Note that the SPC is the average number of employees of lower ranks per worker in each supervisory position.[6] For example, if SPC (76, 1, 1, 5) = 20, this means that each rank-5 employee at small firms in manufacturing had on average 20 subordinates in 1976.

2.2. *Hierarchy and Promotion Policies of the Japanese Firms*

Fact 1. For each age cohort, relatives wage is a stable, increasing and concave function of the span of control. After controlling for the span of control, average tenure does not have significant explanatory power on relative wage.

Fact 1 characterizes some fundamental differences in factors determining compensations for regular workers and management level employees. Figure 1 plots SPC and RLW: each point represents a weighted average of

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data on wages by job ranks are available from 1970; however, the Census between 1970–1975 does not include rank-1 workers. The Census also includes a table for industry total in which the data classified by education is available. For our main purpose of the paper, we decided not to use these tables because disaggregations into industries are obviously far more important in assessing the effect of growth on employment structure. For example, within the sample period, the average growth rates of per capita value added varied from 2.7% (distribution) to 5.4% (finance).

[5] See the Appendix for the definition of age classes.

[6] Alternatively, SPC can be defined as the average number of the direct subordinates in the rank immediately below. As the ranks available in the Census are far from exhaustive, we prefer our definition. For example, most of the firms have ranks between 3 and 4 as well as 4 and 5 which are not available in the Census. Because of these omissions, taking the ratio of employees between the neighboring pairs of ranks in the data can give us seriously distorted pictures.

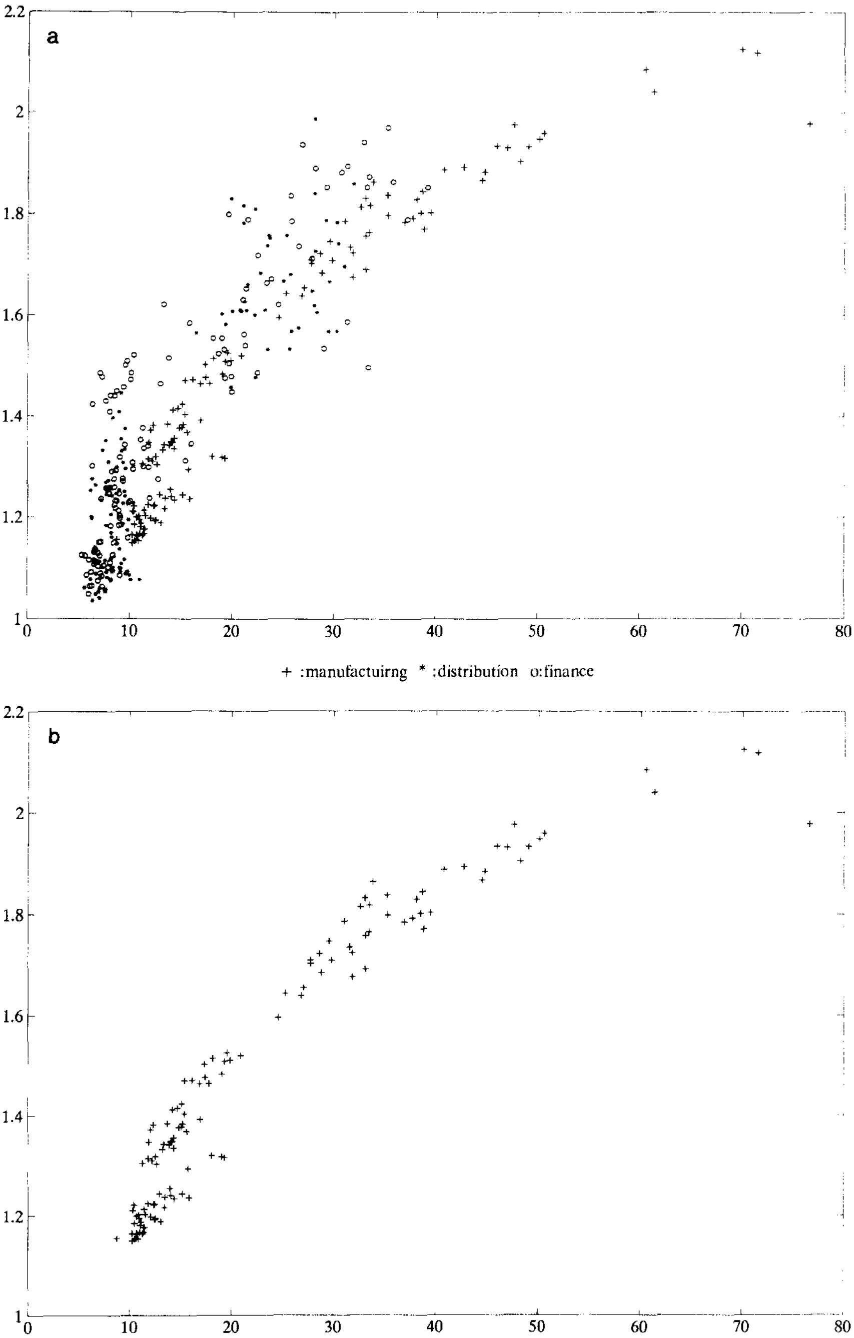

FIG. 1. Relative wages vs the span of control: (a) all industries, (b) manufacturing, (c) distribution, and (d) finance.

