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by

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I. INTRODUCTION

The impact of long-term labor contracting on lifetime wages is a topic of growing interest among labor economists.[1] There is evidence that an important fraction of the U.S. labor force is employed in near-lifetime jobs. Hall (1980 p.20) finds that in 1978 over 35 percent of males held jobs that would last twenty years or more.[2] There are several competing explanations for the existence of long-term jobs: the specific human capital hypothesis and, more recently, the agency and self-selection models. To date, no attempt has been made to distinguish empirically between them.

The problem is that these models make similar predictions about the pattern of wage growth and labor turnover over the worklife. In the human capital approach, workers forgo high initial wages to invest in specific training which increases their productivity and earnings in subsequent years. The specific skills are, however, not transferable to other firms. In the agency and self-selection (henceforth, 'incentive') approach, firms offer workers wage profiles which are steeper than their productivity growth in order to reduce incentives to shirk (Lazear 1981) or to attract workers with low quit propensities.[3] In both approaches,

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[1] Another, and more developed, area of research is the impact of long-term contracts on wage and employment adjustment responses over the business cycle. See, for example, Baily (1974).

[2] From data on job retention rates for each level of current tenure, estimates of eventual tenure conditioned on current tenure can be made. These calculations form the basis of Hall's conclusions.

[3] For example, see Salop and Salop (1976) and Viscusi (1980). Requiring potential employees to pay a testing fee is another self-selection devise to attract high-quality applicants (see Guasch and Weiss 1981). Apprentice programs are one obvious example of such an incentive scheme.

labor turnover declines with experience because relative wages in the current firm and elsewhere grow over the worklife. However, the one major difference between these approaches--the presence or absence of a correlation between earnings and productivity over the life cycle--is not readily exploited because of the paucity of productivity data.

This paper explores an alternative approach of distinguishing among the competing theories. It isolates two variables--the rate of employment growth and the rate of technical change--that are hypothesized to determine the profitability of specific training investments but not the use of incentive schemes. Empirical tests of the relationship between wage-tenure profiles and the predicted distribution of specific human capital can be used to ascertain the relative efficacy of competing theories. Section II presents the analytic framework and justification for these hypotheses. The data and variables used in the analysis are discussed in Section III. The empirical findings are reported in Section IV and their implications for the length of implicit labor contracts discussed. Concluding comments appear in the final section.

II. ANALYTIC FRAMEWORK AND HYPOTHESES

THE COMPETING MODELS

Consider the different rationale for steep wage-tenure profiles. In the incentive models, wage-tenure profiles are 'tilted' so that wages (W) are lower than value marginal product (VMP) initially but are higher than VMP in later years of the implicit employment contract. If early job separation occurs, workers forfeit the difference between VMP and W. Workers, in effect, post bond guaranteeing their non-shirking on the job or their employment stability. In the human capital scenario, on the other hand, workers tradeoff low initial wages to invest in specific skills which raise their productivity and earnings in the future. It follows that both VMP and wage profiles increase with years of tenure in the firm. This intimate link between wage-tenure profiles and VMP over the worklife is central to the human capital explanation of long-term contracts but not to the competing agency and self-selection hypotheses.

Figure 1 is a graphical representation of the competing models. To highlight their differences, two simplifying assumptions are made: first, that no acquisition or depreciation of skills takes place in firms using incentive schemes; second, where firms provide training, workers invest only in completely firm specific human capital. In all models, wage profiles W(t) are observed to rise with years of tenure t in the firm. In the first scenario, productivity is unchanged over time by assumption so that steeply rising W(t) is a pure incentive wage scheme.

Workers' VMP is represented by a horizontal VMP1(t) schedule. The shaded area where VMP1(t) exceeds W(t) is the 'bond' which workers post. The second scenario has workers investing in firm specific skills which are of value only to the current employer. The bilateral bargaining situation that arises is resolved only if both the employer and workers share the costs and returns of specific training.[1] The productivity profile of specific skills to the current employer, VMP2(t), is steeper than W(t) since specific training returns accrue in part to the employer. The shaded area is the worker's share of training costs while W(t) in excess of VMP1(t) represents his share of returns.

