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Productivy Growth and Tenure: A Test of on-the-Job Training Theories of Wage and Productivy Growth

Abstract

[Excerpt] Studies have found consistently that there is a strong positive correlation between a worker's tenure with a firm and that individual's wage rate. Becker's (1975) on-the-job training (OJT) model is the most widely accepted explanation for this association. The OJT model posits that new employees receive training early in their tenure, which raises their productivity both in and outside the firm. Competition forces the employer to pay employees who have completed this training at least as much as they are worth outside the firm less transfer costs. Jobs that offer such training are more attractive than jobs that do not, so competition forces down the entry wage of jobs that provide training below the entry wage of jobs that offer no training. During the training period, the supervisors and other workers are spending time away from other activities, helping the new employee learn the job. The new employee may also spend time in learning activities instead of production activities. In order to offer training, the employer must be compensated for the resulting sacrifice in current output. When the training provides general skills, the only way such compensation can be provided is by a further lowering of the entry wage. Thus, there are two forces that cause wage rates of new employees to rise: the increase of the employee's productivity and the decline of training expenses. When training is entirely specific, and therefore does not raise the worker's productivity in other firms, the forces causing a rising wage profile are weaker. They do not disappear, however, for a rising wage profile reduces the quit rate of trained workers, and thus protects the firm's investment in training.

Keywords

CAHRS, ILR, center, human resource, job, worker, advanced, labor market, worker tenure, wage rate, OJT, costs, training, employee, productivity, firm

Comments

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PRODUCTIVITY GROWTH AND TENURE: A TEST OF ON-THE-JOB TRAINING THEORIES OF WAGE AND PRODUCTIVITY GROWTH

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PRODUCTIVITY GROWTH AND TENURE: A TEST OF OJT THEORIES OF WAGE AND PRODUCTIVITY GROWTH

1.0 Introduction

Studies have found consistently that there is a strong positive correlation between a worker's tenure with a firm and that individual's wage rate. Becker's (1975) on-the-job training (OJT) model is the most widely accepted explanation for this association. The OJT model posits that new employees receive training early in their tenure, which raises their productivity both in and outside the firm. Competition forces the employer to pay employees who have completed this training at least as much as they are worth outside the firm less transfer costs. Jobs that offer such training are more attractive than jobs that do not, so competition forces down the entry wage of jobs that provide training below the entry wage of jobs that offer no training. During the training period, the supervisors and other workers are spending time away from other activities, helping the new employee learn the job. The new employee may also spend time in learning activities instead of production activities. In order to offer training, the employer must be compensated for the resulting sacrifice in current output. When the training provides general skills, the only way such compensation can be provided is by a further lowering of the entry wage. Thus, there are two forces that cause wage rates of new employees to rise: the increase of the employee's productivity and the decline of training expenses. When training is entirely specific, and therefore does not raise the worker's productivity in other firms, the forces causing a rising wage profile are weaker. They do not disappear, however, for a rising wage profile reduces the quit rate of trained workers, and thus protects the firm's investment in training.

Recently a number of papers have proposed alternate explanations of the positive correlation between tenure and wage rates. Salop and Salop (1976) have proposed that a rising wage profile may be a strategy for attracting workers with low quit propensities to a firm. Jovanovic (1979) has developed a job-matching theory of turnover which hypothesizes that workers remain in jobs in which their productivity is high and are fired (or quit) from jobs in which their productivity is low. He concludes that "since wages always equal expected marginal products for all workers, the model generates (an average) wage growth as tenure increases." (p. 974) A rising wage profile has also been shown to be a consequence of efforts to prevent shirking (Lazear 1981). Lazear and Moore tested this model and concluded that "under some strong assumptions, our conclusion . . . is that most of the slope of the age earnings profile reflects incentive based wealth and not human capital accumulation via on-the-job training." (Lazear and Moore 1981, p. 19)

The most persuasive attack on the dominance of the OJT explanation for wage growth comes from a series of papers by Medoff (1977) and by Medoff and Abraham (1980, 1981a, 1981b). Medoff and Abraham observed that "despite the straightforward nature of the test required to establish empirically the superiority of the human capital explanation of the experience-earnings profile over alternative models, . . . no one has ever provided evidence which demonstrates that experience-earnings differentials can in fact be explained by experience-productivity differentials" (1981a, p. 187). Using microdata from the personnel records of four large United States corporations, Medoff and Abraham found that while within a grade level there is a positive association between wage rate and experience, there is a negative association between performance rating and experience. They concluded that "under the assumption that rated performance is a valid indicator of relative productivity, our results imply that a substantial fraction of the return to experience among the groups we are studying is unrelated to productivity" (1981a, p. 187). Medoff and Abraham also reviewed a large number of other studies and concluded that employees with less-than-average seniority who are beyond the initial very short orientation/training period are normally slightly more productive than workers with more than average senority (Medoff and Abraham 1981a). Most of the studies reviewed were either of unionized employees or of employees in large corporations.

