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WAGE STRUCTURES AND LABOR TURNOVER IN THE U.S. AND IN JAPAN

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ABSTRACT

The starting point of this study is the proposition that intensive formation of human capital on the job is the basic proximate reason for the strong degree of worker attachment to the firm in Japan. The greater emphasis on training and retraining, much of it specific to the firm, results also in steeper wage trajectories, due to growth of skills in the firm.

We explore this insight more thoroughly by a detailed use of micro-data for the two countries: We measure wage profiles and turnover in age groups, and we test the inverse relation between the two on industry sectors within each of the countries.

Using productivity growth indexes for industries in the U.S. and in Japan we test the hypothesis that rapid technical change which induces greater and continuous training, is responsible for steeper profiles, hence indirectly for lesser turnover. The hypothesis is confirmed on the sectoral level in both countries.

Finally, we try to standardize for the cultural background of workers, by observing a sample of Japanese plants in the U.S. which employ American workers, and use Japanese labor policies in recruitment and training. We find that the steeper tenure-wage slopes and lower turnover place this sample closer to Japan than to the U.S.

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1. Introduction

The relation between labor mobility, or turnover, and the structure of wages, especially by age, seniority and skill level, is a subject of research in the U.S. and a topic of lively interest in the analyses of Japanese labor markets. In particular, theories of human capital investment in worker skills and in hiring and screening have been used to explain tenure and experience wage profiles and to link them to turnover patterns across workers. This linkage, which we shall refer to as the duality hypothesis,[1] has been invoked by several researchers[2] to explain the very low Japanese turnover rate, often portrayed as a product of the "lifetime employment system." Although hard estimates are not readily available, it is well known that labor policies of Japanese firms involve a strong emphasis on recruitment for jobs, and training plus retraining of workers. The greater volume and greater firm specificity of such human capital investments in Japan than in the U.S. is claimed to be the central, proximate reason for the large differences in the degree of attachment to the firm in the two countries.

Our research is guided by the same hypothesis: Put briefly, larger investments in workers on the job result in steeper tenure-wage profiles and, given a degree of specificity in each unit of human capital, turnover is smaller the steeper the profile. This is a testable proposition in contexts other than the U.S.-Japan comparison, and we report on such tests by industry sectors within the two countries.

Of course, observed dualities of this sort need not arise from specific human capital alone. Wage-tenure profiles may be steepened, independently of skill formation, to deter shirking,[3] or to deter worker quit in order to amortize fixed costs of employment, such as recruitment and training costs. If training costs are important and recruitment efforts are related to training needs,[4] the fixed costs and specific capital hypotheses overlap, and may be treated as one.

To the extent that the reputation of Japanese workers for loyalty and discipline can be ascribed to their cultural background in upbringing and in historical tradition, steeper wage profiles in Japan are not likely to reflect greater needs to deter shirking. Moreover, contrary to the monitoring model[5] in which steep profiles substitute for greater supervision, there is a great deal of supervision in Japan, but it is largely a matter of guidance and training. As Koike (1984) describes it: A young recruit who joins a work group, following a period of (orientation) training, "is usually backed up by the sub-foreman for a period of several months. Even after that he is instructed and attended by a senior worker who occupies the next position in the rotation sequence." Indeed, Koike remarks, "the foreman in Japanese labor markets is much more involved than his Western counterpart in a worker's career."

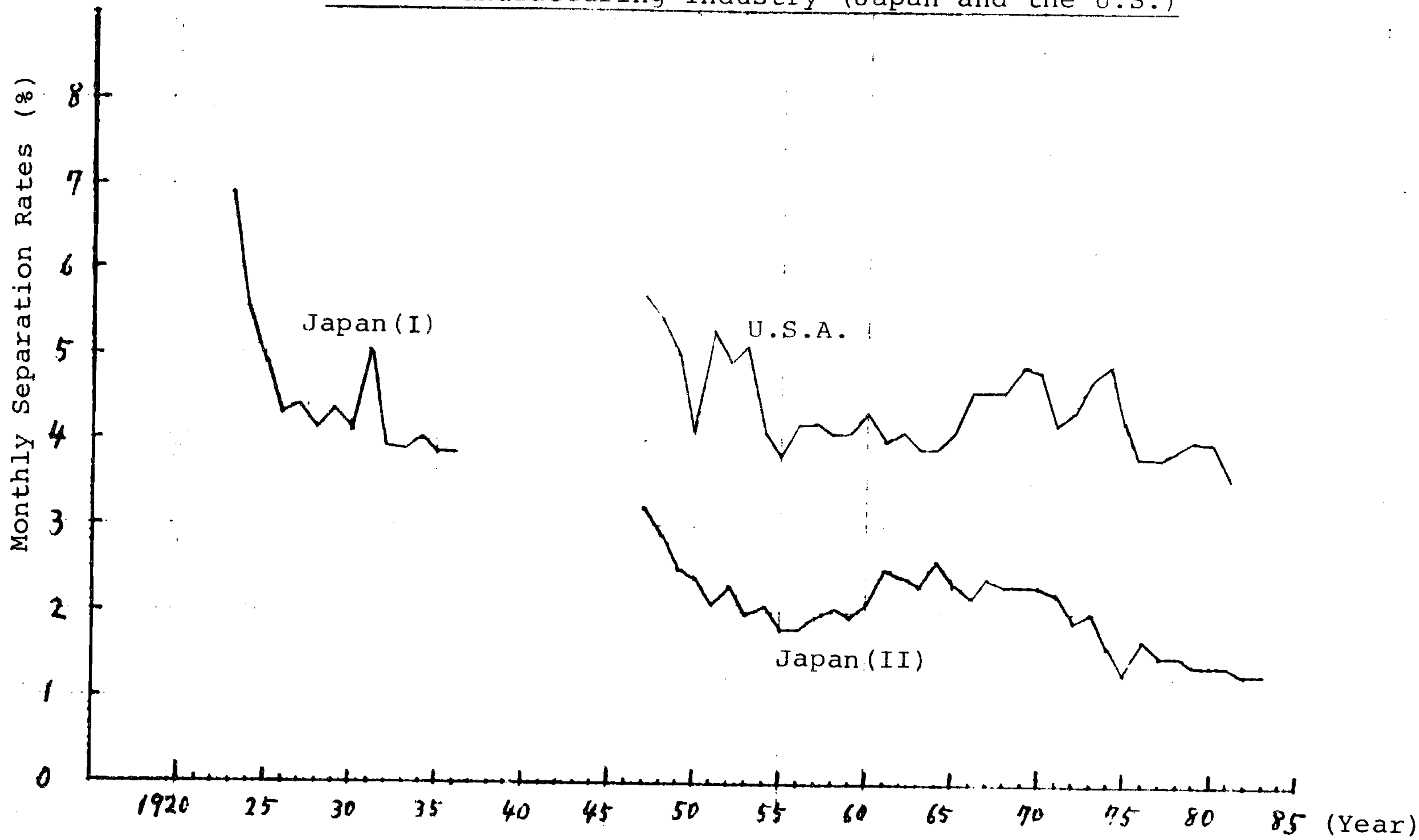
It may, of course, be argued that the cultural traits of Japanese workers which obviate the need to deter shirking are sufficient to explain low turnover behavior or the so-called "life-time employment system." Although it may well be a facilitating condition, cultural background has long historical roots, but very low turnover in the labor market appears to be a modern day phenomenon in Japan. Although the evidence is incomplete, there are indications that major declines in turnover accompanied the onset of rapid economic growth in Japan in the early 1950's.[6] Fig. 1 shows that in manufacturing the turnover rate is significantly lower in the recent decades than in the interwar period.

We think that the timing is not coincidental. We also think that the nature of training processes and of policies in Japanese firms, which makes the specific human capital hypothesis particularly useful, derives in part from the context of rapid economic growth. There is evidence in U.S. data that rapid productivity growth promotes training and retraining, by increasing its profitability.[7] In addition, the special emphasis on training for job flexibility and rotation in Japanese firms[8] strongly suggest a policy geared to the progressive introduction and absorption of technological improvements. To the extent that the adaptations vary across firms, greater specificities are generated in human capital investments on the job.

This study is an attempt to deepen our understanding of the Japanese labor market, by comparing it with the U.S. labor market. We take the differences in on-the-job skill formation of workers as the central source of differences in wage profiles and in turnover behavior, while placing the skill formation and related labor policies in the context of economic growth and technological change.

In section (2) we use micro-data for both countries, not previously employed for this purpose, to contrast the two national labor markets, as well as to test the wage growth-turnover duality at the sectoral (industry) level within the countries. In section (3) we trace inter-country differences in labor policies to differences in rates of economic growth or technical change. We utilize information on productivity growth by industrial sectors to assess effects on training and on shapes of wage profiles. We also explore corollary evidence on the effects of rapid economic growth on depreciation (obsolescence) of human capital and on mandatory retirement age. In section (4) we compare the wage-turnover relation in a sample of Japanese firms employing American workers in the U.S. with the relation in comparable American firms, and in the general Japanese and U.S. labor markets. This comparison is expected to reveal the effects of differential labor policies, net of differences in cultural backgrounds of workers which are often emphasized in discussions of Japanese labor markets. Section (5) contains a summary and concluding remarks.

Figure 1 Historical Changes in Monthly Separation Rates in the Manufacturing Industry (Japan and the U.S.)



Sources : Japan (I) Statistcs on Labor Movement History in Japan, vol.10, Chūō Kōron Sya.
(II) Monthly Labor Survey, Japanese Ministry of Labor.
the U.S. Monthly Labor Review, B.L.S.

Notes : Japan (I) : The average monthly separation rates of workers in the plants with 50 workers or more (the figure in 1923 is the average from May through December)
(II) : The average monthly separation rates of regular workers in the establishments with 30 workers or more (manufacturing)
the U.S. : The average monthly separation rates of workers in all establishments (manufacturing)

2. The human capital duality hypothesis and the micro-evidence.

That greater volumes of job training imply steeper wage profiles, on the job, and over longer work experience is a theorem in human capital analysis. A similar theorem predicts a negative effect of job training on turnover, on the plausible assumption that larger volumes of training contain also more firm-specific training, even if the latter is not a fixed part of the former.