Steeply rising W(t), whatever its cause, will have the same effect of inducing longer tenure in the current firm. To see this, let W*(t) denote the relative valuation of current tenure t by the employer and by the external labor market. In both models, the opportunity wage is VMP1, that is, the value of skills workers bring to their current job. In one scenario, no new skills are acquired and forgone earnings (the 'bond') are a sunk cost for workers who leave the firm. In the human capital model, the higher productivity from training (VMP2 minus VMP1) is not transferable to other employers. Since W*(t), i.e. W(t)/VMP1(t), grows over time, incentives to change jobs are likely to decline with the accumulation of tenure in the firm.

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[1] This well-known result arises because neither worker nor the employer will finance all specific training costs since quits or layoffs by one party impose a capital loss on the other. Sharing the costs and returns is the solution to this dilemma (see Becker 1975; Hashimoto 1979).

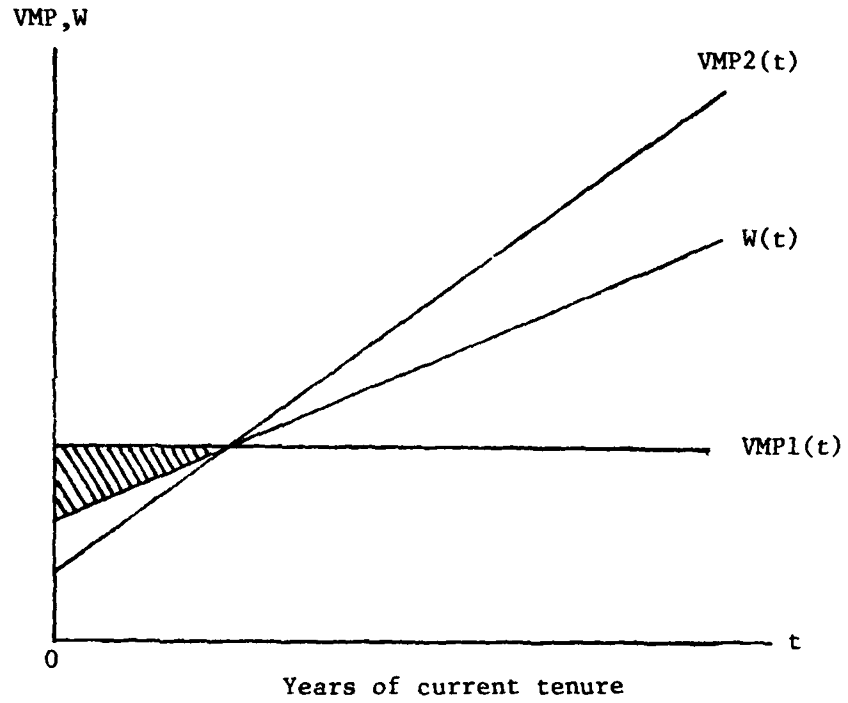

Fig. 1--The Competing Models of Long-Term Labor Contracts

The competing models are not easily distinguished empirically for three major reasons: First, the productivity data needed to test the correlation between VMP and W(t) over the worklife are seldom available to the analyst. Second, the available evidence on W*(t), while pointing to wage premiums for current tenure over other experience, is nonetheless equally consistent with either approach. Finally, competing models make few, if any, mutually exclusive predictions about the interfirm distribution of W*(t). For example, Lazear (1981) suggests that incentive schemes may be used more often in large firms because employers have greater difficulty monitoring workers' performance. Other economists argue that specific training investments are more profitable in large firms, citing scale economies in training, capital-intensive production, and the use of superior quality equipment (Kuratani 1973; Hashimoto 1979). In what follows, two determinants of specific training are isolated that allow tests of the relationship between the unobserved VMP2(t) and W(t).

HYPOTHESES

The first hypothesis is that the profitability of specific training investments increases with the growth rate of the firm (Hashimoto 1979, p.1097). This hypothesis builds on two points: (1) specific human capital, unlike general skills, are not readily available in the open market but must be developed within the firm; and (2) the training process is time consuming in that skills are produced only with a lag. Together, these two points imply that specific skills will be relatively scarce in rapidly growing firms. They therefore command a higher price compared to general skills which would make them more attractive investments for the firm. This leads to the prediction that specific training is positively correlated with the firm's rate of employment growth. To my knowledge, no attempt has been made to verify this hypothesis.