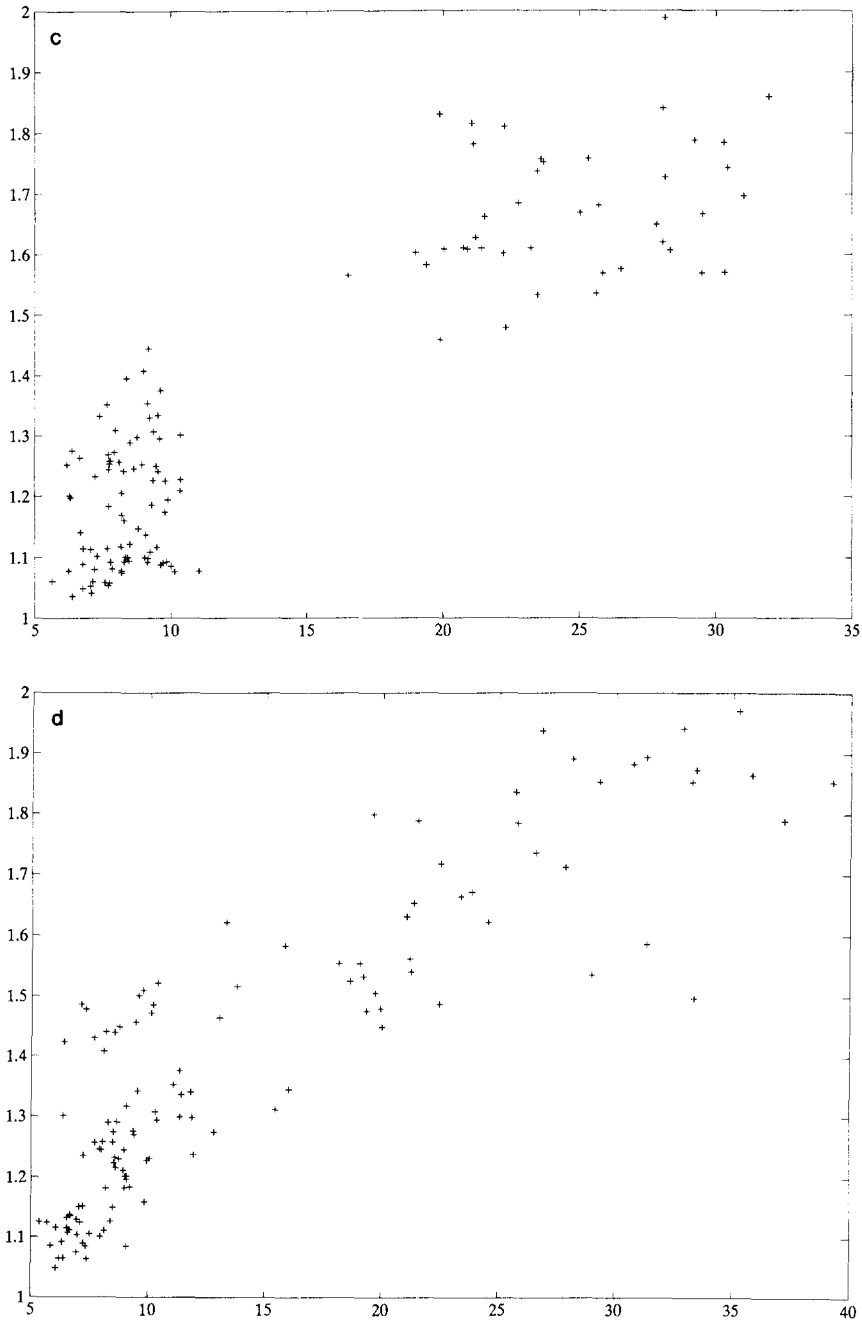

FIG. 1—*Continued*

TABLE I
ESTIMATED COEFFICIENT OF AVERAGE TENURE IN WAGE REGRESSIONS

	Positive and significant[a]	Positive not significant	Negative (significant[a])
Rank 1	45.7%	37.0%	17.3% (1.8%)
Rank 3	24.6%	53.4%	21.9% (1.9%)
Rank 4	28.2%	46.1%	25.7% (2.4%)
Rank 5	15.8%	43.4%	40.8% (4.7%)

[a] 5% Confidence level.

Note: The regressions are weighted OLS with weights being the number of workers in each cohort. At each rank, we run 3 (number of industries) $\times$ 2 (firm scale) $\times$ 7 (age classes $3 \sim 9$) = 42 regressions which include constant, the span of control, and the average tenure in each cohort.

relative wages for workers with job rank, k, firms scale, s, and industry, i. The correlation is by far the strongest in manufacturing and the weakest in the distribution. The fact that tenure is insignificant can be confirmed from Table I, which shows the explanatory power of tenure on wages. Explanatory power of tenure on wage steadily declines as we move up job ranks.[7]

Fact 2. On the SPC and RW. In almost all the cases, both SPC and RW are larger at larger firms among supervisors with the same job rank. See Table II.

As we demonstrate in Section 3, firm scales closely approximate the extent to which the internal labor market is developed. If this is the case, correlations between the firm scale and the SPC may reflect some systematic differences in employment structure between larger and smaller firms.

Alternatively, larger SPCs at larger firms can be a simple consequence of higher relative wages paid at larger firms. To the extent that promotions at larger firms mean deeper commitments by firms to pay them well *now* as well as to promote them further in the *future*, promotion to a higher level is a more *costly* decision at larger firms.

[7] This seems to contradict directly with the conventional wisdom on the Japanese wage–tenure profile. See, for example, Hashimoto and Raisian (1985) and Mincer and Higuchi (1989) for the strong and relatively stable effect of tenure on wages. Their data do not include job ranks, and we suspect that the stable relationship between wages and tenures apply only for relatively young and nonmanagerial workers. We also found elsewhere (Ohkusa *et al.*, 1991) that the standard wage regressions on age, tenure, education, etc., do perform relatively poorly among whitecollar workers.

TABLE II
SPC AND RELATIVE WAGES

Industry:		Manufacturing			Distribution			Finance		
Firm scale:		s^a	m^a	l^a	s	m	l	s	m	l
SPC	Rank 3	11.4	12.1	13.2	8.5	8.7	7.0	6.8	6.8	8.7
	Rank 4	13.3	16.1	18.1	8.8	8.5	7.4	8.5	11.3	8.5
	Rank 5	31.0	41.4	46.0	21.6	23.9	25.5	17.8	24.1	31.3
Relative wage	Rank 3	1.185	1.192	1.270	1.113	1.027	1.063	1.072	1.096	1.218
	Rank 4	1.358	1.402	1.528	1.268	1.231	1.300	1.246	1.322	1.462
	Rank 5	1.762	1.825	1.901	1.702	1.613	1.656	1.539	1.688	1.874

Numbers shown are 1981–1989 averages.
[a] s, ~ 100 employees; m, 101 ~ 999 employees; l, 1000 ~ employees.

In a different paper (Ohkusa *et al.*, 1991) we estimated separation rates for comprehensive cross sections of workers. Table III shows the relevant portion of our estimates. Note that the separation rate at older age is higher, especially so at larger firms, in comparison with lower separation rates in other age brackets. It is then quite unlikely that promotion at larger firms involve the kind of costly commitments which limit the number of workers at higher job ranks. Moreover, we see below that the larger firms adjusted the SPC downward more fully in response to the growth deceleration and the population aging. Although not conclusive, these observations suggest that the conventional human capital theory, or its model of wage profile, does not offer a convincing explanation of Fact 2. A more satisfactory explanation must be found in incentive effects of promotion and the differences in required levels of effort across job ranks and firm scales.

Fact 3. At larger firms, age distributions of employees at each job rank have sharper peaks and larger shares of employees are concentrated

TABLE III
SEPARATION RATES: 1978

		Firm scale (%)	
Age	Tenure	Large	Small
30–39	17–19	0.61	1.76
40–49	20–24	4.94	5.47
50–59	25–29	32.79	21.11

Source: Ohkusa *et al.* (1991).

TABLE IV
AGE CONCENTRATIONS AT EACH JOB RANK

		Rank 3		Rank 4		Rank 5	
Manufacturing	Large	60.9%	(35–44)	67.4%	(40–49)	77.0%	(45–54)
	Small	50.7%	(30–39)	52.0%	(40–49)	52.6%	(45–54)
Distribution	Large	65.3%	(30–39)	59.5%	(35–44)	66.9%	(45–54)
	Small	61.3%	(30–39)	58.5%	(35–44)	53.1%	(45–54)
Finance	Large	—[a]	—	62.5%	(40–49)	76.5%	(45–54)
	Small	—	—	54.0%	(35–44)	60.1%	(45–54)

[a] The number of rank-3 workers have been declining throughout sample period. Apparently, rank 3 are now gradually replaced by the new title: vice director of subdivision, whose statistics are not available. For these reasons, we dropped rank-3 workers in finance.

Note. Numbers shown are the share of employees at each job rank within the 10-year age bracket shown in parenthesis, which has the largest share among all the age brackets. The numbers are 1981–1989 averages.

in narrower age brackets. Moreover, this tendency of age concentration becomes more pronounced at higher job ranks. See Table IV.

Fact 3 suggests two things. First of all, at larger firms, limiting the candidates for promotions by age/tenure (*nenko*) is more common than at smaller firms.[8] This is another indication of the systematic differences in employment structure between smaller and larger firms. Avoidance of *vertical* (across age/tenure) competition is more strictly adhered to at larger firms. The second point is that the tournament mobility *cum nenko* rule narrows down the age distributions further as we move up job ranks (more on this in Section 3).

In order to see more closely the difference in promotion policies across firm scales, we have estimated 5-year promotion probabilities by combining the data on number of workers in the Wage Census and the separation rates taken from Survey on Employment Movements (*Koyodoko Chosa*) [See the Appendix for the details of the estimation]. Figure 2 shows the distribution of the employees in manufacturing at each job rank according to the age at which they are promoted to the rank (see the Appendix for the computation of these distributions). The distributions are flatter at smaller firms and more sharply peaked at larger firms, as we would expect

[8] Koike (1991) used a panel data of engineers at a large manufacturing firm and found that promotions to rank 3 starts at 7th year and the standard deviation of the tenure at the moment of promotion to rank 3 is 1.5 years. His data also shows that timings of promotions to upper ranks are equally concentrated in narrow ranges: to rank 4, 16.5 ± 1.6 years, to rank 5, 19.1 ± 1.4 years (numbers are means and standard deviations of tenures at the moment of promotions).