Until recently, the absence of empirical measures of job training has made much of the human capital analysis of wage structures (Mincer, 1974) and of its effects on mobility (Mincer and Jovanovic, 1981) largely indirect. What was testable was the relation between wage growth and labor mobility, both of which are, according to the theory, affected by job training. More recently useful measures of job training have become available in U.S. micro-data sets, such as the Current Population Survey (1983), recent panels of the National Longitudinal Samples, and the Panel Studies of Income Dynamics. Direct evidence on the effects of training on wage growth has appeared in the research literature. Brown (1983), Parsons (1986), Tan (1987), and Mincer (1984) all show evidence of the wage growth effect in the cross-section and over time.[9] In particular, Brown and Mincer (separately) showed that when the tenure profile of wages was decomposed into 3 segments in the PSID data, wages grew slowly before the training period, rapidly during the training period, and levelled off after it. Training periods were defined as months and years during which training occurred. An additional year with training raised wage growth in the firm by 4-5% over the year, in cross-sections and over time.

The effects of training on mobility are explored in Mincer (1984) using the PSID data panel of working men: An additional year with training reduces the separation rate of workers by over 1%, while it lengthens the completed duration of tenure in the firm in which training is received by less than a year at younger ages and by more than a year at older ages. These effects hold for workers with the same education, experience, marital status, union status, and health. The same study shows that more educated and married men tend to receive more training,[10] which also helps to explain why turnover is lower for more educated and married workers.

We proceed to estimate wage functions in U.S. and in Japanese national sample micro-data, in order to derive experience and tenure-wage profiles for otherwise similar workers in the two countries and in (over 20) industrial sectors in each country. Mobility behavior is then estimated on the same data using the same independent variables for standardization. Tests of the duality hypothesis--that turnover is inversely related to tenure-wage growth--are then performed at the sectoral levels.

(a) Wage Functions in Japanese and U. S. Micro-data.

Our data is drawn from the 1979 Japanese Employment Structure Survey (ESS) and the U.S. Panel Study of Income Dynamics (PSID) for the period 1976-81[11]. The Japanese sample consists of male employees from 15 years of age through 55. The sample surveyed in the 1979 ESS is made of about 330 thousand households. A sample of 21,140 male employees (about 10 percent of the total) was selected at random. Because ESS does not provide direct information about the hourly wage rate, we substitute the ratio

$$\frac{\text{Annual earning from main job}}{\text{Annual working hours in main job}}$$

for it.[12] The U.S. (PSID) sample consists of over 7,000 observations on white males, heads of household (ages 18-60),[13] who were employed during each survey. The real wage rate in the main job was deflated by the 1979-based CPI. Marital status (M), union membership (U), and the dummy of job changes (C) are entered as independent variables in addition to education, experience, and tenure. In the U.S. equation, year dummies are added to eliminate aggregate wage changes over time. Due to lack of exact information about years of schooling in ESS, 9 years is selected if the person is a junior high school graduate, 12 years if a senior high school graduate, and 16 years if a college graduate or beyond. Total work experience is calculated for both countries as the employee's age minus his years of school completed minus 6 (the elementary school entrance age).

The estimated wage function is of the form:

$$(1)\ \ln w = \alpha_0 + \alpha_1 E + \alpha_2 E^2 + \alpha_3 X + \alpha_4 X^2 + \alpha_5 T + \alpha_6 T^2 + \alpha_7 Z$$

Here, the human capital variables are E-years of schooling, X-years of work experience, and T-years of tenure in the firm. As these are expressed in time units, wages are expressed in logarithms, and the coefficients measure rates of increases in wages with E, X, and T respectively.[14]

Table A1 shows means and standard deviations of variables for Japan and the U.S. Average current tenure in the employing firm is 3.5 years longer in Japan, and the average annual separation rate is over 3 times greater in the U.S. Other differences are small. Wage functions are shown in Table A2 for all, younger workers (up to age 30) and older workers (over 30) for the U.S. and Japan.

The coefficients in Table A2 show the usual signs in all groups, except for differing signs of the quadratic on education in the U.S. (positive) and Japan (negative).[15] As described in equations (A), where tenure is not included, wages grow with experience over twice as rapidly in

Japan than in the U.S. But when tenure is added, the experience coefficients are reduced in both countries, but more drastically in Japan. This indicates that the growth of wages with experience are in large part due to growth of wages with tenure, especially in Japan. The inference is that larger volumes of human capital, largely of a firm specific nature, are accumulated in Japan.

Other important differences emerge in the complete equations (C), where age groups are compared: Growth of wages with tenure is similar in both countries in the younger age group; the big difference--and steeper slope in Japan--is evident in the older (>30) age group. Put another way, there is little if any decline in wage growth in the firm as age advances in Japan, compared to a large decline in the U.S. The human capital interpretation is that on-the-job training processes are much more continuous, more evenly distributed over working age in Japan.

The summary Table (1) below shows the partial derivates of (log) wages with respect to education, experience, and tenure based on wage equations in Tables A2. These were calculated at common (average) levels of the independent variables, and show the much steeper tenure-wage trajectories in Japan compared to the U.S. in the national micro-data samples.

Table 1
Growth of Wages with Education, Experience and Tenure

All Age Group

Equation Type		Japan (C)	U.S. (C)	U.S. (D)
Schooling	12 years	17.05%	6.45	6.94
Experience	17 years	0.65	0.95	0.63
Tenure	9 years	4.19	1.22	1.01
		Young Age Group		
Schooling	12 years	15.63	5.78	6.27
Experience	6 years	2.25	1.94	1.91
Tenure	3 years	3.72	3.91	3.18
		Old Age Group		
Schooling	12 years	17.70	6.48	6.94
Experience	23 years	0.66	0.50	0.32
Tenure	12 years	4.07	1.13	0.91

Note on the interpretation of the coefficients in the wage functions.

The human capital interpretation of the coefficients in the wage functions requires a little more elaboration: In principle (Mincer, 1974), the coefficients of experience, and of tenure reflect (multiplicatively) rates of return to the respective investments, volumes of them (measured as ratios to labor costs, or time-equivalents of training costs), and the rate of decline of such investments over time. It is sufficient, for our purpose in this note to look at the linear coefficients: Thus, the linear coefficient of experience X in (A) of Table A2 equals r_x K_{ox}, where r_x is the rate of return to post-school investments, including general and specific job investments, indexed by the initial investment ratio K_{ox} , assumed to decline linearly over experience. Similarly, the coefficient of tenure (T) in Table 2 equals r_T K_{oT} with corresponding interpretation for specific investments in the firm, given that X is in the equation.

Since the rate of return to schooling (r_s) measured as $\frac{\partial \ln w}{\partial E}$ is over twice as high in Japan than in the U.S. (in Table 1), and the same is true of coefficients of X and of T, it may be true that volumes of job training (measured by K_{ox} for total training, and by K_{oT} for specific training) are similar in both countries, but that the rate of return on it is over twice as high in Japan.

Even in this case the implication for turnover of the over twice steeper tenure-wage profile in Japan would still be the same, since returns (to workers and employers) from a unit of investment would be increasing more rapidly in Japan, providing a greater deterrent to turnover. Judging, however, by fragmentary evidence on the comparative prevalence[16] and on ratios of job training (and recruitment) costs to labor costs in Japanese and American firms (see section 4), an emphasis on differences in both magnitudes and efficiency of job training is probably correct.

(b) Turnover Functions

We proceed to estimate turnover functions in Table A3, corresponding to the wage functions in Table A2.

One purpose in estimating turnover functions is to compare turnover rates in the U.S. and Japan for similar workers, by adjusting for worker characteristics specified in the turnover equations. Another is to observe, in the light of the specific capital hypothesis, differences or similarities in the effects of education, experience, and tenure on turnover. For example, a stronger positive relation between schooling and job training, which is partly specific, should lead to a stronger negative relation between education and turnover. Of particular interest is the relation between tenure in the firm and turnover: The more specific training he accumulates in the firm, the longer the worker is likely to stay with the firm. The larger the volume of training and the more it is bunched in early tenure the bigger the decline in the separation as tenure lengthens. Moreover, the less intensive the screening of workers before hiring, the more important is job matching after hire, hence the bigger the separation rate in early tenure. Consequently, the decline in separations with tenure $\frac{\partial S}{\partial T}$ is steeper, the less prior screening, the larger the volume of training, and the shorter the period of training in the firm, given the volume.

Also, a decline in turnover (s) should be observed as age (experience, X) advances since

$$(2)\ \frac{dS}{dX} = \frac{\partial S}{\partial T}\frac{dT}{dX} + \frac{\partial S}{\partial X} < 0$$

because $\frac{\partial S}{\partial T} < 0$, as already suggested, while $\frac{dT}{dX} > 0$ (it would be zero, if turnover were instantaneous) and $\frac{\partial S}{\partial X}$, the effect of "pure aging" (given tenure), is also likely to be negative, as costs of moving increase with age, apart from specific capital reasons. If "pure aging" is unimportant, as seems to be the case, the main reason for a negative age effect $\frac{dS}{dX} < 0$, is the negative tenure effect, $\frac{\partial S}{\partial T} < 0$.

Table A3 utilizes U.S. data in the PSID for the period, 1976-81, as in the wage equation. But, because the data on firm tenure in the previous job is not available in the 1979 ESS, the Japanese sample is drawn from the 1982 ESS. The samples are male employees of the same age group as in the wage equation including part-time and temporary workers in both countries. In this paper we define labor mobility by whether the worker changes firms during the past year. We exclude exits from and entries into the labor market. Consequently, job separation is synonymous with job change in our data.