Except for Medoff-Abraham, tests of Becker's OJT hypothesis have usually estimated only the wage-tenure profiles with the presumption that added tenure is a proxy for added OJT. Actually, there are several implicit subhypotheses which also need to be examined:

1. an increase in tenure leads to an increase in OJT;
2. an increase in OJT leads to an increase in productivity; and
3. an increase in productivity leads to an increase in wage rates.

Prior studies have lacked data to test these relationships, but this study is significant in having a national sample of individual data on wage rates, reported productivity, tenure, and time spent by peers and managers in training an employee in the first month on the job. After the first month, we do not have an explicit measure of OJT, but we do have measures of reported relative productivity. These data and appropriately specified econometric models (that correct for selection bias that may result from turnover) enable us to test the latter two of the three subhypotheses listed above.

1.1 Data

This analysis will make use of a unique data set on 3,416 recently hired employees in approximately as many different firms. Descriptive statistics are presented in table 1. The data set is unique because it is based on interviews conducted with the new worker's employer, and therefore contains information on the firm, the job, and the employer's opinion of the employee. Such data have not been available to previous studies of job turnover and wage growth. The sample of recently hired workers was obtained by asking a stratified random sample of employers to provide information on an unskilled or semiskilled new hire who was hired between January 1, 1978 and October 1, 1979. (A description of the employer survey and its sampling frame are available upon request from the authors.) An unskilled or semiskilled worker was defined as a sales worker in the retail or service industries or a laborer, service worker, operative, or clerical worker in any industry. The employer was asked to select the most recently hired employee fitting this description regardless of whether the individual was still with the firm. A series of thirty-five questions was asked about this new employee. If the firm had hired a worker for whom it received a subsidy from TJTC, WIN, or CETA-OJT in the last two years, it was asked to answer a parallel set of questions about this worker.[1] The sample we analyzed includes 391 workers subsidized by CETA-OJT, 44 subsidized by TJTC, and 43 subsidized by WIN.

One of the more unique elements of this data set is its measurement of the employer's opinion of the productivity of a recently hired new employee. A productivity rating was assigned to each employee at two different points in time by asking the employer or supervisor the following question, "If you consider the productivity of an average-experienced worker in this job to be 50 on a scale from 1 to 100, what rating would you give NAME for (his/her) productivity during (his/her) second week of employment?"

Comparable productivity ratings for a period of six to twenty-four months later were obtained for workers that remained with the firm by asking an identical question about current performance. A similar question was asked about the productivity of the separating worker just prior to separation. Note that all of these questions ask for a comparison between a particular worker and an average-experienced worker. They are not attempting to measure productivity in any absolute sense. They provide an ordinal indicator of the relative productivity of different workers in the same job or of the same worker at different points in time as perceived by the employer or supervisor.

1.2 Correcting for Selection Bias

In estimating a wage growth equation for workers in our sample, we are faced with a complex missing data problem. Since many of the workers for whom we have data were no longer with the firm at the time of final contact (i.e., they had quit or were terminated), we do not observe wage growth for all workers. If the worker's presence/absence is not the result of a random process, the distribution of wage growth values becomes truncated (or censored). If ordinary least squares is applied to the subsample of workers still at the firm, parameter estimates will be conditional on the presence of the worker. Consequently, estimates of the effects of changes in policy-related variables on wage growth will be subject to a potentially serious selection bias.

If we had a perfect measure of the probability that a given worker was at the firm at last contact, we could use this predictor as a regressor in the

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1. These acronyms refer to the following programs: Targeted Jobs Tax Credit (TJTC), Work Incentive Tax Credit (WIN) for recipients of Aid to Families with Dependent Children, and the on-the-job training subsidies funded by the Comprehensive Employment Training Act (CETA-OJT).

wage growth equation, thus relieving the parameter estimates of the condition mentioned previously. We do not have such a measure, however, and if there are unobservable characteristics of the worker or firm that influence both the probability of still being at the firm and the wage growth of the worker, then this probability will be correlated with the error term in the wage growth equation, thus violating one of the more crucial assumptions of ordinary least squares.