Tests of the hypothesis are complicated by firm size. Obviously, rapidly growing firms become large over time. And since large firms are more likely to use incentive wage schemes, steep wage-tenure profiles cannot be attributed unambiguously to investments in specific training.

Note, however, that the converse is not necessarily true. The rapid growth of large firms sometime in the past need not continue if market size imposes a constraint on current expansion. If so, controls for firm size in the empirical analysis can be used to disentangle the wage effects of rapid employment growth from the incentive wage effects associated with firm size.

The second hypothesis relies on previous research on the link between human capital and technical change (Tan 1980). In that study, a model of technology-skills is developed as an alternative to the firm-specific skills approach. The hypothesis is that individuals working with new technologies acquire new and more productive skills which are specific to that technology. This training is not readily transferred to other firms using different (older) technologies. In this model, skills are firm-specific only insofar as the company retains exclusive access to that technology. Over time, technology-specific skills become general as technology diffuses to other firms; accordingly, the quasi-rents which these skills command also fall. However, firms which innovate faster than the rate at which their technologies diffuse can continue to generate new skills and quasi-rents. The implicit, and not implausible, assumption is that the obsolescence rate of skills is not speeded up by rapid technical change. With the exception of major technological breakthroughs, much of technical change is incremental in nature, building upon knowledge acquired in modifying and improving innovations introduced earlier.[2] Other things equal, we would expect

[2] See Hollander (1965) for a discussion of the micro-evidence that supports this contention.

increased specific training investments in firms experiencing rapid rates of technical change.

A link between technical change and wage differentials has been found by several Japanese labor market studies.[3] For example, there is historical evidence that within an industry, firm size differentials widened and narrowed with the introduction and subsequent diffusion of foreign technology. This finding is consistent with a quasi-rent interpretation of wage premiums in large innovative firms. Other research on the cotton spinning industry at the turn of the century is also revealing. The uniformity of technical practices appeared to have inhibited incentives to train workers since their skills were easily transferred to other firms. Research on inter-industry wage differentials in post-World War II Japan has found a strong positive relationship between the rate at which wages increase with tenure and measures of technical change.

These hypotheses may be tested using an expanded specification of the conventional wage model. The exposition is simplified considerably by suppressing the quadratic experience terms (these are included in the empirical analysis):

$$\ln W_i = \alpha_1 + \alpha_2 S_i + \alpha_3 EXP_i + \alpha_4 TEN_i \tag{1}$$

where for individual i, lnW = logarithm of hourly wage, S = years of schooling, EXP = years of market experience (defined as age minus S minus 6) and TEN = years of current tenure. This specification of the wage model has been used by a number of recent studies to decompose

[3] For a review of this literature, see Tan (1981).

wages into the returns to specific and general skill components (e.g. see Mincer and Jovanovic (1979); Chapman and Tan (1980)). The rationale is as follows: when skills are completely general, no distinction need be made about where experience is acquired and general training returns are adequately captured by the coefficients of EXP. On the other hand, specific training increases a worker's productivity more in the current firm than elsewhere. Thus, the added wage effects of TEN, over and beyond those of EXP, may be interpreted as the returns to firm-specific training. Note that this expanded specification of the wage model is not without problems. The selectivity problems associated with tenure endogeneity are well-known.[4] No attempt is made in this paper to deal with this interesting, but difficult, issue.

Equalization of the present values of training costs and returns requires an inverse relationship between initial wages and subsequent rates of wage growth.[5] The hypotheses that specific training investments increase with the rates of employment growth (EMPGR) and technical change (TECH) lead to the following predictions: that starting wages are negatively related to EMPGR and TECH while wage-tenure

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[4] Tenure endogeneity arises because of the stayer-leaver problem. The unobserved traits that determine whether a worker stays or leaves, and thus also his length of tenure, are likely to confound estimates of the returns to specific training measured by the coefficient of TEN. For a discussion of these issues, see Jovanovic (1979).