The table shows regressions of turnover rates for each country and for age groups. The dependent variable in each equation is denoted as unity if the employee changed firm during the past year, and zero if the employee stayed within the same firm. Independent variables such as experience, tenure, and industry are defined on the information in the previous years of the survey period. The negative effect of schooling on separations is observable in both countries. This is due to a positive correlation between schooling and training, a relation consistent with the theory of investment in human capital over the life-cycle, or with complementarity between the two. The relation is a bit weaker in the U.S., but it gets stronger at higher levels of schooling. The experience effect, where tenure is not included, is negative and convex (i.e., it decelerates), with a steeper decline in the U.S. data. This is induced by the pattern of tenure coefficients as seen in equations (B), according to the decomposition of $\frac{dS}{dX}$, shown above. The larger negative coefficients on X (without tenure) are due to the larger coefficients on T (given X). It is surprising, at first glance, to find that the decline of separations with tenure is slower in Japan than in the U.S. However, the more intensive recruitment and pre-hiring screening effort in Japan (see section 4) means that separations are reduced in the immediate post-hiring period, and the spreading out of training activities over longer periods of tenure implies that the decline of separations with tenure is rather slow. Indirect evidence on the spreading out of training (and retraining) activities in Japan was noted in the wage profiles of Table A2: Tenure wage profiles continued to grow for senior workers in Japan, while their slopes decline much more in the U.S., hence the difference in the steepness of wage growth between the countries was much more pronounced among older workers. It is also possible that the flatter Japanese tenure-separation profile is, in part, due to an often asserted greater homogeneity of Japanese workers. The same heterogeneity bias[17] would also apply to the tenure-wage profile, biasing it downward for Japan. Apparently, the bias is of little consequence in the inter-country comparison, as the Japanese wage-profile is so much steeper, not flatter.

In order to estimate differences in separation rates among workers with similar characteristics, we standardize by education, experience, and marital status of common (average) levels of these variables. The results are shown in summary Table (2):

Table 2
Adjusted and Unadjusted Mean Turnover Rates (%)

	U.S		Japan		
	Adj	Unadj	Adj	Unadj	At X
All	13.9	16.6	3.3	4.9	X=17
Young	28.4	28.1	8.1	8.6	X=6
Older	10.1	10.0	2.5	3.5	X=23

Source: Table A3, col (A).
Education is 12 years for all three groups.

It appears that the over threefold higher U.S. turnover rate shown in the unadjusted data (Table 1), is true for similar workers as well.

(c) Sectoral Evidence on Wage Growth - Turnover Dualities.

While the steeper tenure-wage profile and lower turnover in Japan than in the U.S. is consistent with the human capital induced duality, one such comparison does not by itself represent compelling evidence. It is plausible that industrial sectors within the countries also differ in skill acquisition processes of their workers, given differences in production functions. If so, dualities could be tested across such sectors in both countries. We proceed to do this by including industry dummies (for 24 industry sectors in Japan and 17 in the U.S.) in the micro-data regressions previously shown without them in Tables A2 and A3. In the wage equations we added an interaction variable IND x T, where T is the individual tenure variable. Its coefficient α_i measures differential slopes of the tenure-wage profiles by industry. The estimated parameters are shown in Table A4. The α_i coefficients measuring wage-tenure slopes appear to differ significantly across industries in both countries. In the separation equation the coefficient β_i of added industry dummies IND_i measures differential turnover by industry i of workers with the same education, experience, marital status (and union membership in the U.S.). The β_i coefficients also shown in Table A4 are less significant (using 10% levels), especially in the young age groups in the U.S. and in the older age groups in Japan. The upper panel of Table 3 shows the correlations between α_i and β_i in each country by age groups:

Table 3
Effects of Industry Tenure-Wage Slopes on Separation Rates

(A) Correlations between Industry Coefficients in Table A4

	U.S. (17 industries)	Japan (24 industries)
All	-.347*	-.280
Young	-.070	-.377*
Older	-.348*	+.138

* Significant at 20% level.

(B) Regression Coefficients of Industry Tenure-Wage Slopes (α_1) and of Industry Wage Levels (α_2) in U.S. Separation Equations, 1976-1981[1]

Variables	All		Age ≤ 30		Age > 30		All Non-Union
α_1	-2.26	-1.50	-.48	-1.04	-2.92	-2.89	-2.03
	(2.9)	(1.9)	(.9)	(1.8)	(3.8)	(3.7)	(2.3)
α_2		-.23		-.22		-.13	-.20
		(4.6)		(2.3)		(2.8)	(2.8)

[1]Excludes agriculture and Construction which are highly seasonal.
Shown in Table A5.

The U.S. correlation coefficient has a negative value in every age group as predicted by the duality hypothesis. The coefficients in the old-age group and the all-age group are statistically significant at the 20 percent level. In the young-age group, where industries with significant coefficients are few, the correlation coefficient is not significant. In contrast, the Japaneses correlation coefficients are positive but insignificant in the old-age group.[18] In the young age group the coefficient has a significant negative value.

These results confirm the duality hypothesis, but the procedure of correlating regression coefficients tends to produce statistically weak (biased toward zero) correlations.

A better procedure is to introduce the industry tenure-wage slopes (α_i) into the separation equation, previously shown in Table A3. We are able to do this in the U.S. data, and the results are shown in Table 3, U.S. panel B. To the extent that industry wage levels also differ and reflect barriers to mobility, such as unionization, we introduce both industry dummies (α_2) and tenure-wage slopes (α_1) in the equation. Both are negative and significant in the total sample and in both age groups. The tenure-wage slope effects on turnover are much stronger in the older age group (suggesting greater firm specificity of accumulated skills than in the younger). Also, in contrast to the level effect (coefficient of α_2) the tenure wage slope effect (coefficient of α_1) is stronger in the non-union sector than in the total sample.

Since tenure-wage slopes are more likely to reflect training in the non-union sector, we can use the coefficient (-2.03) in the last column of Table 3, to estimate the extent to which differences in tenure-wage slopes account for the differences in turnover rates between the U.S. and Japan. According to our Table 1, tenure-wage growth per year is 1.2% in the U.S. and 4.2% in Japan, at average (9 years) tenure levels, for otherwise similar workers. Thus an increase of 3.0% in the wage slopes should reduce the separation rate by -2.03 x 3.0 =-6.1%. This would bring down the standardized U.S. rate from 13.9% to 7.8%, cutting the U.S.-Japan differential in turnover rates by close to 60% of the gap.

3. Economic Growth, Human Capital, and Wages.

Why do labor policies of Japaneses firms emphasize human capital investments which result in low turnover rates, or conversely, what explains the greater efforts of Japanese firms to strengthen worker attachment?

Although Japan was already an industrial power with a relatively educated labor force early in this century, the industrial relations system which produces low turnover became especially prominent in the post World War II era. The successful effort to rebuild industrial plant, to catch up with Western technology and to continue improvements yielded a very rapid rate of economic growth, initially capitalizing on the boom created by the Korean War in the early 50's. The evolution of labor policies in the firms may be viewed as a response to and in anticipation of rapid technological change. Introduction of new technologies requires complementary, growing and changing worker skills on the job, as well as a strong basic educational system which promotes continued learning skills. Technology is not quite a public good[19], and its use is uncertain at any point. The result is considerable variation among firms in the technologies they create and adapt, particularly in industries where technology is advancing rapidly. Hence the emphasis on skill upgrading and remolding on the job, with strong elements of specificity.

Whether or not firm specificities are inherent in technological change, in its face firms must make choices: Should the present workers be retrained and reassigned to new or modified tasks, or should new workers be hired and trained while the old employees are laid off? If training is general, that is fully transferable, the firm is indifferent between hiring a new trainee and retraining and reassigning an old worker. It may prefer hiring new workers if new technology is already embodied in skills outside the firm, or if newer vintages of education are helpful.[20] But, to the extent that training is specific (including that which is conditioned by the new technology), the firm will offer retraining and or continuous flexible training with rotation.

The resulting strong attachment of workers to firms and the avoidance of layoffs are mutually profitable for workers and employees, according to the theory of specific human capital. Training for flexibility and job rotation are of particular importance in facilitating long-term attachments in the face of changing technology. What is more, the perception of job security eliminates worker resistance to technological change and encourages innovative contributions on their part.[21]

If these arguments are correct, the steeper wage growth in the firm and the resulting lower turnover in Japan compared to the U.S. can be attributed, at least in part, to the differential rates of economic growth in the two countries in the post-war decades. To test this proposition we analyze several links between rates of productivity growth and behavior in the labor market.

Recent research in the U.S. (Lillard and Tan, 1986) reveals that job training is increased in industries which experience more rapid long-term productivity growth. It also shows that in-house training is encouraged while outside vocational training as well as prior on-the-job training in other firms is de-emphasized in such industries.[22] If these findings apply to differences across countries which differ in rates of economic (productivity) growth, the steeper tenure-wage profiles in Japan and lower turnover would follow as a consequence.

(a) Sectoral Evidence on Effects of Productivity Growth

Using indexes of total factor productivity growth constructed by Conrad and Jorgenson (1985) for about 30 U.S. and Japanese industries, we are able to test the predicted effects by industry sector in each country.[23] Table A6 shows these indexes for both countries.As we have more information in U.S. data, we can analyze them more comprehensively, both in substance and in form. Thus, we first inquire into evidence of greater demand for education and training in sectors with greater productivity growth underlying the greater use of human capital in such industries. Panel A of Table 4 shows the effect of long-term productivity growth on the incidence of training, by education level. It is positive without the interaction, as well, according to Lillard and Tan (1986). Panel B shows the positive effects of productivity growth--both long and short-term--on the profitability (returns) to education and training. This we see in the positive coefficients of interactions of productivity growth indexes with education (PG x E) and with training (PG x RQT) when they were included in the 1976-1981 PSID wage equations. The results indicate that the demand for education and for training increases as productivity grows, a fact of great importance for the understanding of the long-term growth of human capital in growing economies, and of its very rapid growth in recent Japanese history.

Table 4
Effects of Productivity Growth in U.S Industries on:

(A) The Incidence of Training by Education Level

Education	< 12	12	13-15	16	17+
Coefficient of PG x E	1.92	.41	2.88	3.56	5.32

All coefficients significant at 1% level.
Source: Lillard and Tan (1986).

(B) Returns to Education and Training

	1960-1979	1970-1979
PG x E	.082 (8.0)	
PG x E		.061 (4.0)
PG x RQT	.164 (10.1)	
PG x RQT		.100 (4.0)

t - values in parentheses
PG = Productivity growth over the periods
RQT = Training on the job, in years.
Source: PSID males, 1976-1981.

The first column uses longer-term productivity growth (PG) measured by the 1960 to 1979 increases in the indexes, the second--shorter term--over the 1970 to 1979 period.