To circumvent the potential selection bias problem, we adapt a strategy similar to that of Heckman (1979). Heckman shows that while using a censored sample of workers still at the firm, the missing data problem can be reformulated as a specification error resulting from the omission of an important control variable, λ, defined as

$$(1)\quad \lambda = \frac{\theta(Z)}{1-\emptyset(Z)}$$

where θ and $\emptyset$ are respectively the density and distribution functions for the standard normal variable Z. Z is defined as $-\beta X$ where X is a vector of independent variables and B are associated coeffiecient estimates from a first stage probit model of the probability of having two wage observations.

Heckman's technique has the advantage of (1) allowing consistent estimation using only workers with accurately measured wage growth and (2) taking into account the possibility of unmeasured variables affecting both the selection equation (Is the worker still with the firm?) and the outcome equation of interest (What has the worker's wage growth been?). As long as data are available on all workers, regardless of current status, a first stage probit can furnish $-\beta X$ (and thus Z), needed to construct λ.

Care must be taken, however, if the same set of independent variables is used both in the probit and the wage growth regressions. It can be seen from equation (1) that λ is simply an algebraic transformation of the predicted probability of being at the firm, obtained in the probit procedure. This probability is in turn a function of the independent variables. Now, in theory there is no identification problem in the system, since the probit utilizes a different functional form than does the wage growth equation. In practice, however, λ often can be highly correlated with other explanatory variables in the wage growth regression, resulting in problems of collinearity, or in extreme cases, an ill-conditioned X-prime-X matrix.

2.0 Productivity Growth Results

In this section we analyze the determinants of productivity growth. Our dependent variable is the change in the index of relative productivity multiplied by 100. The mean of the variable is 15.77 points for all workers and 19.86 for those who remain with the firm. The mean of the index of relative productivity for those still at the firm at the time of the interview is 76.4 points.

TABLE 1

VARIABLE DEFINITIONS AND DESCRIPTIVE STATISTICS

VARIABLE	MEAN	STANDARD DEVIATION	DESCRIPTION
Worker Characteristics			
Education	12.029	1.689	Years of schooling when hired
Experience	43.340	67.330	Months of prior relevant job experience
Age	27.497	10.161	Age when hired
Age-Squared ÷ 100	859.311	722.548	
Male	0.483	0.499	Sex dummy; 1 = male, 0 = female
Characteristics of Firm-Worker Match			
Relative Wage Ratio	0.620	0.263	Current starting wage for this job divided by average market wage in manufacturing for 1977-1979
Selection Investment	6.260	23.280	Hours spent recruiting, screening, and interviewing applicants for the job
Training by Management	20.103	25.448	Hours spent orienting and training new employee by management personnel in the first month
Training by Peers	14.426	23.089	Hours spent orienting and training new employee by nonmanagement personnel in the first month
Productivity 2nd Week	0.564	0.221	Productivity level of employee at second week of employment; ranges from 0 to 1
Productivity 2nd Week Interacted with Log of Estab. Size	1.734	1.071	Productivity at 2nd week multiplied by log of of firm size, December 1979
Productivity 2nd Week x Proportion Unionized	0.057	0.162	Productivity at 2nd week multiplied by proportion of workers unionized
Growth of Productivity	0.202	0.165	Difference between current and initial productivity
White-Collar Job	0.478	0.499	Equals 1 if white-collar job (as defined by census code); 0 otherwise
Subsidy Programs			
TJTC	0.014	0.120	Equals 1 if employee is eligible for TJTC: 0 otherwise
WIN	0.011	0.107	Equals 1 if employee is eligible for WIN: 0 otherwise
CETA/OJT	0.063	0.244	Equals 1 if employee is eligible for CETA/OJT; 0 otherwise
Employer Characteristics			
Log Establishment Size	3.134	1.528	Log of the number of employees at establishment in December 1979
Log Establishment Size above 50	0.323	0.680	Log establishment size minus log 50 if employment is GT 50; 0 if employment LT 50
Proportion Unionized	0.111	0.289	Proportion of employees unionized
Proportion White-Collar	0.464	0.352	Proportion of employees in white-collar jobs
Proportion Craft	0.160	0.241	Proportion of employees in craft jobs
Market Characteristics			
Log Market Wage	1.889	0.133	Log of average market wage in manufacturing, from 1977-1979
Change Market Employment	0.083	0.040	Change in local labor market employment, 1977-1979
Log Market Size	11.303	1.330	Log of employment in local labor market

Table 2 presents the results of estimating our model on two different samples. The first two models present the results when the full sample is used. The full sample includes workers who left the firm before the survey interview date, as well as workers who were still at the firm on the interview date. The longer a worker is at the firm, the more effective that individual is likely to become so the actual tenure at the time of the second measurement of productivity is included as a control variable. Since, however, slow learners are more likely to leave the firm and therefore have short tenure, coefficients on the tenure variables may be biased. One way to avoid this bias is to limit the sample to workers who have not left the firm. Models of this type are subject to another type of bias: selection bias. Mechanisms are available for correcting this bias, however. Model 3 corrects for selection bias by entering the inverse of the Mills ratio derived from a probit model of job retention.