[5] Indeed, Chapman and Tan (1980) sought to use this human capital prediction as an explanation for interindustry wage differentials in U.S. manufacturing. Their finding of low initial wages in industries with steep wage-tenure profiles is, however, also consistent with the predictions of agency and self-selection models.

profiles are positively related to EMPGR and TECH. These predictions can be tested using an expanded specification of (1):

$$\ln W_{ij} = \alpha_1 + \alpha_2 S_i + \alpha_3 EXP_i + \alpha_4 TEN_i + \alpha_5 EMPGR_j + \alpha_6 TECH_j + \alpha_7 EMPGR_j * TEN_i + \alpha_8 TECH_j * TEN_i \qquad (2)$$

Equation (2) includes both EMPGRj and TECHj and their interactions with the TEN variable. The specific training hypothesis is supported if firms experiencing rapid employment growth and technical change in industry j have low starting wages (negative α_5 and α_6 coefficients) and higher rates of wage growth with tenure (positive α_7 and α_8 coefficients). Otherwise, one might argue that incentive and self-selection schemes are responsible for steep wage-tenure profiles.

III. DATA AND VARIABLE DEFINITION

The primary data source is the May 1979 Current Population Survey (CPS). Each month, the CPS collects data on labor force status and a variety of personal and job characteristics. Information on usual weekly earnings and hours worked is available for a fourth of the sample. The May 1979 CPS also fielded a supplemental Pension Survey which included questions on current job tenure, union status and employer size. With this job tenure information, issues raised in this paper can be investigated for the first time on a truly broad-based sample of the U.S. population.

Analysis is limited to males between the ages of 18 and 65 years who were engaged in non-agricultural wage employment. Excluding individuals with incomplete responses resulted in a working file with 9917 observations. Responses to questions on usual weekly earnings and hours worked are used to construct an hourly wage variable, W. The vector of personal attributes included dummy variables for race (BLACK), white-collar occupation (WCOLAR), union status (UNION), SMSA location and census region. Years of schooling (S), experience (EXP), current tenure (TEN), and squared experience terms (EXPSQ and TENSQ) are entered as continuous variables. Individuals indicated whether they were employed in one of five firm size categories: under 25, 25-99, 100-499, 500-1000, and over 1000 employees. On the basis of their responses, firm size dummy variables corresponding to the four largest size categories are constructed.

The industry data needed to test the hypotheses were obtained from two sources. The BLS Employment and Earnings reports a seasonally-adjusted monthly employment series for a number of two-digit S.I.C. industries. Using data for the period from 1974 to 1979, separate regressions of the logarithm of employment on a linear time trend were run for 26 industries. The coefficient of the time trend variable, converted to its annual equivalent, is used as the industry employment growth variable EMPGR. The mean square error of these regressions, that is, the mean of the squared difference between actual and predicted employment, can be interpreted as a measure of employment variability. This variable (EMPGR) is used as a control for potential compensating wage effects. The argument is that firms in cyclically-sensitive industries pay wage premiums to compensate workers for the uncertainty associated with employment variability. Abowd and Ashenfelter (1980) have found compensating wage differentials of between 1 and 14 percent. The estimates of industry rates of technical change, TECH, are taken from a study by Gollop and Jorgensen (1980). They report translog indices of technical change for 47 two and three-digit S.I.C. industries covering the period from 1966 to 1973. These figures, though somewhat dated, are nonetheless the most recent estimates available. The values of EMPGR, EMPVAR and TECH are reported in Table 1. These variables were merged into the CPS file for the analysis that follows.

Table 1

Industry Rates of Employment Growth, Variability and Rates of Technical Change

Industry Description	Employment Variability (EMPVAR)	Employment Growth (EMPGR)	Technical Change (TECH)
Mining	0.2850	5.83	-3.49/1.97
Construction	0.5046	3.22	-1.16
Lumber	0.3918	2.93	1.02
Furniture	0.4229	1.90	1.48
Stone & Clay	0.1334	1.60	0.70
Primary Metals	0.2287	0.12	-0.46
Fabricated Metals	0.2369	2.01	0.90
Machinery(exc.elec)	0.2204	2.91	1.05
Elec. Machinery	0.7347	2.26	1.60
Transport Equipmt.	0.2031	3.01	0.59/1.04
Instruments	0.1680	3.84	2.43
Miscellaneous	0.1412	0.73	1.66
Food Products	0.0159	0.54	1.23
Textile-Mill Prod.	0.1400	-0.88	2.25
Apparel	0.1191	0.06	1.83
Paper Products	0.1102	0.79	0.94
Printing & Publ.	0.0519	2.47	0.61
Chemical Products	0.0341	1.26	2.67
Petroleum & Coal	0.0177	1.55	0.94
Rubber & Plastics	0.4225	3.69	1.87
Trans. & Utilities	4.5058	3.81	-2.59/4.43
Wholesale	0.0307	3.39	1.22
Retail	0.0153	3.93	0.55
Finance & Insurance	0.0315	3.79	-0.93
Services	0.0064	4.89	-0.45
Public Sector	0.0146	2.11	0.07