RQT is the measure of (years or months) of training received in the current job, reported in 1976 and 1978 in the PSID.

We now proceed to test the effects of differential sectoral productivity growth on tenure-wage slopes in each country. Table 5A shows results for Japan, obtained by regressing industry tenure-wage slopes[24] on indices of industry productivity growth.

Table 5A
Coefficients of Productivity Growth
in Industry Tenure-wage Slopes Regression

Japan (23 industries)[1]

	All (15-55)			Younger (15-30)			Older (31-55)		
PG (60-79)	.0112 (2.9)	----	.0273 (2.6)	.0153 (2.6)	----	.0230 (1.5)	.0197 (1.9)	----	.0598 (2.3)
PG (70-79)	----	.0174 (1.9)	-.031 (1.5)	----	.0277 (2.1)	-.0183 (.6)	----	.0248 (1.0)	-.092 (1.7)
R^2	.286	.147	.359	.240	.167	.251	.243	.048	.248

[1]See Table A6.

Table 5B
Coefficients of Interaction of Productivity Growth (in 15 industries)[1]
with Tenure in U.S. Wage Functions

	All (18-60)			Young (18-30)			Older (31-60)		
PG (60-79)	.0139 (4.3)	----	.008 (1.1)	.040 (2.7)	----	.093 (3.0)	.015 (3.8)	----	.-001 (.2)
PG (70-79)	----	.006 (1.5)	.010 (1.2)	----	-.003 (.2)	-.083 (2.0)	----	.005 (1.1)	.023 (2.6)

t-values in parentheses
[1]See Table A6.

Although the results are not very strong, they do show that the more rapid long-term productivity growth in the sector the steeper is the tenure-wage profile. This is true for younger and older workers, with a somewhat larger effect on wage slopes of older workers. Where the shorter-run productivity growth indices are included in the regressions, they are negative and not significant. Apparently the wage structures induced by economic growth are fairly durable in the short run. Adjustments, which may be expected when economic fortunes change, take time.

We are able to implement the same test in U.S. data with a statistically more efficient procedure. In Table 5B we interact productivity growth indices with tenure in the wage equation. All interaction variables follow level variables in the equations.

Table 6A
Regressions of Industry Turnover Rates
on Industry Productivity Growth

Japan (23 industries)[1]

	All (15-55)			Young (15-30)			Older (31-55)		
PG (60-79)	-.009 (1.0)	----	-.014 (.6)	-.061 (3.0)	----	-.035 (.7)	+.007 (.9)	----	-.011 (.6)
PG (70-79)	----	-.016 (.8)	.010 (.2)	----	-.131 (3.0)	-.062 (.5)	----	+.020 (1.3)	+.043 (1.1)
R^2	.048	.033	.050	.301	.296	.311	.040	.008	.092

[1]See Table A6.

As in Japan, the effects of long term productivity growth (1960-79) in the U.S. is to steepen the tenure wage slopes. Here the effects appear to be stronger among the young, suggesting a lesser, if any, degree of obsolescence in the process of productivity growth in the U.S. Perhaps this is plausible at the frontier of Western technology to which Japan was catching up during that period. Also, shorter term (1970-79) effects were not significant, and mixed when included with long-term indices in the equations.

If the steepness of the tenure-wage slopes is increased by productivity growth, an (indirect) effect of productivity growth on turnover should also be visible. This is verified in Tables 6A for Japan and 6B for the U.S.

In Table 6A, coefficients of industry dummies in the Japanese turnover equation are regressed on long and short-run productivity growth indexes.

Table 6B
Effects of Sectoral Productivity Growth
on Separation Rates
U.S. (15 industries)[1]

	All (18-60)		Young (18-30)		Older (31-60)	
PG (60-79)	-.111 (4.2)	-.248 (4.2)	-.146 (2.9)	-.372 (3.6)	-.080 (2.6)	-.130 (2.2)
PG (70-79)	----	.197 (2.4)	----	.358 (2.5)	----	.083 (1.0)

[1]See Table A6.

Although negative signs prevail, they are significant only for the younger group, where turnover is more pronounced. For the older groups, the effect is even positive, contrary to expectation. We return to this anomaly in the next section.

In the U.S. data we can perform the same test more efficiently by including the productivity indexes directly in the turnover equation.

Table 7
Observed and Predicted
Tenure-Wage Slope

	U.S	Japan	Differences
Mean value of (PG x Ten)	.625	2.500	.1875
Observed Tenure-Wage Slope	.011	.042	.031
Predicted (a)	.011	.037	.026
(b)		.032	.021

The results shown in Table 6B are clear: Long term productivity growth reduces turnover, in both age groups indirectly via the effects on training and on corresponding tenure-wage growth. A comparison of Tables 5B and 6B shows clearly the symmetric (or duality) effects of productivity growth on wage slopes and on turnover. The long-run PG positive effects on wage slopes are bigger for the younger group, and so are the negative effects on turnover. The shorter run PG, when included, has negative effects on the wage slopes of young (in 5B) and positive effects on turnover (in 6B). At any rate, the shorter-run effects attenuate the long run effects. It appears that, in the short run adjustments to more rapid productivity growth involve substituting more educated for less educated workers without reduction in turnover. In the longer run, in-house training and reduced turnover dominate.

Returning to Table 5 we can ask the question posed at the outset of this section: To what extent does the more rapid economic growth in Japan account for the steeper wage profiles there?

According to the U.S. data (Table 5B) the effect of adding a unit of long-term growth (measured by the interaction variable (PG x Tenure) is to add 1.4% to the tenure-wage slope. The mean value of (PG x Tenure) in the U.S. was .625. Since Japanese productivity growth was 4 times as rapid over the period, the corresponding mean value for Japan was 2.500. The predicted difference in tenure-wage growth was therefore (2.500-.625) x 1.4 = 2.62%, using the U.S. Table, or 2.06% using the Japanese Table. As the summary Table 7 indicates, the differences in productivity growth account for 70% to 80% of the differences in tenure-wage slopes in the two economies.

We do not carry out a similar calculation for each age group separately, because the effects of productivity growth on wage profiles are much larger for young than for older workers in the U.S. (Table 5A) but no smaller for the latter in Japan (5B). This observation, calls for a closer look at the labor market consequences of obsolescence which accompanies rapid changes in technology.

(b) Obsolescence, Life-time Distribution of Training, and Early Retirement

One effect of rapid changes in technology is an increased depreciation of physical and of human capital, due to obsolescence. In effect, the pay off period of investments in human capital is shortened. Hence less is invested at any given time, but investments (training) are repeated over the working life.[25] Since the investments do not decline much over the working life,wage profiles do not decelerate much. To the extent that training is specific, and it is plausible that such specificity is accentuated by firms' adaptations to technology, the lack of deceleration is pronounced in tenure-wage profiles. We saw evidence of this lack of deceleration in Japanese data, contrasted with significant declines in tenure-wage slopes at older ages in the U.S. We also saw, in part (a) of this section, that effects of productivity growth on steepness of wage profiles was no smaller for older than for younger workers in Japan, but much smaller in the U.S. Apparently, the overall much weaker growth rate in the U.S. did not involve obsolescence, or potential obsolescence as much as in Japan.

Despite the greater potential obsolescence, total volumes of training are increased in conditions of rapid productivity growth as was indicated in part (a), presumably because of the greater profitability (indicated by positive coefficients PG xRQT in Table 4) of the up-to-date training. We should note, of course, that obsolescence of human capital does not necessarily imply obsolescence of workers. By gradual adjustments in continuous training, with emphasis on flexibility and job rotation, potential obsolescence is overcome without changing much of the work force in the firm.

However, workers who interrupt their work experience for a long period, are much more handicapped when returning to work in a regime of rapid technical change than in one where changes are milder. One way to gauge the difference in rates of potential obsolescence of worker skills in Japan compared to the U.S. is to observe the rate of decline in wage rates of persons who drop out of the labor force for a prolonged period. Such estimates are available for the U.S. (Mincer & Polachek 1974 and 1978), Sweden (Gustafsson, 1977) and for Japan (Higuchi, 1987), for married women who withdraw from the labor force (usually for child-bearing and child-rearing purposes). While such interruptions are now much less frequent in the U.S., they were still pronounced in the late sixties period covered by Mincer and Polachek in the U.S., and by Gustafsson in Sweden.

The estimates of depreciation "through non-use" are provided by the co-efficient δ in the wage function of the following form:

$$\ln w = \alpha_0 + \alpha_1 E + \alpha_2 X + \alpha_3 T + \delta D$$

Here X measures actual work experience in the labor market, T- the most recent job tenure, and D the length of interruptions of work activity, all in years. The "depreciation" coefficient on D is in part due to "forgetting" or erosion of skills used in the market prior to interruption. But, even without "forgetting," skills become obsolete if they are rapidly modified in the market place when technology changes rapidly. This obsolescence effect ought to have been greater in Japan than in the U.S. Indeed, estimates of the depreciation coefficient (δ) in married women's wage functions shown in Table 8 are clearly larger in Japanese data than in U.S. or Sweden.

Note also, that the estimated depreciation rates tend to increase with level of education. This would be expected if retraining on the job is complementary with education and with technical change--a hypothesis consistent with our findings in this study.

The estimates are not quite comparable in terms of procedures, time periods, and data sources. Nevertheless, they represent a strong suggestion that obsolescence is an important additional component to "forgetting" in Japan, augmenting the depreciation of skills which are not used over several years (the length of interruption periods are similar in the two sets of data).

Another implication of rapid technological change which necessitates continuing training and retraining of workers, is an adverse effect on continuing employment of older workers. This could happen if it is more difficult, that is more costly, to retrain older workers, while at the same time, the low turnover rates throughout prime ages result in a disproportionate number of such workers in sectors with rapid technical change. Early mandatory retirement from the job--though not from the labor force, and not necessarily from the firm--is a solution apparently practiced in Japan.

A weak test of this hypothesis is performed in Table 9. Here we relate the incidence (in % of firms) with mandatory retirement (Y_1) and, alternatively, the average age of uniform mandatory retirement (Y_2), in 9 industrial sectors (aggregated from the larger numbers used before), to long-term productivity growth by sector (X_1) and to tenure-wage slopes for the (31-55) age groups by sector (X_2). The X's are used alternatively; they cannot be used jointly, since they are strongly correlated on this highly aggregative level, as we would expect.