2.1 The Time Pattern of Productivity and Wage Growth

Medoff and Abraham (1981a, 1981b) have presented persuasive evidence that in large firms the most senior employees are often somewhat less productive than the less senior employees found in the same position. In the first year or so of employment, however, the answers we obtained to questions about productivity growth imply significant increases (15.77) over the course of the first year. There is no contradiction between these two findings for they refer to quite different segments of the tenure-productivity relationship.

Is there evidence in our data of a slowdown in the rate of productivity growth as tenure increases? Yes, there is strong evidence of such a slowdown. Because it controls for inputs of training time and productivity in the second week, model 2 provides a better measure of the time pattern of productivity growth than model 1. The coefficients on the tenure splines imply that the productivity index rises at a rate of 1.05 points per month in the first three months of employment, at a rate of 3.09 points per month in the next three months, at a rate of .72 points per month in the next six months, and at a rate of .36 points per month thereafter. The decline in the rate of growth of the productivity index is statistically significant. If we assume that the productivity index is a proportional transformation of true productivity, percentage rates of increase may be calculated. They are 1.9 percent per month in the first three months, 5.4 percent per month in the next three months, 1.1 percent per month in the next six months, and .55 percent per month thereafter. These rates of increase are quite substantial. Even the rate of increase for the period after one year is impressive: 6.6 percent per year.

As previously mentioned the coefficients on the tenure variables in model 2 are likely to be biased. Model 3 was estimated using data from stayers only so it is not subject to potential simultaneous equation bias. The number of observations having fewer than six months of tenure is too small to produce stable estiates of tenure slopes during the first six months of employment, however, so we will focus on the period after six months of employment. For the period beyond six months, model 3 is a potentially useful check on our

TABLE 2

THE DETERMINANTS OF CHANGE IN THE PRODUCTIVITY INDEX

	Full Sample				Stayers	
	Model 1		Model 2		Model 3	
Worker Characteristics						
Education LT 4	2.25	(.12)	-11.82	(.70)	-18.58	(.97)
Yrs of Education	- .79	(.35)	- 2.10	(1.00)	- 2.94	(1.24)
Yrs of Education GT 8	1.54	(.61)	3.39	(1.42)	4.12	(1.55)
Yrs of Education GT 12	- .37	(.68)	- 1.01	(2.00)	.89	(1.65)
Experience + 100	-2.89	(2.54)	.42	(.40)	1.72	(1.47)
Experience Squared + 10,000	.72	(2.06)	.13	(.42)	.28	(.77)
Age	- .31	(1.67)	- .15	(.86)	- .04	(.23)
Age Squared	.003	(1.27)	.002	(.68)	.001	(.31)
Male	-1.29	(1.96)	- .77	(1.12)	- 1.32	(1.75)
Characteristics of Firm-Worker Match						
Selection Investment	--	--	.000	(.05)	.003	(.20)
Training by Management	--	--	.050	(4.66)	.087	(7.21)
Training by Peers	--	--	.025	(2.12)	.039	(3.00)
Productivity Index 2nd Week	--	--	- .32	(25.37)	- .33	(17.94)
Subsidy Programs						
TJTC	1.51	(.60)	- .43	(.20)	- .18	(.08)
WIN	-1.23	(.49)	- 3.16	(1.37)	- 3.91	(1.40)
CETA-OJT	1.48	(1.59)	- 2.10	(2.36)	- 6.96	(3.10)
Employer Characteristics						
Log Establishment Size	.87	(2.86)	.85	(2.95)	2.30	(3.78)
Log Establishment Size GT 50	.05	(.06)	- .70	(1.01)	- 1.77	(2.22)
Proportion Unionized	.75	(.63)	.97	(.86)	.24	(.21)
Proportion White Collar	4.41	(4.52)	1.43	(1.51)	1.38	(.96)
Proportion Craft	2.67	(2.04)	.38	(.31)	1.38	(.96)
Market Characteristics						
Log Market Wage	-1.05	(.47)	- 2.66	(1.23)	- 2.26	(.96)
Change Market Employment	--	--	- 2.21	(.32)	5.39	(.74)
Tenure Variables						
Actual Tenure + 100	.003	(.14)	.035	(1.63)	.041	(.70)
Tenure GT 3 months + 100	.105	(3.23)	.068	(2.23)	- .097	(1.30)
Tenure GT 6 months + 100	- .075	(4.48)	- .079	(5.02)	.059	(2.18)
Tenure GT 12 months + 100	- .016	(2.12)	- .012	(1.70)	.005	(.65)
Lambda	--	--	--	--	17.01	(3.78)
Dummies for Industry	X		X		X	
Job Requirements			X		X	
Dummies for Wage Rate	X		X		X	
R Square	.120		.276		.350	