Note: EMPGR and EMPVAR are taken from the regression of the logarithm of monthly employment on a linear time trend. EMPVAR is the mean square error of the regression (x100). EMPGR is the annual equivalent of the time trend coefficient. *TECH is a translog index of industry* total factor productivity growth. A range of values appear whenever 3-digit industry level estimates of TECH are reported.

IV. EMPIRICAL FINDINGS

Regression estimates of wage models (1) and (2) are reported in Table 2. Using a wage model that excludes job tenure (TEN), the returns to general experience (EXP) are estimated to be 3.6 percent. However, as is apparent from regression (1), this figure overestimates the 'true' returns to experience. The inclusion of TEN reduces the estimates of the EXP coefficient to the 2.8 to 3.0 range. The accumulation of job tenure is associated with added wage effects over and beyond the effects of experience acquired both in the current firm and elsewhere. The linear wage effects of each extra year of TEN averages about 1.5 per cent.

Most of the other variables have the expected sign, and generally appear to be fairly insensitive to the inclusion of other explanatory variables. Increased schooling attainment, white collar occupations and SMSA residence are associated with significant wage premiums. The black-white wage differential is estimated to be 14 percent.

The wage effects of unions and firm size, though not central to the paper [1], are nonetheless of considerable interest. In (1), union membership is associated with a wage premium of 13 per cent, consistent with other findings in the literature (for example, see Johnson 1975). However, this finding is sensitive to the inclusion of firm size variables and their interactions with UNION in regression (2). Union effects vary systematically across firm size. The union effect in small firms employing less than 25 workers (the reference group) is large -- about 27 per cent -- but this disappears in the largest firms with over

[1] The relationship between firm size and unionism is investigated in greater depth by Mellow (1981), using data from the 1979 CPS.

1000 employees. The free-rider problem may be pertinent here. Large nonunion firms may match union wage premiums to counter the threat of unionization. Small, and presumable less visible, nonunion firms may be under less pressure to do so. In any case, this finding suggests that union wage effects reported by other research are misleading since employer size is seldom controlled for adequately.

Firm size has a large independent effect on wages. Employees in the largest firms receive wage premiums of about 25 percent relative to the smallest firm size category. Firm size dummy variables were also interacted with tenure to test the predictions that specific training investments and agency problems are more important in large firms. No evidence was found to support these views: F-tests revealed that firm size-tenure interactions (not reported in Table 2) were not significantly different from zero. This result is surprising. Similar analyses in Japan have found a strong positive relationship between wage-tenure profiles and firm size. A more thorough investigation of this finding is needed but is beyond the scope of this paper.

The results of regression (3) suggest that compensating wage differentials are paid in industries with high employment variability. Evaluated at the mean of EMPVAR, this wage premium is around 1.5 percent; a standard deviation change in EMPVAR is associated with premiums and discounts of about 3.5 percent. These effects, though small, are still within the range of compensating wage differentials reported by Abowd and Ashenfelter. Of more direct interest to the paper are the wage effects of TECH, EMPGR and their interactions with the TEN variable. Consistent with the specific training hypothesis, a negative

Table 2

Estimates of the Wage Model
(dependent variable=ln(hourly wage); sample=9917)