Table 8
Depreciation Rates in Wage Functions of Married Women (%)

	Age	Educ: 9-11	12-15	16+	Period
Japan	35-39	-3.99	-4.44	-5.35	Late 1970's
	30-34	-1.35	-3.59	-3.05	
U.S. (a)	30-44	-.20	-1.30	-2.30	Late 1960's
(b)	30-44	-1.16	-1.40	-4.30	
Sweden (c)		-.16	-2.75	-1.57	Early 1970's

(a) All married workers
(b) Married women with children
(c) Women with interrupted careers

Table 9

Productivity Growth (X_1), Wage-Slopes (X_2), and Early Retirement[1](Y_1,Y_2)
Japan, 9 Industrial Sectors

	Y_1	Y_2
X_1	17.7 (1.5)	-1.39 (2.5)
X_2	590.17 (4.6)	-26.17 (2.4)

[1] Data source: 1980 Survey on Employment Management, the Japanese Ministry of Labor.

Y_1=the incidence (in % of firms) with mandatory retirement.

Y_2=the average age of uniform mandatory retirement.

As the results show, sectors with more rapid productivity growth (X_1) tend to have mandatory retirement rules, and an earlier retirement age. The same is true of sectors with steeper tenure-wage profiles in the (31-55) age group (X_2). Of course, these are very much the same sectors.

Since the average retirement age is only a little over 55 in the rapidly growing sectors, a significant proportion of workers below 55 are induced (by severance pay and other benefits) to change their jobs earlier. This is the reason that for the previously observed apparent anomaly, namely that turnover rates appeared to be larger for older Japanese workers in sectors with higher productivity growth (Table 6A) and with steeper wage slopes (Table 3A).

4. Another Control: A look at Japanese Plants Operating in the U.S.

In this section we summarize our findings on recruitment, job training, and wage structures in a sample of 83 Japanese plants operating in the U.S. (JPUS). Details of sampling data and of analysis are described in Higuchi (1987A)

A popular view of Japanese industrial relations stresses discipline and company loyalty as a cultural characteristic of Japanese workers which is reflected in low turnover. The steep tenure-wage profile is ascribed to company policies of increasing wages with seniority as a reward for loyalty and for disciplined effort. Our comparison of Japanese and U.S. labor markets yields findings that are consistent with the economic analysis of human capital investments on the job, especially under conditions of differential rates of technical change, without attention to cultural conditioning. Nevertheless, the cultural background of workers is not irrelevant. The system of economic incentives that we described may be more effectively implemented, when favorable attitudes are engendered by the culture. A better perspective on the relative importance of the cultural background is to observe effects of Japanese labor policies in the U.S. environment. For this purpose we studied the behavior of American workers employed in JPUS plants. We examine (1) whether there are differences in modes of recruitment and job training between the JPUS and American plants, and (2) if so, how these differences influenced individual wage growth and job separation rates.

In our interviews we found that most of the JPUS plants apply, with some modifications, similar technology and production systems to those in their parent plants. Both Japanese and American managers in these plants stress the importance of job training. Orientation and job training are used not merely to enhance a given skill but also to acquire job flexibility for rotation purposes and to maintain good conditions of machinery without relying on outside experts.

According to Table 10, the proportion of workers who received training in the past year (1985) was about twice as high in JPUS than in comparable American plants. This proportion was also about twice as high as the new hire rate in the JPUS plants, but the proportion receiving training in the American plants was less then the new hire rate. This means that JPUS plants provide not only training for new employees but also continuing training and retraining for the existing work force. Training costs per worker were over two times higher in the JPUS plants, and over four times higher for new employees. Given the strong emphasis on training and its specificity it is not surprising that JPUS firms make strong efforts to recruit more adaptable and stable workers. Indeed, the recruitment costs are twice as high in the JPUS than in American firms. And the positive correlation between training and recruitment costs is clearly observable in Japanese industries as well.[26]

These findings, it should be noted, refer to production workers, not managers. As such they are not small: $1,756 of recruitment and training costs per year of a new employee in JPUS, compared to $626 in American firms. Still, these are underestimates: opportunity costs of job training (foregone productivity) escape the accounting. Similarly, recruitment costs do not include compensation for recruiters' and interviewers' time.

Wage rates are similar in JPUS and American plants, although average tenure is less in JPUS which are newer (the oldest plant dates back to 1963). Total annual labor costs per American worker are about $2,500 (or 10%) higher in JPUS. Over $1,000 of the difference is due to higher training and recruitment costs, and another $1,000 to higher fringes (unspecified), the rest is accounted for by (rather small) periodic bonus payments.

Table 11 shows the rates of growth of wages with schooling, experience, and tenure for JPUS, comparable American industries, and for U.S. and Japan in the aggregate. The estimates are based on wage functions of the form we used before. Tenure wage growth in JPUS is over twice as steep (3.3%) than in comparable American firms (1.4%), but lower than in Japan (4.2%). Prior experience has little or no effect on wages (for workers over 30, who were hired from other firms) in JPUS, in contrast to American firms. While prior experience is de-emphasized in JPUS, selectivity at upper education levels is apparent among white collar workers and managers. This shows up in the schooling coefficient of the wage equation which is far higher for workers over 30 years of age in JPUS plants than in American firms: Since prior work experience is less valuable in the JPUS plants whose technology and labor utilization differ from those in U.S. plants, quality and education may have been used as a substitute in hiring older workers for higher level positions.

Table 12 presents a comparison of turnover rates. As expected, all the rates are lower in Japanese plants, despite the fact that they are more recent and have a much larger proportion of younger workers. One seeming exception is the layoff rate which is not much lower in JPUS then in the American plants. But the statistic is unduly affected by one large electrical machinery plant which laid off 40% of its workers. Without this exception, the layoff rate is, like the quit rate, about half as large in JPUS than in U.S. plants. Quite remarkably, as in the comparison of tenure-wage slopes, the JPUS turnover rate is about two-thirds of the distance from the higher national U.S. rate to the lower national Japanese rate, as shown below in Table 13:

Table 10

Training and Recruitment Costs in JPUS and in American Plants

	JPUS	American
Proportion of worker who received training Last year (%)	24.35	13.48
Cost of Training per worker ($)	134.2	52.9
Cost of Training per new hire ($)	1000.0	215.0
Recruitment cost per new hire ($)	759	411

Table 11

Percent Growth in Wage Rate Attributable to Schooling, Work Experience and Job Tenure in the JPUS Plants, American Firms and Japanese Firms (%)

	JPUS (with bonus)	JPUS (without)	U.S (all industries)	U.S. (Non-Union workers in Textile, Metal, Machinery and Food)	Japan (all industries)	
			ALL AGES			
Schooling	18.92	18.78	6.62	8.76	16.79	(12.335 years)
Experience	0.57	0.64	0.98	0.82	1.46	(17.415)
Tenure	3.33	3.23	1.54	1.49	4.75	(9.600)
			UNDER 30 YEARS OLD			
Schooling	9.74	9.06	6.05	8.53	14.39	(12.655)
Experience	2.23	2.16	1.79	0.49	3.76	(6.585)
Tenure	5.25	5.00	3.69	4.02	6.36	(3.770)
			OVER 30 YEARS OLD			
Schooling	22.41	22.60	6.55	8.76	17.16	(12.170)
Experience	-0.19	-0.04	0.53	0.57	0.66	(23.110)
Tenure	2.47	2.43	1.31	1.30	4.28	(12.550)

Note: The Percentage growth in wage rate attributable to schooling calculated by the equation $\partial \log W/\partial E = b + 2CE$ is the simple average of means years of schooling in the U.S. and Japan, which are shown in parenthesis (the common value is given to the above five categories). The percentage growth in wage rate attributable to experience and tenure is similarly calculated. None of these calculations takes account of marital status which was not available in the JPUS data.

Table 12

Turnover Rates in JPUS and in American Plants

	JPUS		American	
	Annual	Monthly	Annual	Monthly
Separation rates	19.5	1.7	28.2	3.5
Quit rates	9.3	0.8	17.9	2.3
Layoff rates	7.3	0.7	8.6	0.9
Layoff rates (b)	1.6	0.1		
Percent of plants with layoff	16.1		55.0	

(b) Excluding 1JPUS plant which accounted for 40% of all layoffs.

Table 13

Tenure-Wage Growth and Turnover in Three Environments

	Japan	JPUS	U.S.
Tenure-wage Growth	4.7[a]	3.3[a]	1.5[a]
Separation Rate (Monthly)	0.9[b]	1.7[c]	3.5[c]

Sources: a - Table 11.
b - the 1985 Monthly Labor Survey.
c - Table 12.

We may conclude that the relation between the wage structure (the tenure-wage profile) and turnover is similar in all three cases, but that the (transplanted) hiring and training practices of Japanese firms account for about two/thirds of the differential between the U.S. and Japanese wage and turnover behavior.

5. Summary and Conclusions

The starting point of this study is the proposition that intensive formation of human capital on the job is the basic proximate reason for the strong degree of worker attachment to the firm in Japan. The greater emphasis on training and retraining, much of it specific to the firm, results also in steeper wage trajectories, due to growth of skills in the firm.

Several previous studies viewed the differences between Japanese and U.S. labor markets in the light of the same hypothesis. We explore this insight more thoroughly by a detailed use of micro-data for the two countries: We measure wage profiles and turnover in age groups, and we test the inverse relation between the two on industry sectors within each of the countries. Numerical estimates of this relation permit us to conclude that about two-thirds of the differential in turnover between the two countries is explainable by the differences in the steepness of the profiles.

As we indicated, the relation between wage slopes and turnover is indirect--attributable to the effects of human capital formation on each. This is in contrast to theories of seniority wage incentive schemes which encourage worker effort, thereby permitting reductions in monitoring costs. In such theories, the effects of wage profiles--which rise more rapidly than productivity--on turnover is direct. In our opinion, this interpretation of differences in wage profiles between the U. S. and Japan is inappropriate, prima facie, in view of the traditional reputation of Japanese workers for discipline and loyalty to the firm. Moreover, there is evidence that supervision plays a larger role in the careers of Japanese workers--but the purpose is to guide worker development, and not to monitor shirking behavior. Neither do we agree with the view that cultural attitudes are the major reason for the inter-country differences especially because the system we observe has been changing over time. We do not deny that cultural factors may play a facilitating role.