model 2 findings. The slopes are .12 percent per month for month six through twelve and .30 percent per month (3.5 percent per year) thereafter. Neither of these slopes are significantly different from zero so we cannot reject the hypothesis that the slope is negative. The point estimates, however, suggest that the point at which productivity starts declining with tenure has not been reached in our data (166 of the 2,248 observations in the stayer sample have two or more years of tenure.)

The growth rate of wage rates during these time intervals are rather similar to these calculated productivity growth rates. Wage rates grew 0.36 percent per month between the sixth and twelfth month and 0.49 percent per month thereafter (see table 3). The data does not reject the hypothesis that the growth rates of wages and productivity are the same in corresponding time intervals. Some employers may have mistakenly reported the actual starting wage for that individual rather than the current starting wage for the job. If so, some observations are not adjusted for inflation of the scale wage and these measures of the growth of the real wage are upward biased.

2.2 The Impact of Worker, Employer, and Market Characteristics

Models 2 and 3 are structural models of the impacts of worker and employer characteristics that control for the worker's productivity in the second work week and the employer's training investments. Model 1 is a reduced form that does not control for job requirements, initial productivity, and the employer's training investments. The coefficients on worker and employer attributes in this model capture both the direct effects and the indirect effects that operate through initial productivity and employer investment decisions.

In the structural models, experience and education have small, positive effects on productivity growth that are generally not significant. The impact of age is negative, small, and statistically insignificant. The size of the establishment has a large, statistically significant impact upon productivity growth. The change of the productivity index for a new employee at a fifty-employee establishment is 7.4 points (2.7 points in model 2) greater than it is at a two-employee establishment. The change of the productivity index at a 500 employee establishment is 1.22 points greater than it is at a 50 employee establishment. None of the other characteristics of the employer or the market have a large or statistically significant impact on the change of the productivity index.

Training provided by the firm in the first month is associated with large statistically significant increases in growth of the productivity index. Management provided training seems to be twice as effective as peer provided training.

The reduced form model also yields interesting results. New hires with relevant previous experience generally have less to learn (have higher initial

TABLE 3

DETERMINANTS OF WAGE GROWTH

	Log Wage Growth	Log Wage Growth	Log Starting Wage
Worker Characteristics			
Education LT 4	-.48 (2.43)	-.47 (2.41)	-.36 (1.35)
Years of Education	-.054 (2.21)	-.056 (2.27)	-.038 (1.14)
Years of Education GT 8	.076 (2.81)	.80 (2.92)	.071 (1.89)
Years of Education GT 12	-.018 (3.27)	-.019 (3.39)	-.011 (1.44)
Experience ÷ 100	.024 (2.03)	.025 (2.12)	.111 (6.55)
Experience Squared ÷ 10,000	-.004 (1.19)	-.005 (1.30)	-.021 (4.27)
Age ÷ 10	.069 (3.64)	.065 (3.40)	.228 (8.21)
Age Squared ÷ 100	-.010 (3.84)	-.010 (3.66)	-.030 (7.61)
Male	.063 (8.13)	.063 (8.17)	.164 (15.31)
Characteristics of Firm Worker Match			
Selection Investment ÷ 100	-.011 (.71)		
Training by Management ÷ 100	.031 (2.49)		
Training by Peers ÷ 100	-.001 (.08)		
Productivity 2nd Week	.123 (3.19)	.056 (1.62)	
Change In Productivity Index	.173 (4.53)		
Size x Latest Productivity	-.020 (1.99)		
Size x Productivity 2nd Week		-.016 (1.76)	
Log Starting Wage	-.133 (10.58)	-.130 (10.41)	
Subsidy Programs			
TJTC	.004 (.05)	-.003 (.14)	-.021 (.54)
WIN	.016 (.56)	.008 (.61)	.024 (.03)
CETA-OJT	-.010 (.41)	.006 (.25)	-.022 (1.54)
Employer Characteristics			
Log Establishment Size	.026 (2.47)	.017 (1.95)	.018 (4.03)
Log Establishment Size GT 50	.008 (1.02)	-.005 (.67)	-.008 (.72)
Proportion Unionized	-.004 (.38)	-.005 (.43)	.251 (14.44)
Proportion White Collar	.027 (2.48)	.025 (2.26)	.108 (7.20)
Proportion Craft	.088 (5.91)	.087 (5.83)	.090 (4.46)
Market Characteristics			
Log Market Wage	.070 (2.91)	.071 (2.95)	.240 (7.02)
Change Market Employment	.205 (2.75)	.210 (2.80)	.352 (3.25)
Tenure Variables			
Tenure ÷ 100	.020 (1.00)	.027 (1.37)	
Tenure ET 6 mo ÷ 100	-.008 (.38)	-.012 (.56)	
Tenure GT 12 mo ÷ 100	.004 (.57)	.002 (.33)	
Lambda	.055 (1.14)	.031 (.69)	
Dummies for Industry	X	X	X
Job Requirements	X	X	X
R Square	.179	.165	.453