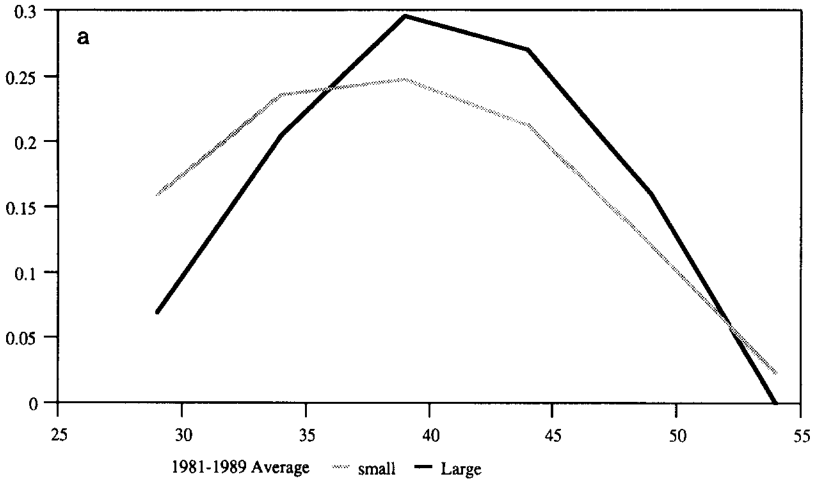

FIG. 2. Promotion and *nenko* in manufacturing: (a) rank 1 to rank 3, (b) rank 3 to rank 4, and (c) rank 4 to rank 5. The graphs show the steady-state distribution of employees at each job rank according to the age at which they were recruited to each rank from below. The distributions are obtained from 5-year promotion probabilities discussed in the text. See the Appendix for details.

from the difference in promotion policy.[9] This tendency becomes even more pronounced in promotions to higher ranks.

Interindustry comparisons of the age distribution and the promotion probabilities reveal some of the characteristics of employment structure in each industry. Table IV shows that in comparison with manufacturing and finance, the firms in the distribution system have flatter age distributions. The firms in the distribution system also have larger separation probability: annual average separation probability in distribution is

[9] Promotion probabilities in Fig. 2 also show the large differences in the promotion processes between the Japanese firms and the Rosenbaun's sample of a large American bank. Rosenbaum's estimates of promotion probabilities are uniformly decreasing over age and the speed of decline is quite large (Rosenbaum, 1984). This difference confirms a conventional wisdom that, in American firms, the distinction between fast flyers and the rest are made at a very early stage of the career, whereas the late selection and the *nenko* rules are important characteristics in the Japanese firms. Takeuchi (1987) carefully studied this using the pseudo panel data that he constructed. He found that the competition for promotion at larger firms is closer to a race of attrition among those who joined the firms in the same year, rather than a contest among all the potential candidates including those senior as well as junior pillar workers. He drew this conclusion by observing that, at larger firms, failure or delay in promotion appears predominantly as the *delay in promotion relative to their colleagues* who entered the firm *same year*, whereas, at smaller firms, delays in promotions occur relatively more as being *left behind junior employees* who are promoted beyond them.

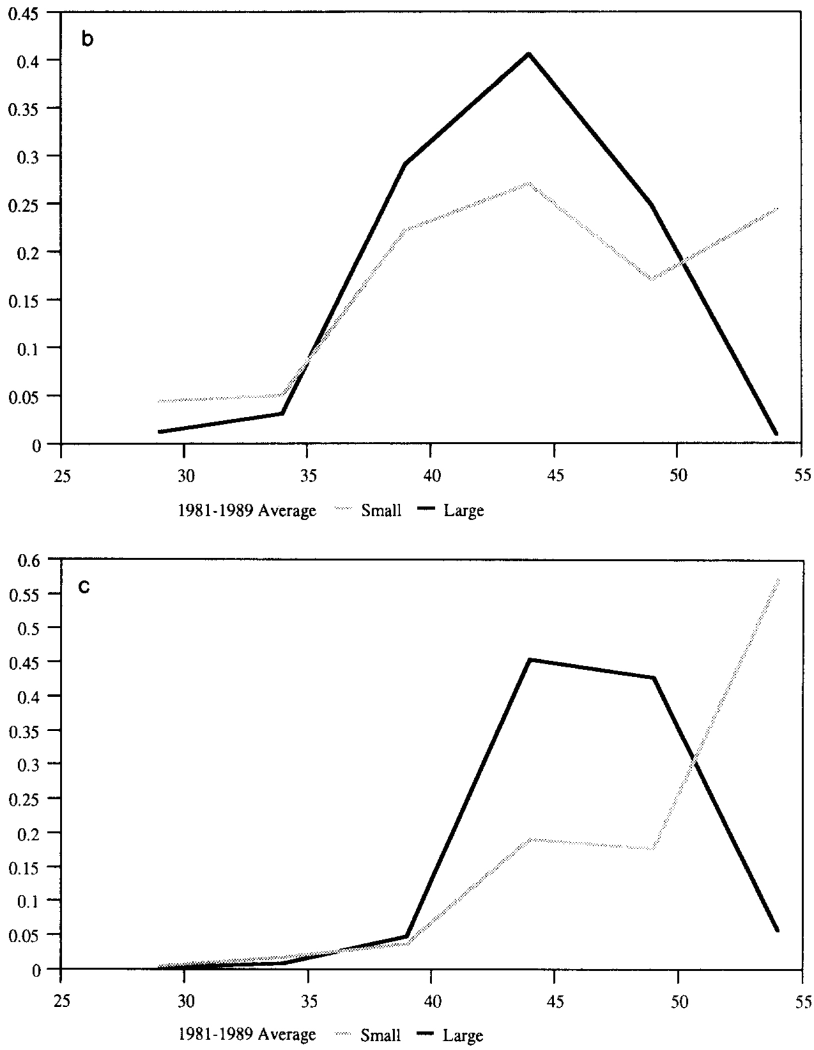

FIG. 2—*Continued*

12.3%, compared to 9.8% in manufacturing and 4.8% in finance (1982–1989 averages). Recall also that the correlations between the SPC and the relative wage are weakest in distribution and the strongest in manufacturing. Interrank differences in relative wages are also smallest in distribution.

These observations lend some support for the hypothesis that the prototypical employment structure of firms with highly developed internal labor markets are better represented by larger firms than by smaller firms, and also by manufacturing and finance industries firms than by the distribution firms.

In sum, the findings so far suggest systematic differences in employment structure not only between larger and smaller firms but also among manufacturing, finance, and distribution industries.

Observation 1. It appears that the firms with more highly developed internal labor market have larger SPCs and RWs. The age distributions and promotion probabilities of employments at these firms tend to be more sharply peaked.

Let us move on to the findings concerning the major changes occurred during the period.

Fact 4. The average age of workers increased in all industries, firm sizes, and job classes between 1976 and 1989. However, the average age of higher job ranks increased more than the nonsupervisor workers. The only exceptions are large scale firms in manufacturing and finance. Along with aging, tenure also increased in all industries, firm sizes and job ranks. Moreover, average tenure at each age class increased as well. See Table V.