The question remains why the emphasis on human capital formation on the job is so much greater in Japan than in the U.S. Our answer is that such emphasis is conditioned by rapid economic growth. More specifically, Japanese labor policies in the firm represent adjustments of worker skills and activities to very rapid technological changes of the past decades.

Several indications lead us to this hypothesis: (1) The timing of strong reductions in turnover during the 1950's, when economic growth accelerated in the postwar period. (2) The lack of deceleration in the wage profile of mature workers relative to younger workers in Japan--suggesting continuous training and retraining processes characteristic of rapid technological change. (3) Actual obsolescence of skills reflected in larger declines (than in the U.S.) in wages of workers who interrupt labor force participation for several year periods. (4) Earlier retirement age in sectors with more rapid productivity growth in Japan. Research on U.S. data suggests that the more rapid productivity growth in an industry the greater the demand for education and training in it.

Using productivity growth indexes for industries in the U. S. and in Japan we test the hypothesis that rapid technical change which induces greater and continuous training, is responsible for steeper profiles, hence indirectly for lesser turnover. The hypothesis is confirmed on the sectoral level in both countries. We conclude that differences in productivity growth between the U. S. and Japan account for 70-80% of the differences in the steepness of wage profiles, hence indirectly for the differences in turnover.

Finally, we try to standardize for the cultural background of workers, by observing a sample of Japanese plants in the U.S. which employ American workers, and use Japanese labor policies in recruitment and training. We find that the steeper tenure-wage slopes and lower turnover place this sample closer to Japan than to the U.S.--about two/thirds of the distance.

The question whether these transplanted policies are profitable and may serve as a model for American industry to emulate is not easily answered, certainly not within the scope of this study. In answering such questions one should keep in mind that the JPUS ventures are highly selective in regard to: tax advantages and other incentives provided by local governments to induce their location, non-unionized and carefully recruited employees, and industrial activities in which their parent firms excel.

FOOTNOTES

[1] Explicated by Mincer and Jovanovic (1981).

[2] References: Kuratani (1973), Shimada (1981), Tachibanaki (1984), Hashimoto (1981), Hashimoto and Raisian (1985).

[3] See Becker and Stigler (1974), and Lazear (1981).

[4] Some evidence is cited in note 26, below.

[5] References in footnote 3.

[6] In his survey of the steel industry, Koike (op. cit.) found that tenure lengthened over that decade. A similar finding is shown by Saxonhouse (1976) for cotton textiles.

[7] See Lillard and Tan (1986), and Section 3 below.

[8] According to Koike's survey (op. cit.) there was a large number of rotations within Japanese plants. By contrast he finds that rotation in U.S. firms is infrequent. Mary Brinton (1987) emphasizes rotation as an important component of training in Japanese firms.

[9] Parsons uses NLS data, Tan the CPS.

[10] Similar findings are shown by Lillard and Tan (1986) in CPS and NLS data.

[11] Most studies of Japanese wage structures use the Wage Structure Basic Survey (Shimada (1981), Hashimoto and Raisian (1985)). The reasons for employing the ESS in this paper are as follows: (1) While the WSBS is an establishment survey, the ESS is a household survey which is comparable to the PSID (Mellow and Sider (1986) suggest that there are discrepancies between the estimated results of wage equations in establishment data and household data). (2) We were required to employ micro data which contain information on wage, job separation and other related variables at the same time, and the ESS is the only nationwide data source available in Japan which satisfies these conditions. (3) While the WSBS conducts a survey of wages in June only for the employees in firms with more than 10 workers who worked for more than 18 days a month and more than 5 hours a day, the ESS covers annual earnings and working hours of all workers.

[12] The 1979 ESS contains a question about the annual working days. In addition, the survey asked workers with more than 200 working days a year and workers with less than 200 working days who worked regularly during the survey period about their weekly working hours. But seasonal workers and day workers did not provide information on their weekly working hours. So, these workers are excluded from our wage data because information about both the annual working days and the weekly working hours is necessary for calculating the annual working hours. (These workers are included in the sample for the separation equations). The seasonal employees and the day workers account for just 3.6 percent of the total employees in non-agricultural industries. The annual working days and the weekly working hours were answered on a multiple-choice form. The annual working hours was calculated as the median of the selected answers to both questions.

[13] Working age upper limits of 55 in Japan and 60 in the U.S. are comparable, as they precede imminent retirement.

[14] The human capital interpretation of the coefficients is provided in the note following the description of findings. See Mincer (1974) for the theoretical development.

[15] Greater homogeneity in abilities, and/or larger inequality in opportunities in Japan could lead to such differences (See Becker 1975, Chapter 3).

[16] Cf. Koike (1984) and Brinton (1987).

[17] For a discussion of this bias in the wage-turnover relation, see Mincer and Jovanovic (1981).

[18] A possible reason is provided in the analysis of early retirement (section 3 (b)).

[19] The notion of "proprietary" technological knowledge is stressed by R. Nelson (1981). In an unpublished paper Hong Tan (1987) translates this notion into firm technology-specific worker skills.

[20] This appears to be an initial phase for technological adaptations in American industries (Bartel and Lichtenberg, 1986). According to Saxonhouse (1976) the unavailability of skills embodying new technology on the outside of the firm, led to major firm specific efforts to mold worker skills in Japan in the 1950's.

[21] This resistance, or fear that workers "will work themselves out of a job" is a common theme in the industrial relations literature. As Koike (1984) puts it, the job rotation training system in Japan produces a "deeper" career pattern of company specific skills which underlies worker attitudes toward technological change and their commitment to the company.

[22] Lillard and Tan (1986), Tables 3.4 and 3.5.

[23] We combined some of the indexes in order to apply them to the smaller number (aggregated) of industries in our data sources (PSID in the U.S.).

[24] These slopes were estimated by interacting industry dummies with tenure in the micro wage equations shown before.

[25] See Becker (1975), pp 73-74.

[26] The R^2 is .43 in 26 industries, excluding public utilities and textiles. Data are from the 1983 Survey on Welfare Facilities Systems for Employees, and 1983 Survey on Employment Trend.

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Table A1
Means and Standard Deviations* of Variables

	U.S. (18-60)	Japan (15-55)	U.S. (18-30)	Japan (15-30)	U.S. (31-60)	Japan (31-55)
Log wage rate **	1.470 (0.42)	9.030 (1.58)	1.308 (0.37)	8.696 (1.51)	1.564 (0.42)	9.191 (1.59)
Schooling (E) (Year)	12.73 (2.70)	11.94 (2.49)	12.83 (2.10)	12.48 (2.32)	12.67 (3.00)	11.67 (2.52)
Total work experience (X) (Year)	16.30 (10.93)	18.53 (10.63)	6.24 (2.66)	6.93 (3.99)	22.10 (9.60)	24.12 (7.98)
Tenure at the current firm (T), (Year)	7.85 (8.31)	11.35 (8.94)	2.82 (2.52)	4.72 (3.61)	10.75 (9.07)	14.35 (8.99)
Separation rate (S)	0.166 (0.377)	0.049 (0.22)	0.281 (0.45)	0.086 (0.28)	0.100 (0.30)	0.035 (0.18)
Married (M)	0.874 (0.33)	0.757 (0.43)	0.814 (0.39)	0.382 (0.49)	0.910 (0.29)	0.938 (0.24)
Sample size	8103	21140	2963	6881	5140	14259

Sources: The 1979 Japanese Employment Status Survey.
The 1976-81 U.S. Panel Study of Income Dynamics.

Note: * Figures in parenthesis are standard deviations.
The Japanese samples consists of male employees. The U.S. sample consists of white male employees who are household heads.

**The Japanese wage rate is shown at 0.1 yen/hour
The U.S. wage rate is deflated by the 1979-based CPI (in dollars/hour)

Table A2
Regressions of Male wage Equations in Japan and in the U.S.
($Log W=a_0+a_1E+a_2E^2+a_3X+a_4X^2+a_5T+a_6T^2+a_7C+a_8M$)

	Japan (1979)			The U.S. (1976-81)			
Equation Type	(A)	(B)	(C)	(A)	(B)	(C)	(D)
Age Group	15-55	15-55	15-55	18-60	18-60	18-60	18-60
Constant	3.511**	4.414**	4.588**	0.5185**	0.5752**	0.5706**	1.0587**
E	0.5668**	0.4491**	0.4489**	0.0198**	0.0144	0.0141	0.0070
	(12.66)	(10.15)	(10.17)	(2.13)	(1.59)	(1.56)	(0.79)
E^2	-0.0149**	-0.0114**	-0.0116**	0.0019**	0.0021**	0.0021**	0.0026**
	(-8.43)	(-6.51)	(-6.81)	(5.26)	(5.72)	(5.74)	(7.16)
X	0.0843**	0.0390**	0.0167**	0.0347**	0.0237**	0.0231**	0.0233**
	(22.37)	(8.87)	(3.35)	(22.87)	(14.33)	(13.95)	(14.30)
X^2	-0.0013**	-0.0007**	-0.0003**	-0.0006**	-0.0004**	-0.0004**	-0.0005**
	(-13.71)	(-6.85)	(-2.93)	(-14.87)	(-10.96)	(-10.72)	(-10.90)
T		0.0629**	0.0491		0.0231	0.0158**	0.0137**
		(14.80)	(10.23)		(14.16)	(8.46)	(7.40)
T^2		-0.0008**	-0.0004**		-0.0004**	-0.0002**	-0.0002**
		(-5.89)	(-2.77)		(-7.24)	(-3.32)	(-2.69)
C			-0.1070**			-0.0964**	-0.0923**
			(-1.78)			(-7.60)	(-7.38)
M			0.2639**			0.0725**	0.0664**
			(8.22)			(6.07)	(5.65)
U							0.1308**
							(15.13)
R^2	0.098	0.129	0.134	0.268	0.305	0.313	0.333

Note: Figures in parentheses are t-values.