productivity) and require less employer investment. As a result the coefficient on experience that is positive in the structural models becomes negative and statistically significant in the reduced form model.

The reduced form model also implies that new hires at firms with high proportions of white-collar jobs and high proportions of craft jobs experience higher rates of productivity growth. None of the characteristics of the local labor market have a statistically significant effect on the change in our index of productivity.

3.0 Wage Growth

In this section we examine the determinants of the wage increases that new employees receive in the first year or so of their tenure at a firm. Our dependent variable, the logarithm of wage growth, has a mean of .118 and a standard deviation of .15. The models of growth that we will be analyzing are estimated using data on workers who were still at the firm at the time of our employer survey. The restricted nature of the sample implies that these models may be subject to selection bias. The procedure that was adopted for correcting this potential selection bias problem is described in section 1.2. The subsections that follow present the empirical findings. The impact of the measured productivity of the worker on the wage increases received is examined in section 3.1. The impact of other characteristics of the worker is discussed in section 3.2. The impacts of the employer's characteristics and the pressure of demand in the local labor market are presented in sections 3.3 and 3.4.

3.1 Impacts of the Employee's Productivity

The most important finding of this paper is the positive and significant impact of our index of productivity in the second week and the growth of the productivity index on the wage increases received by an employee (see table 3). Holding the growth of the productivity index constant, a one standard deviation increase in the index of productivity in the second week (an increase of .22 units) is associated with a 2.7 percent higher wage increase in firms with only one employee. Holding initial productivity constant, a similar increase in productivity growth is associated with a 4.0 percent higher wage increase in firms with only one employee. The interaction between the index of current productivity and firm size has a statistically significant negative impact on wage growth. This implies that the responsiveness of wage growth to the individual worker's relative productivity is greatest in small firms. The impact of a one standard deviation change in initial productivity on wage growth is 2.8 percent in a one-employee establishment, 1.0 percent in an establishment with 50 employees and zero in an establishment with 500 employees. The impact of a similar change in the index of productivity growth on wage growth is 4.0 percent in establishments with only one employee, 2.2 percent in establishments with 50 employees, and 1.1 percent in establishments with 500 employees.

Some simple models of wage setting predict that the individual's wage should be varied in proportion to his or her relative productivity. Our data suggest that this prediction does not square with reality. If we assume that the index of relative productivity is a proportional transformation of true relative productivity, the elasticity of the individual's current wage rate with respect to that person's true productivity implied the coefficients in model 1 is between .09 and .13 in the smallest establishments and correspondingly lower in larger establishments. If our productivity index is a more than proportionate transformation of true productivity (so that it exaggerates the proportionate size of productivity differentials between people and over time), or if the variance of measurement error is large relative to the variance of true productivity, .09 and .13 are downward biased estimates of the true underlying elasticity of current relative wage with respect to current relative productivity in very small firms. It seems unlikely, however, that correcting for these measurement problems would raise the estimate of the true elasticity in very small firms to unity. Even if the smallest firms had a relative wage-relative productivity elasticity of one, large firms would definitely have lower elasticities.

There are a number of plausible explanations for an elasticity of the relative wage with respect to true relative productivity of less than one. First, productivity differentials between workers at a firm might reflect differences in skills that are highly specific to the firm. If the worker is not able to translate high productivity at the current employer into a higher wage offer at another firm, the competitive pressure on the current employer to raise the individual's wage is reduced.