TABLE V
CHANGES IN HIERARCHY AND RELATIVE WAGES

	Manufacturing		Distribution		Finance	
Rank	Small	Large	Small	Large	Small	Large
			Age Changes[a]			
1	2.90	6.25	5.91	6.11	7.39	3.52
3	4.52	3.67	8.46	5.26	6.72	1.37
4	4.60	4.50	5.99	5.26	4.30	1.84
5	3.67	2.12	5.29	4.03	6.83	3.90
			SPC Changes[b]			
3	16.7	32.3	6.5	17.8	—[c]	—[c]
4	21.1	41.0	16.2	28.8	10.4	28.7
5	16.9	39.8	12.4	19.5	8.2	16.4
			RW Changes[b]			
3	4.2	21.30	1.5	4.23	—[c]	—[c]
4	8.9	23.13	1.9	11.56	2.1	3.3
5	8.6	11.66	6.7	17.03	+2.3	6.4

[a] % Changes from 1976 to 1989.
[b] % Changes from 1976 to 1989. Numbers are all negative unless stated otherwise.
[c] Rank-3 jobs in Finance appears to be a dying species and thus are not included. See also the note in Table IV.

Fact 4 makes it clear that the corporate hierarchy and the promotion policy responded indeed to these two factors; i.e., apparently, firms did not maintain a rigid promotion policy in which predetermined fractions of workers at a predetermined age cohorts are promoted. They delayed promotions and/or applied a more stringent selection policy during the course of the period.

Fact 5. Hierarchical structure also changed during the period: overall, the SPC at each job class decreased substantially, especially so at large firms. See Table V.

Facts 4 and 5 together reveal that adjustments to the slower growth and the aging occurred at both ends, not only by delaying or decreasing promotions but also by increasing the share of higher rank positions. Mirroring these observations is the changes in the SPC. Moreover, the SPC declined far more substantially at larger firms.

There are reasons to believe that reappraisal and subsequent restructuring of the corporate hierarchy and promotion policies were far more important and fundamental at the larger firms. As we can see from Table V, the larger firms adjusted hierarchical structure more drastically. Along with the changes in the SPC, declines in relative wages are far larger at the larger firms. So we may conclude:

Observation 2. The effect of growth deceleration on hierarchy and promotion appear to be far more substantial at larger firms, where the use of the *nenko* rule appears to be more common.

You may wonder why, then, the *nenko* rule for promotions is more common at larger firms, and, less so at smaller firms: Apparently, the *nenko* rule puts rather stringent constraints on adjustments to hierarchy structures as well as on the promotion policy. To expose this and other aspects of employment structure under closer scrunity, we formalize our approach fully in the next section.

3. An Illustrative Model of Hierarchy and Promotion

As we made clear in the Introduction, our main interest lies in interactions between the hierarchy design and promotion policies.

In order to focus more sharply on this issue, this section serves two purposes. First, we consolidate the stylized facts including those in Section 2 in order to justify the major features of a simple illustrative model developed in this section. Then the latter half of the section analyzes the model and derives several testable predictions.

TABLE VI
ROLE OF TENURE (*Nenko*) IN PROMOTION DECISION (1987)

	Promotion decisions on (%)		
Firm scale	Rank 1 → 3	Rank 3 → 4	Rank 4 → 5
Large	65.0	65.4	57.3
Small	49.1	50.6	46.3

Notes. (1) Promotion decisions on white collar (clerical) workers. Results on production and engineering workers are quite similar thus not shown. (2) Numbers shown indicate the percentage of the firms in each category which answered that tenure (*nenko*) is an important factor in the promotion decision. (Source) Koyo Kanri Chosa, Ministry of Labor.

3.1. *Two Types of Firms*

It is well known that competition for promotion in large corporate hierarchies take the form of *tournament mobility*. That is, competition is such that at each level (say, level j) of hierarchy, potential candidates for promotion is limited to those who have reached the level $(j - 1)$.[10] As in Bhattacharya and Guasch (1988) and Macleod and Malcomson (1988), tournament mobility can be considered as a device to isolate adverse selection from moral hazard problems. Assignment to job ranks based upon the past performance should over time reveal with some accuracy the ability of a worker. By assigning a relatively homogeneous (in ability) group of workers to each job rank, the adverse selection problem is probably diminished. In this sense, assignment of workers to a position is a *screening* mechanism, whereas promotion, demotion, or layoff is an incentive device to overcome moral hazard.

We believe that the use of the *nenko* (age or tenure) in limiting the candidates for promotions performs similar functions. As we have seen in Fact 3 (Table IV), the *nenko* rule defined this way is far more common at larger firms than at smaller firms. Table VI also attests our argument. Tenure (*nenko*) plays far more important role in promotion decision at larger firms.

Conventional wisdom on human capital theory tells us that general

[10] See Rosenbaum (1984). For Japan, Koike (1991) surveys many important studies on the career mobility. Most of these studies cited in Koike's book use company's panel data, which are obviously more desirable in principle but the sample sizes are generally too small to estimate promotion probabilities in a comprehensive manner. Koike concludes his survey by noting that most of these studies on Japan including some of his own support the basic premises of Rosenbaum's tournament mobility.

experience and tenure at the current work place performs reasonably well as a proxy of human capital, or ability.

An analogous reasoning would suggest that, instead of job ranks or tasks, simple age/tenure can be used to control for ability. No doubt this is a very coarse grading. But the practices of Japanese firms using age/tenure for such a proxy can be defended by investigating the *nenko* rule more closely.

First of all, such a grading (*nenko*) system is applied stringently only among relatively younger workers. If the firm invests in screening of workers at entrance stage, the abilities of younger generations are probably relatively homogeneous within the same age/tenure cohort. Moreover, large Japanese firms spend a long time in training a worker over a wide variety of jobs within a firm. It is common among large firms, for example, that new graduates entering a firm spend their first 10-year period by experiencing many (say, 5) different jobs, a few (2) years for each job. Not surprisingly, by the end of the first 10-year period, workers within the same age bracket will have experienced a quite heterogeneous assortment of jobs. Interworker comparisons are made very difficult for this reason.

As the grouping by age/tenure is a coarse grading system, firms adopting such a policy must spend fairly large amounts of resources in screening. For jobs at these firms using such a mix of employment policies, entrants typically are rationed by screening. Screening of the applicants is conducted in several dimensions. By far the most important is education. In some of the largest and the most prestigious firms, they limit the applicants by colleges from which they graduate. It is very often the case that graduates from lesser known colleges are excluded from the beginning in the screening process. Screening also occurs by grades. Table VII shows the ratio of firms which emphasize grade performances in screening applicants. It is far more common at larger firms. The hallmark of these firms is

TABLE VII
SCHOOL GRADES IN RECRUITMENT SCREENINGS (1986)

	High school		University	
Firm scale	Whitecollar (%)	Bluecollar (%)	Clerical workers (%)	Engineers (%)
Large	33.5	19.6	19.0	20.7
Small	20.1	11.3	16.7	16.5

Notes. (1) Numbers shown are percentages of the firms among the surveyed who answered that they use school grades as an important screening means for the applicants. (Source) Koyo Kanri Chosa, Ministry of Labor.

the deep and well developed internal labor market with the *nenko* promotion system.

Emphasis on the long and intensive on-the-job training [OJT] also provides additional reason to prefer the *nenko* promotion system. The effectiveness of OJT depends critically upon the ability and willingness of lower level management, such as team captain, foreman, etc., in teaching younger workers. The *nenko* system avoids the potential conflict between them by placing them in different cohorts in promotion decisions.[11] Although we lack direct evidence on the intensity of the OJT, many econometric studies almost uniformly confirm that the effect of tenure at current firms on wages are larger at larger firms. To the extent that this reflects the accumulation of firm-specific human capital, these studies support our argument that OJT is more intensive at larger firms.[12]

Simply put, what seems to be relatively unique to large Japanese cooperate hierarchy is the *vertical* (across *nenko* cohorts) cooperation and the fierce *horizontal* (within *nenko* cohorts) *competition*. We call these firms type-I firms.

Consider another type of firm which does not invest so heavily in screening. Typically these firms are smaller in size and their promotion policies are more open in the sense that they will not strictly adhere to age/tenure ordering. They are called type-E firms. To make the distinction between the two types of firms clearer, let us assume that type-E firms will not limit the potential candidates at all according to age/tenure ordering. Type-E firms have relatively large labor turnovers, and workers are often recruited from outside to a higher level position.