*: Significant at the 10 percent level.
**: Significant at the 5 percent level.

The dependent variable is the log wage rate. E is the number of years of schooling, X is total work experi T is tenure at the current firm, C is a dummy for a job changer, M is a dummy for a married person, U is a dummy for a union member. In the Japanese data, the information of whether the worker is a union memb non-union member is not available. Year dummy variables are added to the above independent variables ir U.S. equations. These coefficients are omitted in this table.

Table A2 (Continued)

Regressions of Male Wage Equations in Japan and in the U.S.

	Japan (1979)			The U.S. (1976-81)			
Equation Type	(A)	(B)	(C)	(A)	(B)	(C)	(D)
Age Group	15-30	15-30	15-30	18-30	18-30	18-30	18-30
Constant	3.9588** (7.54)	4.4086** (8.34)	4.744** (8.95)	0.3914** (2.14)	0.5048** (2.85)	0.4963** (2.79)	1.0806** (6.73)
E	0.5121** (6.20)	0.4456** (5.37)	0.4395** (5.30)	0.0224 (0.81)	0.0099 (0.37)	0.0122 (0.46)	-0.0093 (-0.38)
E^2	-0.0138** (-4.34)	-0.0117** (-3.67)	-0.0118** (-3.72)	0.0017* (1.62)	0.0020** (1.97)	0.0019** (1.87)	0.0030** (3.32)
X	0.1138** (7.21)	0.0587** (3.31)	0.0333* (1.77)	0.0790** (7.51)	0.0442** (4.11)	0.422** (3.90)	0.0383** (4.31)
X^2	-0.0035** (-3.14)	-0.0016 (-1.28)	-0.0009 (-0.74)	-0.0036** (-4.48)	-0.0020** (-2.44)	-0.0019** (-2.35)	-0.0016** (-2.50)
T		0.0982** (5.84)	0.0422* (1.71)		0.0769** (9.62)	0.0637** (5.81)	0.0498** (5.41)
T^2		-0.0046** (-3.45)	-0.0009 (-0.57)		-0.0052** (-5.69)	-0.0041** (-3.69)	-0.0030** (-3.36)
C			-0.1243 (-1.26)			-0.0340* (-1.64)	-0.0366* (-1.95)
M			0.2054** (4.86)			0.0456** (2.83)	0.0506** (3.41)
U							0.1794** (14.17)
R^2	0.055	0.064	0.070	0.173	0.223	0.225	0.293

Table A2 (Continued)

Regressions of Male Wage Equations in Japan and in the U.S.

	Japan (1979)			The U.S. (1976-81)			
Equation Type	(A)	(B)	(C)	(A)	(B)	(C)	(D)
Age Group	31-55	31-55	31-55	31-60	31-60	31-60	31-60
Constant	3.4884** (10.11)	4.4255** (12.96)	4.281** (12.55)	0.5871** (8.50)	0.6538** (9.72)	0.6115** (8.90)	1.0833** (15.16)
E	0.5396** (9.75)	0.4295** (7.91)	0.4146** (7.66)	0.0182* (1.76)	0.0138 (1.37)	0.0120 (1.19)	0.0046 (0.45)
E^2	-0.0133** (-6.01)	-0.0103** (-4.74)	-0.0099** (-4.57)	0.0020** (4.76)	0.0021** (5.06)	0.0022** (5.30)	0.0027** (6.25)
X	0.0905** (8.80)	0.0404** (3.94)	0.0388** (3.79)	0.0281** (9.73)	0.0180** (6.14)	0.0188** (6.42)	0.0216** (6.71)
X^2	-0.0014** (-6.64)	-0.0007** (-3.48)	-0.0007** (-3.52)	-0.0004** (-6.97)	-0.0003** (-5.27)	-0.0003** (-5.57)	-0.0004** (-5.93)
T		0.0658** (13.54)	0.0527** (9.65)		0.0184** (9.98)	0.01369** (6.43)	0.0115** (5.25)
T^2		-0.0009** (-5.80)	-0.0005** (-3.39)		-0.0003** (-4.19)	-0.0001** (-2.02)	-0.0001 (-1.32)
C			-0.1398* (-1.59)			-0.0836** (-4.19)	-0.0855** (-3.96)
M			0.4314** (8.22)			0.0875** (4.99)	0.0792** (4.27)
U							0.0961** (8.21)
R^2	0.089	0.130	0.136	0.216	0.260	0.266	0.277

Table A3

Regressions of Male Separation Equations in Japan and in the U.S.

	Japan (1982)		The U.S. (1977-81)		
Equation Type	(A)	(B)	(A)	(B)	(C)
Age Group	15-55	15-55	18-60	18-60	18-60
Constant	0.2677** (6.23)	0.2102** (4.90)	0.4908** (7.54)	0.4689** (7.43)	0.4756** (7.56)
E	-0.0150** (-2.31)	-0.0043 (-0.68)	0.0027 (0.28)	0.0075 (0.83)	0.0121 (1.34)
E^2	0.0003 (1.31)	0.00002 (0.09)	-0.0007* (-1.89)	-0.0008** (-2.19)	-0.0011** (-2.98)
X	-0.0082** (17.99)	0.0017** (2.80)	-0.0194** (-12.51)	-0.0017 (-1.04)	-0.0018 (-1.07)
X^2	0.0002** (13.03)	-0.00004** (-2.59)	0.0003** (7.48)	-0.0000 (-0.13)	-0.00000 (-0.14)
T		-0.0156** (-26.07)		-0.0377** (-22.99)	-0.0361** (-21.95)
T^2		0.00037** (21.25)		0.0010** (17.30)	0.0010** (16.66)
M		-0.0177** (-4.35)		-0.0588** (-4.89)	-0.0565** (-4.73)
NUR			-0.0101 (-1.28)	-0.0070** (-0.93)	-0.0088 (-1.16)
U					-0.0708** (-7.85)
R^2	0.020	0.050	0.063	0.137	0.142
F val. on E	50.63**	12.58**	71.47**	47.06**	48.86**

Note: Figures in parentheses are t-value.
*: Significant at the 10 percent level
**: Significant at the 5 percent level.
The dependent variable is the dummy for a job separation. We exclude exits from and entries into the labor market. Consequently, job separation is synonymous with job change in our data. The total work experience (X) and the tenure (T) is defined on the basis of the information in the previous year of the survey period. The nationwide unemployment rate (NUR) is that of white males age 18-60 in each year.

Table A3 (continued)

	Japan (1982)		The U.S. (1977-81)		
Equation Type	(A)	(B)	(A)	(B)	(C)
Age Group	15-30	15-30	18-30	18-30	18-30
Constant	0.5698** (4.54)	0.3671** (2.97)	1.0871** (4.96)	0.9268** (4.41)	0.9673** (4.30)
E	-0.0504** (-2.83)	-0.0056 (-0.32)	-0.0490 (-1.50)	-0.0299 (-0.96)	-0.0275 (-0.82)
E^2	0.0013** (2.15)	-0.00006 (-0.10)	0.0007 (0.55)	0.0002 (0.14)	-0.0001 (-0.04)
X	-0.0154** (-7.06)	0.0081** (3.24)	-0.0508** (-4.79)	-0.0021 (-0.19)	0.0033 (0.28)
X^2	0.0006** (2.85)	-0.0004** (-1.65)	0.0021** (2.70)	-0.00005 (-0.06)	-0.0004 (-0.41)
T		-0.0695** (-16.22)		-0.1039** (-12.37)	-0.1057** (-10.98)
T^2		0.0037** (11.60)		0.0065** (7.02)	0.0071** (6.24)
M		0.0062 (0.80)		-0.0389** (-2.03)	-0.0447** (2.24)
NUR			-0.0272* (-1.88)	-0.0239* (-1.73)	-0.0333** (-2.28)
U					-0.0901** (-5.10)
R^2	0.018	0.074	0.046	0.133	0.135
F val. on E	51.38**	29.08**	45.21**	30.87**	31.04**

Table A3 (Continued)

	Japan (1982)		The U.S (1977-81)		
Equation Type	(A)	(B)	(A)	(B)	(C)
Age Group	31-55	31-55	31-60	31-60	31-60
Constant	0.2134** (4.95)	0.1713** (4.02)	0.3341 (5.15)	0.3164 (5.03)	0.3095 (5.02)
E	-0.0104* (-1.64)	-0.0011 (-0.17)	-0.0064 (-0.73)	-0.0020 (-.02)	0.0045 (0.53)
E^2	0.0002 (0.89)	-0.00003 (-0.14)	-0.0001 (-0.15)	-0.0001 (-0.36)	-0.0005 (-1.42)
X	-0.0063** (-6.16)	0.0010 (0.98)	-0.0084** (-3.07)	0.0048* (1.81)	0.0043* (1.71)
X^2	0.0001** (5.58)	-0.00002 (-0.70)	0.00008 (1.41)	-0.0001** (-2.24)	-0.0001** (-2.20)
T		-0.0118** (-21.20)		-0.0291** (-18.76)	-0.0294** (-19.01)
T^2		0.0003** (16.68)		0.0007** (13.60)	0.0007** (13.93)
M		-0.0349** (-7.15)		-0.0494** (-3.28)	-0.0438** (-2.99)
NUR			0.0022 (0.25)	0.2253 (0.64)	0.0071 (0.87)
U					-0.0478 (-4.93)
R^2	0.004	0.039	0.017	0.114	0.120
F val. on E	32.13**	11.06**	13.05**	11.21**	12.11**

Table A4
The Coefficient of Industry Dummy in wage Equations and Separation Equation

The U.S.