Second, even if all productivity differentials within the firm reflected differences in generalized competence, it is very difficult for other employers to measure these differentials accurately and thus base wage and job offers on them. Self-reports of one's productivity are necessarily treated with skepticism. If the worker is currently employed or on temporary layoff, the individual's employer has a positive incentive to speak very positively about the workers he wants to get rid of and negatively about the workers he wants to keep. The threat of legal action by ex-employees has caused many employers to establish a policy of handing out no information at all.

The third explanation is the high cost of accurately measuring a particular worker's productivity. In most jobs, objective indicators of productivity simply do not exist. This is why in November 1975, only 1.2 percent of the nation's workers were paid on a piece rate basis and only 1.9 percent on a pure commission basis (Flaim 1976). In most work environments productivity-based wage setting would have to use subjective evaluations by immediate supervisors. Top managements of large organizations legitimately fear that some line supervisors may abuse the power this kind of wage setting gives them. If a union represents the workers, the ability and inclination of management to adjust wages to productivity is reduced even further. As a result, large organizations greatly restrict the range over which wage rates may be varied. A supervisor's perception of a 50 percent productivity differential may translate into only a 1 or 2 percentage point differential in the wage increase that is awarded. Supervisors may also misperceive the criteria they are supposed to use. While we cannot prove it from our data, it is our view that it is the threat of unionization and the difficulty of insuring that supervisors will carry out instructions correctly that are responsible for the very weak connection between relative productivity and relative wage rates in large establishments. In small owner-managed firms, unions are not as much of a threat and the owner makes the decision about the wage to offer. Even if one trusted supervisors to be as fair as possible and employees believed the system was fair, supervisory ratings would not be perfectly correlated with true productivity. Optimal wage setting in such an environment would take into account the measurement error, and the elasticity of the wage rate with respect to measured productivity would be less than one.

The fourth reason for an elasticity below one is random month-to-month or year-to-year variations in productivity. Actual productivity will not be perfectly autocorrelated, so current productivity is an imperfect predictor of next period's productivity. If next period's wages are set equal to next period's expected productivity, the elasticity of the wage with respect to this period's productivity will be less than one.

3.3 The Impact of Workers' Qualifications

Education, experience, age, and being a male all have positive statistically significant effects upon both the level of the starting wage and the rate at which it grows in the first year or so of employment. Controlling for the characteristics of the job, the firm and the reported productivity of the worker reduces but does not eliminate the effects of these characteristics on wage growth.

The small size of the coefficients on our direct measures of productivity leaves room for these proxies for productivity--education, experience, and age--to have direct impacts on wage growth.[1] Our analysis of the determinants of productivity growth showed that both education and experience had small positive impacts on wage growth. How consistent are the coefficients on these productivity proxies in the wage growth equation with the corresponding coefficients in the productivity growth equation? A comparison can be made if we make an assumption about the scaling of the productivity index. Assuming that it is a proportional transformation of true productivity and a multiplicative error, the change in productivity growth divided by the mean level of productivity is a measure of percentage changes in productivity. In model 3 the change produced by a year of high school is 1.6 percent, by a year of college is 2.7 percent, by four rather than zero years of relevant experience is 1 percent, by being thirty rather than twenty years old is almost zero (.04 percent). The comparable coefficients in the model 1 wage equation are 2.2 percent for high school, 0.04 percent for college, 1.1 percent for four years of relevant experience, and 1.8 percent for being thirty rather than twenty. The effects of experience on the two outcomes were almost identical. The education coefficients seem similar and are not statistically different from each other.

The effect of age is, however, completely different in the two equations. Older workers are not growing more productive any faster than young workers and are not reported to be any more productive at the time of the interview, but they do get considerably larger wage increases and have higher starting wage rates as well. The hypothesis that age coefficients in the wage and productivity growth equations are the same, is rejected by the data (t = 2.43 assuming that the error variances of the two equations are uncorrelated). Sex also has dramatically different effects in the two equations. Men get a 6.3 percent greater wage increase than women but they seem to learn less quickly and their index of relative productivity is about 3 percent lower than women at the time of the interview.[2] The difference between the coefficients in the two equations is statistically significant (t = 6.37, assuming that error variances of the two equations are uncorrelated).