At type-I firms, the *nenko* rule of promotion serves two purposes. To review, first, to limit the candidates for promotions by age/tenure brackets so that the candidates are relatively homogeneous. Investment in screening also reduces the potential cost of adverse selection. The *nenko* rule also avoids the potential conflicts of interests between supervisors and trainees. For a type-E firm, the effectiveness of the *nenko* rule is greatly diminished. As type-E firms recruit workers openly, workers entering the firm the same year are far more heterogeneous. Controlling for ability by *nenko* is less effective. Higher separation rates at type-E firms also reduce the efficiency of OJT.

In conclusion, we believe that circumstantial evidence is strong for the correlation between, on one hand, the use of the *nenko* rule, heavy investment in screening, and OJT, and, on the other hand, firm size and the degree to which the internal labor market is developed. In what follows,

[11] See Itoh (1991) on this.

[12] For the effect of current tenure on wages, see Hashimoto and Raisian (1985, 1989, 1992).

we consolidate these stylized facts into a simple model of hierarchy and promotion policy.

3.2. *An Illustrative Model*[13]

To compare employment structure in these two types of firms, consider the following model. Suppose each worker lives two periods. During the first period, she is an entrant in the firm. Effort during this preliminary period is equal to the fully observable minimum level $e^{\min}$ and its cost is normalized to zero. We assume that type-I firms screen each entrant at the fixed cost F per entrant. This cost represents the screening processes during the recruitment necessary to reduce the heterogeneity in ability of the entering workers. For simplicity, we ignore the remaining differences in ability among the entering workers. At the end of the first period the worker can either quit and move to another firm or stay and become an incumbent. Workers who move are called newcomers. An incumbent participates to a promotion tournament by spending effort e over the minimum observable level. The effort spent generates skills necessary to perform supervisoring tasks. The tournament, which occurs at the beginning of the second period, selects supervisors among competing incumbents. After the tournament, production takes place and developed skills can be put to work.

The skill and technology necessary to perform level-1 tasks are general and all workers equally qualify for the job. On the other hand, the productivity of supervisors depends on costly effort. This effort is firm specific and can be assimilated to investment in firm specific human capital. Incumbents are equally able (have the same general human capital), but their input at the start of the second period (effort) is observable only to them. The output of their investment, on the other hand, is observed only by the firm. Crucially, the observation of effort by employees is assumed not to lead to collusive behavior that reduces effort.

The technology adopted by the type-I firm is described by the production function

$$Y = sef\left[\frac{m + m_{-1} - s}{se}\right], \tag{1}$$

where

$$f' > 0, \qquad f'' < 0,$$
$$s < m^{-1},$$

[13] This section is based upon Ariga, Brunello, *et al.* (1991).

and s, m, and m_{-1} are, respectively, the number of supervisors, entrants, and incumbents (entrants in the previous period). Efficiency depends on this skill level e, which can be acquired by spending $c(e)$ in effort, where c is an increasing and convex function. We discuss the determination of e below. The function f denotes the productivity of a division headed by a supervisor and is increasing and concave in the number of production workers per unit of effective supervision, i.e., the span of control times the efficiency of supervisors.

In order to focus the analysis on the effect of growth on the slope of the wage tenure profile, we shall assume that employees hired by each type-I firm grows at a constant rate (μ).[14] This implies that

$$m = (1 + \mu)m_{-1}.$$

Define

$$k = \frac{s}{m + m_{-1}} = \frac{s}{(2 + \mu)m_{-1}}$$

as the ratio of supervisors to total employment. The span of control is $(1 - k)/k$, a decreasing function of k. Define also

$$\theta = \frac{s}{m_{-1}} = (2 + \mu)k$$

as the probability of promotion from within. Note that, by definition, this probability depends in a natural way on the rate of growth μ. Consider a promotion tournament a là Malcomson (1984), where each type-I firm adopts a noisy test statistic q to select supervisors among incumbents. Define q as

$$q = e + u,$$

where u is a random variable with distribution function H and e is the true level of skill. We assume that u has zero mean and that H is unimodal around $\bar{x}$. As we assume that workers are risk neutral, expected net income over the two periods for an entrant employee is given by

$$V = w_0 + \delta[w_1 + \tau(w_2 - w_1) - c(e)], \tag{2}$$

[14] An equivalent, but somewhat more awkward assumption to deal with analytically, is that the output grows at a constant rate, μ.

where w_0, w_1, and w_2 are, respectively, wages for entrants, incumbents not promoted to supervisor and supervisors, δ is the discount factor, set equal to 1 in the rest of the paper, and τ is the subjective probability of being promoted to supervisor in the next period. Since all the incumbents are homogeneous, their optimal level of skill e^n must be identical. This implies

$$q = e^n + u.$$

If the firm needs to promote s incumbents, the required standard q will be

$$q^s = e^n + u^s,$$

where

$$H(u^s) = 1 - \frac{s}{m_{-1}} = 1 - \theta.$$

Hence τ is given by

$$\tau_j = \tau(e_j, e^n) = \text{Prob}(e_j + u_j > e^n + u^s) = 1 - H(e^n - u^s - e_j).$$

Each worker sets e_j by taking the skill level by co-workers (e^n) as given. In a symmetric equilibrium e_j^n is equal to e^n. The level of effort that maximizes (2) is thus given by

$$c'(e^n) = (w_2 - w_1)\frac{\delta\tau}{\delta e^n} = (w_2 - w_1)h(H^{-1}(1 - \theta)).$$

The required level of skill e^* can be elicited by the firm that offers the appropriate wage premium $p^* = w_2 - w_1$.[15] This requires

$$p^* = \frac{c'(e^*)}{h(H^{-1}(1 - \theta))}. \tag{3}$$

[15] As stressed by O-Keefe *et al.* (1984), the optimal premium p^* must satisfy the global constraint $\theta p^* - c(e^*) \geq 0$, otherwise incumbents set their optimal level of effort to the minimum observable level. On the other hand, the wage paid to entrants cannot be below some minimum wage w_{MIN}, typically because entrants belong to the young generation and are liquidity constrained. One can show that these two constraints establish a range of feasible values of μ delimited by a minimum level μ_0, defined by the condition above, and by a maximum level μ_1, defined by the absence of complete bonding. See our earlier paper, Ariga, Brunello, *et al.* (1991) for the detail.

Substituting (3) into (2) we get

$$V = w_0 + [w_1 + \theta p^* - c(e^*)].$$

The market for entrants is competitive. This implies that the participation constraint

$$V \geq V_0. \tag{4}$$

where V_0 is the reservation level of utility, holds as an equality. *Ex ante* quits are effectively ruled out by the no-quit constraint,

$$w_1 + \theta p^* - c(e^*) \geq V_1, \tag{5}$$

where V_1 is the (expected) level of utility offered by one period contracts available in the market. In a partial equilibrium context, changes in the promotion and wage policy of the firm do not affect V_0 and V_1.