Age Group	18-60		18-30		31-60	
	Wage (Ind_iT)	Separation (Ind_i)	Wage (Ind_iT)	Separation (Ind_i)	Wage (Ind_iT)	Separation (Ind_i)
Industry	(α)	(ß)	(α)	(ß)	(α)	(ß)
1.	0	0	0	0	0	0
2.	0.01198**	-0.09626**	0.05601**	-0.08985**	0.00828**	-0.10040**
3.	0.01412**	-0.04778**	0.05815**	-0.06179*	0.01057**	-0.05390**
4.	0.01691**	-0.06792**	0.07166**	-0.04074	0.01287**	-0.09275**
5.	0.00816**	-0.03639**	0.04647**	0.02604	0.00477**	-0.07182**
6.	0.01256**	-0.08634**	0.04687**	-0.03799	0.00900**	-0.11906**
7.	0.00113**	-0.10275**	0.04726**	-0.16591**	0.00797**	-0.06274**
8.	0.001428**	-0.03401*	0.05607**	-0.02892	0.01055**	-0.04259*
9.	0.01290**	-0.09895**	0.05801**	-0.07102*	0.00924**	-0.12117**
10.	-0.00628**	0.06231**	0.02151**	0.09546**	-0.00913**	0.03368
11.	0.00772**	-0.00804	0.03950**	0.01869	0.00430*	-0.03087
12.	0.02113**	-0.00170	0.04345**	0.02506	0.01806	-0.02436
13.	0.01239**	-0.03012	0.03666**	-0.06499	0.00903**	-0.01639
14.	0.00076	-0.06661**	0.03193**	-0.04993	-0.00252	-0.07939**
15.	-0.00465**	-0.06183**	-0.02249**	-0.07684*	-0.00742**	-0.08012**
16.	-0.00115	0.02791	0.04952**	0.10032**	-0.00550**	-0.02982
17.	0.01122**	-0.10450**	0.03447**	-0.10463**	0.00848**	-0.10478**

Note: *: Significant at the 20 percent level.
**: Significant at the 10 percent level.
The coefficients of Industry No.1 are zero because the industry is assumed to be base-industry for estimation.
The coefficients of constant term, E, E^2, X, X^2, M, Unemployment (also C, T, T^2, Union and year dummy in wage equations) are omitted in this table.

The U.S. Industries classification: 1.Agriculture, Forestry & Fishing. 2.Metal prod. 3.Machinery, 4. Transportation equipment, 5. Lumber stone work & Furniture, 6. Food & Kindred prod., 7. Chemical ind. 8. Transportation and Communication Services, 9. Public utility, 10. Retail trade, 11. Wholesale, 12. Finance, Insurance & Real estate, 13. Publishing, Printing & Allied ind., 14. Health care services, 15. Education, 16. Other services, 17. Public Administration.

Table A4 (continued)
The Coefficient of Industry Dummy in wage Equations and Separation Equation

Japan

Age Group	15-55		15-30		31-55	
	Wage (Ind_iT)	Separation (Ind_i)	Wage (Ind_iT)	Separation (Ind_i)	Wage (Ind_iT)	Separation (Ind_i)
Industry	(α)	(ß)	(α)	(ß)	(α)	(ß)
1.	0	0	0	0	0	0
2.	0.00651**	0.00424	0.03366**	-0.02636	0.03754**	0.00918**
3.	0.00079	0.00499	0.00134	-0.03367*	0.00776**	0.01297**
4.	0.01135**	0.01508*	0.01337**	0.00742	0.04787**	0.01317*
5.	0.01007**	0.02056**	0.00640	-0.00174	0.05054**	0.02416**
6.	-0.00347**	-0.00428	-0.00115	-0.03277*	0.02798**	0.00075
7.	0.01099**	-0.01458*	0.00808**	0.06690**	0.03971**	-0.00367
8.	0.01237**	0.01656*	0.00735**	-0.01747	0.05215**	0.01180*
9.	0.01562**	-0.01294*	0.02653**	-0.04860*	0.03851**	-0.00623
10.	0.00740**	-0.00300	0.00865*	0.00033	0.04430**	-0.00491
11.	0.01565**	-0.01932**	0.02332**	-0.00596*	0.04141**	-0.01205*
12.	0.01346**	-0.01603*	0.01566**	-0.04110	0.04071**	-0.01098
13.	0.01143**	0.01072*	0.00547	-0.02908*	0.04497**	0.02000**
14.	0.01235**	-0.02158**	0.01238**	-0.07268**	0.03654**	-0.00893
15.	0.01705**	-0.01172*	0.01505**	-0.07807**	0.01990**	0.01425**
16.	0.01612**	-0.01084*	0.01464**	-0.05395**	0.01605**	0.00038
17.	0.01402**	0.00512	0.01968**	-0.04941**	0.04599**	0.01885*
18.	0.01125**	0.00332	0.01329**	-0.07184**	0.04842**	0.02234**
19.	0.01195**	0.02762**	0.01081**	0.02261	0.05293**	0.01802**
20.	0.02732**	-0.01835**	0.04310**	-0.08956**	0.07425**	0.00020
21.	0.02576**	0.04535**	0.00925	0.07955**	0.06964**	0.03064**
22.	0.01182**	-0.00065	0.01982**	-0.05060**	0.03667**	0.01049*
23.	0.01357**	-0.01285*	0.01274**	-0.05598**	0.05225**	-0.00123
24.	0.00900**	-0.01331**	0.00768*	-0.03609**	0.04787**	-0.00613

The Japanese Industries Classification: 1. Agriculture, Forestry & Fishing, 2. Mining, 3. Construction, 4. Food & kindred products, 5. Textile prod., 6. Lumber & wood prod., 7. Pulp, paper & paper work prod., 8. Publishing, printing & Allied ind., 9. Chemical & Allied ind., 10. Ceramic, Stone & Clay prod., 11. Iron and Steel, 12. Nonferrous metal prod., 13. Fabricated metal prod., 14. Machinery, 15. Electrical machinery, 16. Transportation equipment, 17. Precision trade, 20. Finance & Insurance, 21. Real estate, 22. Transport & Communication, 23. Public Utility, 24. Services.

Table A5
The Coefficients of Industry Dummy x Tenure (IND_iT) and Industry Dummy (IND_i)
in U.S Wage Equations

Age Group	18-60		18-30		31-60		Non-Union (18-60)	
	IND_iT (α_1)	IND_i (α_2)	IND_iT (α_1)	IND_i (α_2)	IND_iT (α_1)	IND_i (α_2)	IND_iT (α_1)	IND_i (α_2)
1.	0	0	0	0	0	0	0	0
2.	0.0040*	-0.1054**	-0.0319*	0.0585	0.0105**	-0.2476**	0.0066	-0.0424
3.	-0.0130**	-0.2815**	0.0067	-0.3558**	-0.0132**	-0.3357**	-0.0137**	-0.2111**
4.	-0.0004	-0.0944**	-0.0029	-0.1035**	0.0017	-0.1443**	0.0014	-0.070*
5.	0.0114**	-0.2259**	-0.0091	-0.1322**	0.0159**	-0.3389**	0.0136**	-0.2210**
6.	0.00003	-0.0568*	0.0024	-0.1237**	-0.0022	-0.0252	0.0070*	-0.0275
7.	0.0026	-0.0942**	-0.0129	-0.0399	0.0065*	-0.1754**	0.0077*	-0.0405
8.	0.0036*	-0.0582*	-0.0181	0.0255	0.0079**	-0.1466**	0.0047	0.0405
9.	0.0017	0.0110	-0.0181	0.0824*	0.0073**	-0.0992	0.0052	0.0254
10.	-0.0006	-0.0500	0.0062	-0.1183**	-0.0008	-0.0516	0.0020	-0.0127
11.	-0.0018	-0.1870**	0.0014	-0.1820**	-0.0003	-0.2415**	-0.0004	-0.1565**
12.	0.0181**	-0.1657**	0.0245*	-0.2328**	0.0163**	-0.1685**	0.0178**	-0.1107**
13.	0.0035*	-0.0536*	0.0046	-0.0694	0.0065**	-0.1227**	0.0082**	-0.0605
14.	0.0022	-0.0635*	-0.0057	-0.0640	0.0058*	-0.1374*	0.0051	-0.0422
15.	-0.0007	-0.2417**	-0.0320**	-0.1428**	0.0036	-0.3309**	-0.0014	-0.1769**
16.	0.0061**	-0.1574**	-0.0182	-0.0831*	0.0111**	-0.2475**	0.0090**	-0.1212**

Notes: Controls included are E, E^2, X, X^2, T, T^2, M, U and year dummy variables.

Industries: 1. Mining, 2. Foods, 3,. Textile, 4. Lumber, Stone and Furnitures,
5. Publishing and printing, 6. Chemical, 7. Metal prod.,
8. Machinery, 9. Transportation Equip., 10. Miscellaneous mfg.
11.Trade, 12. Finance, Insurance and Real estate,
13. Transportation and Communication, 14. Utility,
15. Services, 16. Public Administration.

Table A6
Productivity Indexes by Industry (% Growth over the Period)

U.S Industry	1960-79	1970-79
1. Mining	-0.46	-0.50
2. Foods	0.00	-0.03
3. Textile	0.33	0.16
4. Lumber, Stone and furnitures	-0.01	-0.07
5. Publishing & printing	0.21	0.20
6. Chemical	0.13	-0.03
7. Metal prod.	0.03	-0.02
8. Machinery	0.27	0.12
9. Transport Equip.	0.13	0.05
10.Misc. Mfg.	0.05	-0.03
11. Trade	0.19	0.06
12. Finance & Ins.	0.08	0.08
13. Trans. & Communications	0.21	0.11
14. Utility	0.00	-0.14
15. Services	-0.05	0.02

Japan Industry	1960-79	1970-79
1. Agriculture	-0.06	0.02
2. Mining	0.34	0.11
3. Construct	-0.13	-0.03
4. Foods	-0.18	-0.17
5. Textile	0.27	0.10
6. Lumber & wood	0.45	0.14
7. Pulp & paper	0.17	0.00
8. Publishing & print	-0.11	-0.18
9. Chemical	0.45	0.05
10. Ceramic & Stone	0.26	-0.05
11. Iron & Steel	0.18	0.06
12. Non-ferrous metal	0.01	0.02
13. Fabricated metal	0.48	0.12
14. Machinery	0.25	-0.01
15. Electrical Machinery	0.89	0.31
16. Transport Equip.	0.21	-0.02
17. Precision Instr.	0.65	0.32
18. Miscellaneous mfg.	0.54	0.23
19. Trade	0.28	-0.01
20. Finance & Insurance	1.19	0.43
21. Transport.& Comm.	0.61	0.19
22. Utility	0.19	-0.01
23. Services	0.00	-0.12

Source: Conrad and Jorgenson (1985)