Explanatory Variables	Mean (s.d.)	(1) coef.	(1) t	(2) coef.	(2) t	(3) coef.	(3) t
Intercept		.8228	(32.3)	.8060	(31.7)	.9128	(31.0)
Schooling (S)	12.954 [2.91]	.0457	(25.7)	.0422	(23.9)	.0435	(24.6)
Experience (EXP)	16.514 [13.32]	.0298	(27.3)	.0288	(26.9)	.0278	(26.1)
EXPSQ (/100)		-.0596	(23.5)	-.0571	(22.9)	-.0547	(22.0)
Tenure (TEN)	8.281 [8.81]	.0168	(11.4)	.0141	(9.7)	.0104	(5.6)
TENSQ (/100)		-.0259	(5.8)	-.0224	(5.1)	-.0104	(5.6)
BLACK	0.064	-.1416	(8.6)	-.1434	(8.9)	-.1445	(9.0)
WCOLAR	0.438	.1005	(10.2)	.1009	(10.4)	.1161	(11.9)
Census Region							
West	0.220	.1218	(10.2)	.1290	(11.0)	.1295	(11.1)
North-central	0.269	.0532	(4.7)	.0572	(5.2)	.0588	(5.4)
South	0.287	-.0103	(0.9)	-.0081	(0.7)	-.0093	(0.8)
SMSA	0.610	.0996	(12.2)	.0823	(10.2)	.0839	(10.5)
UNION	0.322	.1311	(14.4)	.2775	(15.7)	.2496	(14.2)
Firm Size							
25-99	0.236			.0788	(6.4)	.0775	(6.3)
100-499	0.211			.1564	(11.8)	.1470	(10.9)
500-1000	0.065			.1649	(7.6)	.1584	(7.4)
over 1000	0.157			.2641	(17.0)	.2565	(16.4)
UNION interactions							
25-99				-.1795	(7.4)	-.1678	(7.0)
100-499				-.2335	(9.6)	-.2188	(9.0)
500-1000				-.1756	(5.0)	-.1603	(4.6)
over 1000				-.2836	(10.8)	-.2576	(9.8)
Empl. Variab. (EMPVAR)	0.577 [1.31]					.0259	(8.5)
Empl. Growth (EMPGR)	3.236 [1.36]					-.0365	(8.1)
Tech. Change (TECH)	0.299 [1.11]					-.0374	(6.9)
TEN interactions							
EMPGR	25.015 [30.17]					.0010	(3.0)
TECH	3.534 [15.04]					.0013	(3.2)
R-squared		0.3215		0.3469		0.3570	

Note: Absolute t-values in parentheses.

relationship is found between starting wages and wage-tenure profiles. More importantly, wage-tenure profiles vary systematically with the rate of employment growth and technical change: negative coefficients for EMPGR and TECH but positive coefficients for their interactions with the TEN variable. These results are robust. Further, F-tests showed that the partial wage effects of EMPGR and TECH, evaluated at the mean of TEN, were different from zero at the 1 percent level of significance.

Next we examine the question of how sensitive wage-tenure profiles are to variations in EMPGR and TECH. The intercept provides a useful reference point for evaluating the rate at which wages grow with years of tenure. Wage-tenure profiles are calculated for three cases: first evaluated at the mean values of EMPGR and TECH, and then for a standard deviation change in each of these variables. Note that these calculations incorporate the coefficients of EXP, TEN and their squared terms. The reason is that firms provide job training that may be partly general and partly firm specific. Take the case of industry j. The sum of the coefficients of TECH and EMPGR, evaluated at TECHj and EMPGRj, measures the extent to which starting wages in j are lower than the sample mean. The rate of wage growth with tenure is the sum of two sets of coefficients: first, those of EXP and EXPSQ, and second, those of TEN, TENSQ, and tenure interactions with TECH and EMPGR, again evaluated at the j values of these variables. The two sets of coefficients are interpreted as general training and specific training returns, respectively. The results of these computations are presented in Table 3.

Table 3

Wage-Tenure Profiles by Industry Rate of Employment Growth and Rate of Technical Change

dln(W)/dTEN = F(EXP,TEN,EMPGR,TECH) = F(Z)