We are now ready to discuss the maximization problem solved by type-I firms. Define profits per head as $\pi = \Pi/(m + m_{-1})$. These profits are given by

$$\pi = kef\left(\frac{1 - k2}{ke}\right) - \frac{1 + \mu}{2 + \mu}\left[w_0 + F + \frac{w_1}{1 + \mu} + \frac{\theta p}{1 + \mu}\right]. \tag{6}$$

Given the structure of the promotion tournament and the reservation utilities V_0 and V_1, each type-I firm sets the optimal wage structure (w_0, w_1, w_2, k) by maximizing (6), subject to (4) and (5). Replacing the participation constraint and the no-quit constraint into (6), we obtain

$$\pi = ekf - \frac{1 + \mu}{2 + \mu}[V_0 + F - V_1] - \frac{1}{2 + \mu}[V_1 + c(e)]. \tag{7}$$

The first-order conditions with respect to k and e are obtained by straightforward differentiations,

$$f - \frac{1}{ek}f' = 0 \tag{8}$$

$$kf - \frac{1 - k}{e}f' - \frac{c'}{2 + \mu} = 0, \tag{9}$$

where we have dropped the arguments of functions f and c for the sake of simplicity. The optimum skill level e can be elicited by setting the wage premium p^* that satisfies (3). Simple differentiation of the first order conditions yields the following lemma:

LEMMA 1. *The optimal promotion probability θ^*, the optimal skill level e^*, the optimal level of productivity $Y/(m + m_{-1})$ are all increasing in the rate of growth μ.*[16] *Moreover, the span of control, $(1 - k)/k$, is also increasing in μ if the elasticity of substitution in $f(\cdot)$ is less than unity.*

Proof. Define $n \equiv (1 - k)/ek$. then $f \equiv f(n)$, and $k = 1/(ne + 1)$. Differentiate the two first-order conditions, (8) and (9), to get

$$e\,\frac{dn}{d\mu} = -n\sigma\,\frac{de}{d\mu},$$

$$(f - nf')\,\frac{dn}{d\mu} = \frac{c'(e)}{e}\,\{\eta(ne + 1) + ne\}\,\frac{de}{d\mu} + \{nc'(e) + (2 + \mu)nf''\}\,\frac{de}{d\mu}, \tag{10}$$

$$\sigma \equiv -\frac{-f'(f - nf')}{nff''}, \tag{11}$$

$$\eta \equiv \frac{ec''}{c'}.$$

Substituting (10) for $e(dn/d\mu)$ in (11), we obtain

$$\frac{de}{d\mu} = (f - nf')/\left[c'(e)\left\{(1 - \sigma)n + \frac{ne + 1}{e}\,\eta\right\} - \frac{(2 + \mu)n^2f''}{e}\right] > 0.$$

Then, we have from (10),

$$\frac{dn}{d\mu} < 0. \tag{12}$$

Next, to sign $d\theta/\delta\mu$, use

$$\theta = (2 + \mu)k = \frac{2 + \mu}{ne + 1} = \frac{c'(e)}{f(n) - nf'(n)},$$

where the last equality follows from (9). Then, we have

[16] The result on the optimal span of control is dependent upon specific functional form. For example, if we take e to be abilities other than supervision, the output function can be $kef((1 - k)/k)$, instead of $kef((1 - k)/ke)$, as specified here. In that case, the optimum level k is determined independently from e or μ. If k is determined in that way, Lemma 1 and Corollary 1, except for the statement on k, can be established without any restriction on the substitution elasticity.

$$\frac{d\theta}{d\mu} = \frac{1}{(f - nf')^2} \left\{ c''(e)(f - nf') \frac{de}{d\mu} + c'(e)nf'' \frac{dn}{d\mu} \right\} > 0.$$

Finally, for the span of control, $(1 - k)/k$, we get

$$d\left(\frac{1-k}{k}\right)/d\mu = \frac{d}{d\mu}(ne) = n(1 - \sigma)\frac{de}{d\mu} > 0 \qquad \text{if } \sigma < 1. \quad \text{Q.E.D.}$$

This lemma is useful to establish another result of this paper, the positive relationship between growth and the slope of the wage tenure profile in type-I firms. We can establish this result with the following corollary:

COROLLARY 1. *The optimal wage tenure profile is steeper in firms experiencing a higher rate of growth.*

Proof. Define the tenure wage profile as follows:

$$t = \frac{w_1 + \theta p^*}{w_0}. \tag{13}$$

Simply replace in (13) both the participation and the no-quit constraint to obtain

$$t = \frac{V_1 + c(e^*)}{V_0 - V_1}$$

and compute the derivative of t with respect to u by keeping both V_0 and V_1 constant. Using Lemma 1, we get

$$\frac{dt}{d\mu} = \frac{c'(e^*)de^*/d\mu}{w_0} > 0. \qquad \text{Q.E.D.}$$

The intuition behind this result is simple. Higher growth increases the first best level of effort, which can be elicited only by increasing the wage premium p^*. With both V_0 and V_1 unchanged, the wage w_0 is also unchanged. Thus, the expected wage in the final period must rise to compensate for the higher distility of effort.

The results above depend on the assumption that the contest for promotion is limited to the incumbents, i.e., the *nenko* rule applies. This promotion policy provides the crucial link between growth and optimal effort. Without this link, changes in the rate of growth μ have no effect on optimal effort. If optimal effort is unchanged, there is no need to vary the optimal wage premium p^*. In lieu of the cost of screening processes, we introduced F for type-I firms, which is not needed for type-E firms. Instead, they must sacrifice the efficiency in promotion process by opening up the competition for promotion to its entire employees.

Type-E firms chooses its optimal share of supervisors and the optimal wage premium by maximizing

$$\pi = kef\left(\frac{1-k}{ke}\right) - w_1 - pk,$$

subject to the participation constraint

$$w_1 + kp - c(e) = V_1.$$

The first-order conditions of this maximization exercise are

$$f - \frac{1}{ek}f' = 0, \tag{14}$$

$$kf - \frac{1-k}{e}f' - c'(e) = 0. \tag{15}$$

The optimal condition for the share of supervisors in total employment, k, is the same in type-E and type-I firms. On the other hand, optimal effort by type-E firms is lower than in type-I firms. It is easy to see that (14) and (15) correspond to the maximization of

$$Y = sef\left[\frac{m + m_{-1} - s}{se}\right] - (m + m_{-1})c(e),$$

so that far too many employees in type-E firms invest in firm-specific training and individual effort is too low. Since (14) and (15) do not contain μ, the following lemma is obvious:

LEMMA 2. *At type-*E *firms, the optimum effort* (e), *the span of control*, $(1-k)/k$, *the promotion probability* (θ), *and the wage/tenure profile* (t) *are all independent from the growth rate*, μ.[17]

[17] The results suggest that the internal promotion reduces the inefficiency associated with asymmetric information and moral hazard. An implication is that, if type-E firms are less efficient, both in the sense that individual effort is lower and that too many people invest in training, they should be crowded out of the market by type-I firms. This is not necessarily the case, however, if internal promotion is costly to implement. In this paper, this is embedded in the assumption that type-I firms require a screening cost F per entrant. In this case, it is possible to establish a condition for the simultaneous existence in the market of both types of firms. See Ariga, Brunello, *et al.* (1991).

As it turns out, optimal levels of e and k for type-E firms are obtained by setting $\mu = -1$ in eq. (8) and (9) for type-I firms. That is, (14) and (15) are recovered simply by setting $\mu = -1$ in (8) and (9). Hence we get:

LEMMA 3. *Compare the two types of firms both growing at $\mu \geqslant -1$. Then, θ, e, and wage/tenure profile are all larger at type-*I *firms. Moreover, if $\sigma < 1$, then the span of control is also larger at type-*I *firms. These results are thus consistent with Observation* 1.

4. PROMOTION, HIERARCHY, AND LONGRUN GROWTH OF FIRMS

One of the key results in the analysis in Section 3 is that, for type-I firms, higher growth rate enhances the skill formation, the promotion probability, the span of control, and the efficiency in screening processes. In type-E firms, such effects are absent because all the workers are candidates for promotion, so that increase in the firm size does not affect the promotion probability. As the empirical distinction between type-I and type-E firms is inevitably a judgmental one, we proceed with a somewhat weaker version of the main thesis: our prediction is that at larger firms, their employment structure is closer to type-I, and at smaller firms, to type E; viz, the effects of growth are larger at larger firms. This is actually what we stated in Observation 2.