Z Variables	Industry with mean EMPGR & TECH Case I	1 std. dev. increase in EMPGR Case II	1 std. dev. increase in TECH Case III
1.1 EMPGR	-0.1181	-0.1676	-0.1181
1.2 TECH	-0.0112	-0.0112	-0.0526
Intercept (1.1+1.2)	-0.1293	-0.1788	-0.1707
2.1 TEN	0.0104	0.0104	0.0104
2.2 EXP	0.0278	0.0278	0.0278
3.1 TEN*EMPGR	0.0032	0.0046	0.0032
3.2 TEN*TECH	0.0004	0.0004	0.0018
4.1 TENSQ	-0.0001	-0.0001	-0.0001
4.2 EXPSQ	-0.0005	-0.0005	-0.0005
Linear Wage Growth (2.1+2.2+3.1+3.2)	0.0418	0.0432	0.0432
Squared EXP & TEN (4.1+4.2)	-0.0006	-0.0006	-0.0006
Overtaking Point	3.3 Years	4.3 Years	4.2 Years

Source: Coefficients are taken from equation (3), Table 2, and evaluated at mean (std. dev.) EMPGR of 3.236 (1.358) and mean TECH of 0.299 (1.108).

Note: The returns to each added year of tenure are the sum of returns to TEN and to EXP spent in the firm.

The first column (Case I) refers to the wage-tenure profile of an average male worker in the sample, that is, one currently employed in an industry with mean values of EMPGR and TECH. Note that we are controlling for the effects of other wage determinants. Starting wages in that industry are 12.9 percent lower than the grand mean, which translates into a wage rate of about $2.50 an hour. However, since wages grow by about 4.2 percent with each additional year of experience, the worker is able to make up for lower starting wages within 3.3 years. Increasing either EMPGR or TECH by one standard deviation produces sizable changes in wage-tenure profiles: starting wages are now 17 percent lower than the sample mean, or a wage rate of $2.10 an hour. Wage growth with tenure, on the other hand, is only increased marginally to 4.3 percent. As a result, the 'overtaking point' is not reached until after 4.3 years of tenure in the firm.

THE LENGTH OF IMPLICIT EMPLOYMENT CONTRACTS

The estimated wage-tenure profiles can be used to provide insights into how the lengths of *implicit employment* contracts vary with different training strategies. General training, which is easily transferred to other employers and therefore produces *no* 'locking-in' effects, is not pertinent to this analysis. Thus, we focus only on specific training. If markets are assumed to be competitive, then internal rate of return calculations can be used to determine the discounting horizon required to yield a competitive rate of return for different investments in specific training. This horizon may be interpreted as the optimal length of an implicit employment contract.

Recall that wage model (2) permits a crude decomposition of the returns to specific and general training. The returns to general training are reflected in the coefficients of the EXP variables while specific training returns can be calculated from the coefficients of TEN and its interactions with TECH and EMPGR. Since the general training wage profile is constrained to be equal across individuals, interfirm variations in wage profiles may be attributed to differential investments in specific skills. The internal rate of return to specific training can be inferred from the following identity:

$$\sum^{N} \{ W(t) - GT(t) \}/(1 + r)^{(t-1)} = 0 \qquad (4)$$

where W(t) = the wage profile, GT(t) = the general training wage profile, r = internal rate of return, and N = length of the employment contract. GT(t) is calculated using the mean starting wage (anti-log of α_1) and the rate of wage growth with experience (from the coefficients of EXP and EXPSQ). W(t) profiles are readily calculated from Table 3 for each of the three cases. The costs and returns of specific training investments are, respectively, the sum of lower wages forgone (when W(t) < GT(t)) and higher wages received in subsequent years (when W(y) > GT(t)). For any interest rate r, equation (4) can be used to find the optimal N that equalizes the present values of costs and returns. Table 4 reports the estimated N for the three cases using a range of plausible interest rates.

For the range of interest rates considered, Table 4 suggests that the average male worker in the U.S. (Case I) is covered by an implicit employment contract of between 12 and 16 years. In Cases II and III, when EMPGR and TECH is increased by one standard deviation, the length of implicit employment contracts rises to between 15 and 27 years. On the surface, these estimates appear large but they are nonetheless quite consistent with Hall's findings on the importance of long-term jobs in the U.S. economy. What is perhaps surprising is the relatively small

Table 4

Length of Implicit Employment Contracts (N) for a Range of Interest Rates

(years)

Interest Rate	Optimal Contract Length Case I	Case II	Case III
10 pct.	12	16	15
15 pct.	13	17	16
20 pct.	14	20	19
25 pct.	16	27	24