In order to test the differential effect of longrun growth on the two types of firms, we pooled data on smaller firms and larger firms (with more than 1000 employees). Table VIII reports the result on promotion probability.

TABLE VIII
DIFFERENTIAL EFFECTS OF LONGRUN GROWTH ON PROMOTION PROBABILITY

	Rank 3 to 4			Rank 4 to 5		
Age class	2[a]	3[a]	4[a]	2	3	4
25–29	−0.067	0.646[c]	0.373[b]	0.616	0.166	0.019
30–34	0.200	0.460	0.459[d]	0.250	0.683[c]	0.480[b]
35–39	0.491[b]	0.547[b]	0.806[d]	−0.025	−0.012	0.134
40–44	0.398	1.109[d]	0.549[d]	0.106	1.435[d]	0.327
45–49	0.569	0.142	0.472[d]	0.286[b]	0.130	0.195

[a] (2) Manufacturing, (3) Distribution, and (4) Finance.
[b] Significant at 10% level.
[c] Significant at 5% level.
[d] Significant at 1% level.
Note. Numbers shown are estimated coefficients of the difference between the effect of growth on larger firms and the effect of growth on smaller firms.

Denote by i the age bracket, and by j the job rank, and by k the industry. $p_k^{ij}(t)$ denotes the probability for rank j age i employees in industry k to be promoted to rank $(j + 1)$ within the 5-year period ending year t. $gpcy_k(t)$ denotes the 5-year growth rate of per capita value added in each industry. The dummy variable is equal to 1 if the $p_k^{ij}(t)$ is for larger firms, is zero otherwise. The estimated regressions are:

$$p_k^{ij}(t) = c_k^{ij} + d_k^{ij} * \text{dummy}_k^{ij} + g_{1k}^{ij} * gpcy_k(t) + g_{2k}^{ij} * gpcy_k(t) * \text{dummy}_k^{ij}$$

$$i = 25, 30, 35, 40, 45, 50$$

$$j = 3, 4$$

$$k = 2(\text{manufacturing}), 3(\text{distribution}), 4(\text{finance}).$$

Table VIII shows the estimated values of g_{2k}^{ij}. These results are fairly convincing evidence in support of our prediction. None of the g_2 coefficients are significantly negative. Among 36 coefficients, 3 are (insignificantly) negative, 14 are positive but not significant, 6 are significant at the 10% level confidence level, 2 are significant at the 5% level, and 7 are significant at the 1% level.

Results on the span of control and relative wages are somewhat less conclusive, although they certainly are supportive of our predictions (see Tables IX and X). All in all, our regressions convincingly point out the strong bias toward higher growth at large Japanese firms, which has been known for some time.

The basic logic is, in the end, very simple. For firms with relatively low turnovers and heavy reliance on the internal labor market for management-level employees, the growth deceleration put the firm in a serious dilemma. If the firm tries to maintain the same incentive structure, pro-

TABLE IX

EFFECT OF LONGRUN GROWTH ON THE SPAN OF CONTROL

	Manufacturing	Distribution	Finance
Rank 3	14.6	2.7	3.8[a]
Rank 4	29.5	2.9[a]	7.0[b]
Rank 5	22.4[a]	27.8[a]	31.6[a]

Note. Numbers shown are estimated coefficients g_{2k}^{ij} in

$$\text{SPC}_k^{ij}(t) = c_{0k}^{ij} + d_{1k}^{ij} * \text{dummy}_k^{ij} + g_{1k}^{ij} * gpcy_k^{ij}(t) + g_{2k}^{ij} * \text{dummy}_k^{ij} * gpcy_k^{ij}(t).$$

[a] Significant at 10% level.

[b] Significant at 5% level.

TABLE X
EFFECTS OF LONGRUN GROWTH ON RELATIVE WAGES

	Rank 3			Rank 4			Rank 5		
Age class	2[a]	3[a]	4[a]	2	3	4	2	3	4
25–29	1.17[b]	0.67[b]	−0.26	2.72[b]	0.51	−0.72	3.86	−0.52	−0.53
30–34	−0.06	0.16	0.14[c]	−0.16	0.26	0.13	2.06	0.02	0.83[b]
35–39	0.25	0.33[c]	0.16	−0.03	0.25[c]	0.29	0.46	0.13	0.44
40–44	0.58	0.38[c]	0.06	0.20	0.47[c]	0.31	0.53	0.21	1.32[c]
45–49	0.31	0.26[b]	0.36	0.22	0.61[d]	0.70[c]	0.35	1.08[c]	1.08[b]
50–54	−0.14	−0.16	0.73[b]	0.04	1.23[d]	1.10[d]	0.27	0.48	1.61[c]

[a] (2) Manufacturing, (3) Distribution, and (4) Finance.
[b] Significant at 10% level.
[c] Significant at 5% level.
[d] Significant at 1% level.
Note. Numbers shown are estimated coefficients g_{2k}^{ij} in

$$\mathrm{RLW}_k^{ij}(t) = c_{0k}^{ij} + d_{1k}^{ij} * \mathrm{dummy}_k^{ij} + g_{1k}^{ij} * gpcy_k^{ij}(t) + g_{2k}^{ij} * \mathrm{dummy}_k^{ij} * gpcy_k^{ij}(t).$$

duction efficiency of hierarchical structure will be seriously sacrificed. If the hierarchical structure is kept intact, then the promotion policy must bear the heavy burden. A higher growth policy ameliorates these problems. On the other hand, for firms with more open promotion policies, growth deceleration did not impose such a serious dilemma.

Before closing this section, confirm our findings from Table XI. The table shows that far larger portions of the larger firms tightened up the promotion policy after the growth deceleration in mid to late 1970s.

TABLE XI
CHANGES IN PROMOTION POLICY (1976/1–1980/12)

	Promotion decisions on					
	Promotion policy tightened (%)			Promotion policy loosered (%)		
Firm scale	Rank 1 → 3	Rank 3 → 4	Rank 4 → 5	Rank 1 → 3	Rank 3 → 4	Rank 4 → 5
Large	41.8	50.7	49.3	1.27	0.93	0.93
Small	18.0	17.1	15.8	3.27	3.02	1.98

Notes. (1) This table contains the proportions of the number of firms that made changes in promotion policy to the number of firms in each cell. (2) Job ranks are the same as those used in the main text. (Source) Koyo Kanri Chosa, Ministry of Labor 1982.

5. Conclusion

This paper focused upon the interactions between the production efficiency requirements and the incentive roles of promotion. A more deeper question would be: *why do large (Japanese as well as other countries') firms predominantly reward employees' performance by promotion, not by simple monetary rewards*? In recent years, Japanese firms faced the dilemma between keeping the incentive effects of promotion intact and maintaining a production-efficient hierarchy. Partial attempts to resolve the dilemma have been made: some firms created alternative promotion ladders in which promotions did not necessarily mean managerial rank jobs; in other cases, new grading systems primarily to adjust compensations are introduced and they are (at least in principle) detached from managerial ranks in hierarchy. Our analysis has demonstrated that this dilemma is a real and serious one at larger firms. Hence, the deeper question above does indeed look even more puzzling. If it were so difficult to reconcile the requirements from production-efficient hierarchy and agency cost-minimizing promotion policies, why simply use a compensations system completely independent from hierarchy?

We believe that the Japanese firms use promotions as the key incentive mechanism because using promotion as an incentive scheme has other advantages, especially at the large Japanese firms. Rewarding for a good performance by straight monetary compensation (say, special bonuses) may not be effective in preventing young fast-flyers from quitting for better paid jobs after receiving bonuses. Rewarding by promotion is necessarily a sluggish way of inducement and thus less susceptible to opportunistic behaviors. If, as we believe, large Japanese firms spend considerably more resources and time in OJT, rewarding superior performance by promotion may enable the sharing of the quasi-rent in firm-specific human capital, which is likely to induce more cooperative behavior. Moreover, to the extent the effectiveness of OJT and the contributions to the training by trainers and trainees are hard to estimate, pay according to (observable) performance may induce serious under investment in OJT by the trainers. The practice of using promotion to reward for good performance is also to some extent conditioned by the past history. Any substantial change in the reward scheme inevitably hurts some employees. In Japanese firms, wherein management-level workers, especially those at lower level management, are deeply involved in training younger workers, such a large change seems especially costly.

Although Japanese firms did not make such a drastic change in the compensation system, they have developed one important avenue through which the dilemma between the incentive problems and the efficiency requirement of hierarchy can be lessened: large Japanese firms created a large number of relatively small subsidiaries. These subsidiaries and the core firm can together pool the personnel and positions. Some may argue that spinning off subsidiaries is just a hidden form of (inefficient) bureaucratic expansion solely in order to make enough vacancies at higher job ranks. Others may also argue for genuine efficiency gains in having smaller, leaner, and more flexible organizations, rather than one gigantic and sluggish hierarchy. We do not have the answer. In any case, such a corporate group clearly has some advantage in allocation of talents in this context.

We have shown that promotion policies and the span of control at larger firms are more sensitive to its longrun growth rate. If, as we analyzed in Section 3, the efficiency gains from higher growth is important, it may also partially account for the bias among Japanese firms toward rapid expansion of size, as opposed to the maximization of the shortrun profit.

A more intriguing question that we cannot adequately treat in this paper is the role of on-the-job training in the growth of productivity. Trainings of this kind are akin to intergenerational transfer of skills. The skill level that one generation can achieve obviously depends upon the level that the preceding generation reached. If the Japanese managerial workers are fairly rewarded for their effort in training younger workers by promotion, intergenerational externality in technology transfer may be internalized, to some extent, in these firms.

As we (and others) argued in this paper, the training system of this kind can be put in jeopardy if the lower level managers are not cooperative. Even if they are not fast-flyers, these employees can be quite valuable. Rewarding some people by direct financial reward may please them; but, more often than not, others *not* rewarded are *hurt,* probably more so than the people *rewarded* are *pleased.* If so, tailoring the incentives scheme to a straight jacket of corporate hierarchy may not be so puzzling, after all.

APPENDIX

In this Appendix we explain the procedure and the data used for the computations of the promotion probabilities and the distributions shown in Fig. 2. First, we give the general idea on how to recover promotion flows from the data on the number of employees in each cohort. Then, we explain the data sources used in the procedure. Finally, we explain the procedure to obtain the distributions shown in Fig. 2.

1. *General Idea*

In order to compute the promotion probabilities, we need the number of promotions within a given period and the size of each cohort. Since promotions are nothing but flows between job ranks, our strategy is to limit a priori possible directions of flows from each cohort. Here are the limiting assumptions employed.

(A1) No employee is promoted more than one ranks during a period.
(A2) No employee is demoted.
(A3) All of the new entrants must be nonsupervisors.

With these three assumptions, for a worker at job rank j in time t, there are only three possible states in time $t + 1$ that he can occupy: rank j, rank $j + 1$, and out of the firm (which implies separation). By definition, there is no promotion from the highest job rank. Hence, if we have separation rates, then we can calculate promotion probability.

2. *Computation Procedure*

In each year, we have samples of number of workers which are classified by age, job rank, industry, and firm scale. Denote by a, age class, j, job rank, i, industry, s, firm scale, and by t, time, respectively. $N(t, i, s, j, a)$ and $D(t\colon t + 1, i, s, j, a)$ are, respectively, the number of (t, i, s, j, a)-employees and total promotions of (t, i, s, j, a)-employees between period t and $(t + 1)$. We measure time and age by a 5-year period because in the Wage Census, workers are grouped into 5-year age brackets.

We define promotion probability P as

$$P(t\colon t + 1, i, s, j, a) = D(t\colon t + 1, i, s, j, a)/N(t, i, s, j, a).$$

We omit i and s for simple representation if obvious. With these three assumptions, $D(t\colon t + 1, j, a)$ can be calculated in the following recursive manner.

Suppose there are three job ranks. Then we have

$$\begin{aligned}
D(t\colon t + 1, 1, 1) &= N(t + 1, 2, 2),\\
D(t\colon t + 1, 2, 2) &= N(t + 1, 3, 3),\\
D(t\colon t + 1, 2, a + 1) &= N(t + 1, 3, a + 2) - \{1 - Q(t\colon t + 1, 3, a + 1)\}\\
&\quad \times N(t, 3, a + 1),\\
D(t\colon t + 1, 1, a) &= N(t + 1, 2, a + 1) - [\{1 - Q(t\colon t + 1, 2, a)\}\\
&\quad \times N(t, 2, a) - D(t\colon t + 1, 2, a + 1)],\\
&\qquad\qquad \text{for } a \geq 2,
\end{aligned}$$

where $Q(t\colon t + 1, j, a)$ is the separation rate of (i, s, j, a)-employees between period t and $(t + 1)$.

TABLE XII
AGE CLASSIFICATION OF WAGE CENSUS

Age class	Age	Age class	Age	Age class	Age
0	Total	5	30 ~ 34	10	55 ~ 59
1	15 ~ 17	6	35 ~ 39	11[a]	60 ~ 64
2	18 ~ 19	7	40 ~ 44	12[a]	Over 65
3	20 ~ 24	8	45 ~ 49	13[a]	Over 60
4	25 ~ 29	9	50 ~ 54		

[a] Age class 11, 12: 1978 ~ 1989.; 13: 1976, 1977.

3. *Data Source*

Here we explain the available data of the number of employees and separation rates.

(1) *Number of Employees.* We obtained the data from Wage Census, Vol. 3, Table 1, which includes the number of (t, i, s, j, a)-employees. See Section 2 for the classifications according to other attributes. We show age classification in Table XII.

(2) *Separation Rates.* The most detailed data available for us related to separation rate in Japan is contained in the Survey on Employment Trend (Koyodoko Chosa) published annually by Ministry of Labor. It includes the number of (t, i, a)-employees and also the total separations of (t, i, a)-employees. Unfortunately, we have two problems. First, separation rates are not classified according to either job ranks or firm scales. We can do nothing about this problem. Consequently, we simply assume that separation rates do not differ across firm scale or job rank. Second, age and sex classifications are not conformable to the Wage Census. So we used a Kalman-filter algorithm in order to reclassify the separation data.

Further details are available upon request.

4. STEADY-STATE DISTRIBUTIONS IN FIG. 2

Given the promotion probabilities, we can compute the distribution of employees in each job rank according to the age at which they were promoted to the current rank. Denote by $m(j, y, a)$ the number of employees in job rank j who are age a and promoted to j at age $y (a \geq y)$. For simplicity, we suppress indices for industry (j) and firm scale (s). We have

$$m(j, y, a) = m(j-1, a-1, y-1) \cdot \bar{p}(j-1, a-1) \quad \text{for } y = a, \quad j = 3, 4, 5$$

$$m(j, y, a) = m(j, a-1, y-1)(1 - \bar{q}(a-1) - \bar{p}(j, a-1)) \quad \text{for } a > y, \quad j = 3, 4, 5,$$

where $\bar{q}$ and $\bar{p}$ are appropriate quit and promotion probabilities for which we used 1981–1989 average in each cell. Similarly, we used 1981–1989 averages for the age distribution of rank-1 employees. These set of equations are recursive, so that starting from the age distribution of rank-1 employees, $m(j, y, a)$ can be computed simply by successive substitutions. Then, we obtain the desired distribution, $n(j, y)$, as follows:

$$m(j, y) = \frac{\sum_{a \geq y} m(j, y, a)}{\sum_y \sum_{a \geq y} m(j, y, a)}.$$

For more details and results in other industries, ask the authors.

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