Note: Case I is an industry with mean EMPGR and TECH; in Cases II and III, EMPGR and TECH are increased by one standard deviation, respectively.

increases in contract length N required to yield higher rates of return to specific training. For example, extending N by one year raises r from 10 to 15 percent; an additional four years increases the rate of return to 25 percent. The reason lies in the different time paths of wage growth with EXP and TEN. The general training wage profile is strongly quadratic in time, peaking at about 28 years.[2] Wage growth with tenure, on the other hand, is nearly linear so that the net difference between the two profiles fans out very rapidly after W(t) overtakes GT(t). Thus, small increases in N yield large wage gains requiring a higher discount rate to equalize costs and returns. This pattern of

[2] The maximum of the quadratic EXP function is readily calculated from Table 3 as (0.0278)/2x(0.0005)=28.

wage growth has the desired effects of deferring payments to later years and motivating long-term employment relationships. In and of itself, this result was not unexpected. What was unexpected was the extent to which specific training returns are shifted into the future. This finding further corroborates the specific human capital interpretation of long-term labor contracting.

One final question: Are observed labor turnover rates consistent with the predicted distribution of long-term employment contracts? From Table 1, EMPGR and TECH are used to select several industries into two groups on the basis of the predicted importance of long-term jobs in that industry. Attention is restricted to manufacturing industries since job separation data are collected only for this sector (Bureau of Labor 1980). Group I (high EMPGR and high TECH) includes instruments, rubber and plastics, electrical machinery and chemical products; group II (low EMPGR and low TECH) includes apparel, food products, primary metals and paper products. On average, annual gross turnover rates appear to be lower in group I (ranging from 1.7 to 4.9 percent) than in group II (2.5 to 6.6 percent).[3] Though not definitive, this pattern of turnover rates is consistent with the prediction that long-term jobs are more common in industries with high rates of employment growth and technical change.[4]

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[3] Group I labor turnover rates were 1.7 percent (chemicals), 2.5 percent (instruments), 3.2 percent (electrical machinery) and 4.9 percent (rubber and plastics); for group II, they were 2.5 percent (primary metals), 2.8 percent (paper products), 5.8 percent (apparel) and 6.6 percent (food products).

[4] One caveat is that the gross turnover figures used are for both males and females, and make no adjustments for differences in workforce composition across industries.

V. CONCLUSIONS

This paper presented a framework for distinguishing between the competing explanations of long-term contracting in the U.S.labor market. The empirical evidence suggests that wage-tenure profiles are positively and significantly related both to the rate of employment growth and to the rate of technical change. These findings are consistent with the hypothesis that investments in specific training are the underlying cause of implicit labor contracts. This in no way implies that incentive schemes are unimportant. On the contrary, agency and self-selection issues are likely to be critical to, and accompany, investments in specific human capital. Firms, who share the costs and returns of training, clearly have a stake in the employment stability and performance of their employees.

The results corroborate Hall's findings that an important segment of the U.S. labor force currently hold long-term jobs. Wage-tenure profiles estimated in this paper imply that the average male worker is covered by an implicit employment contract ranging between 12 and 16 years. Contract length is sensitive to variations in the rates of employment growth and technical change: for the range of interest rates considered, employment contracts increase from 15 years to over 25 years with a standard deviation change in each of these variables. Further, the observed pattern of labor turnover appears to be consistent with the interindustry distribution of long-term jobs predicted by the specific training hypotheses.

The link between technical change and wage growth has implications for the study of productivity growth. There is evidence that much of the productivity gains from introducing a new technology comes from making cumulative small modifications in it, essentially through a learning-by-doing process (Hollander 1965). If so, then innovative firms would use profit-sharing schemes and guarantees of continued employment to motivate worker investments in learning and internalize these more productive skills. Indeed, it has been argued that Japanese wage and lifetime employment practices complemented large R&D and new capital investments in facilitating rapid economic growth. This link between innovation and long-term labor contracting has received scant attention in the debate over the current productivity slowdown and merits additional research.

This paper has isolated two determinants of long-term employment contracts in the U.S. economy. Further research will undoubtedly refine our understanding of how this important labor market operates. However, one thing is clear. The widely held view that lifetime employment is peculiar to Japan, but not to the U.S., needs to be reconsidered.

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