How much confidence can be placed in these findings? Our results depend upon potentially controversial assumptions about the validity and scaling of the index of relative productivity and on having successfully controlled for the characteristics of the job. The jobs that men and women get are generally quite different and our measures of job requirements may not have controlled for all these differences. Therefore, we do not view our findings as conclusive. They need to be checked in other data sets. Our findings about the effects of age are quite consistent with Medoff and Abraham's (1981a) findings. Our age-at-time-of-hiring variable corresponds closely to their years-of-precompany-experience variable. In all of the data sets they examined, they found that when grade level of the job is held constant, additional years of precompany experience were associated with significantly lower performance ratings and with significantly higher wage rates (p. 200, 201). Thus we feel there is good evidence that part of the tendency of wage rates to rise with age cannot be justified by a corresponding rise of productivity with age. In our data, age is rewarded with higher wage rates even when it is not associated with additional, previous, useful work experience. Additional years of previous, useful job experience are associated with being more productive, but controlling for this experience, age has almost no independent effect on the level of productivity and a negative effect on its rate of change. We have not been able to find any studies that have compared wage and productivity growth of males and females in the same job. More research is required before it can be established whether the effects that seem to be associated with the a job occupant's sex are truly an effect of sex or are actually an effect of the job (i.e., Do male typists and female construction workers receive different wage rates and promotions than others in their occupation?).

One possible explanation for this pattern may be that older workers and males have more attractive alternative opportunities, so competitive pressure to raise their wages is greater than it is for women and for young workers. Other possible explanations are that (a) men and older workers typically receive training that is more general, (b) their training is completed while the training of women and younger workers is continuing and will result in a catch-up wage increase in the near future, or (c) some firms display a taste for discriminating against women and young workers.

The receipt of a subsidy has no observable impact upon the rate of wage increase. The time that personnel and supervisory staff spend training the individual does seem to be associated with higher rates of wage increase.

Twenty extra hours of management training time increase wage growth by 0.62 percent, and the effect is significantly different from zero. Wage increases are not, however, affected by the amount of time that coworkers spend training the new employee. The tendency to reward management training time more than coworker training time is consistent with our earlier finding (in section 2.1) that management training time has a larger per hour impact on productivity growth than coworker training time. While the differences between the coefficients in the wage growth equations are larger, the data would not reject a hypothesis that the ratio of the coefficients in the productivity growth equation is equal to their ratio in the wage growth equation. Another possible explanation of the finding is that managers (the people who set wage scales and make promotion decisions) are more aware of the training that they and their staff provide and, therefore, tend to reward it more than the training provided by coworkers.

3.3 Impacts of Employer Characteristics

The size of the establishment has a large statistically significant effect on the rate at which wage rates increase. Establishments with only two employees typically offer wage increases that are 8.5 percent smaller than establishments with 50 employees. Establishments with 500 employees typically offer wage increases that are 4.2 percent higher than establishments with 50 employees. Here again coefficients on establishment size in the productivity growth equations are similar. Making the standard assumptions about the scaling of the productivity index, the productivity growth at establishments with two employees was 9.7 percent lower than the productivity growth at establishments with 50 employees. Productivity growth at establishments with 500 employees was 1.3 percent higher.

The proportion of the establishment's work force in white-collar occupations and the proportion in craft occupations both had large statistically significant impacts on wage growth. A two standard deviation increase in the proportion in white-collar occupations (a change of .70) raises the starting wage rate by 7.5 percent and the rate of wage growth by 1.9 percent. A two standard deviation increase in the proportion in craft occupations (a change of .48) raises the starting wage by 4.3 percent and the rate of wage growth by 4.2 percent. Unionization has no effect on the rate of wage growth but does have a large impact on the level of starting wages. Holding the characteristics of the job and the worker constant, starting wage rates at a unionized firm are typically 25 percent higher than those at a nonunion firm.

3.4 Impacts of Market Characteristics

Indicators of the availability and attractiveness of alternative job opportunities in the local labor market had large positive and significant effects on wage growth and on the level of the starting wage. A 10 percent higher local manufacturing wage was associated in our data with a 2.4 percent higher starting wage and a .7 percent larger wage increase. Workers in tight labor markets also get higher wage rates. The best measure of demand pressure in a labor market is the rate of growth of employment in that labor market. In labor markets with yearly growth rates of employment that are 4.1 percent greater than average (a change of two standard deviations), entry-level jobs typically pay 2.9 percent more and early wage increases are 1.7 percent higher.

CONCLUSION

This study has examined the effect of on-the-job training on the growth of reported productivity and wage rates. The data that is analyzed has been obtained from interviews with a sample of over 3500 employers geographically dispersed around the nation. The examination of the determinants of the growth of reported productivity yielded some very important findings. When initial productivity and training investments are controlled for in a structural model of the learning process, education, previous useful experience, and being female were associated with somewhat higher rates of productivity growth. These results suggest that the rate at which a new job is learned is greatest for women, for more educated workers, and for workers with significant amounts of previous useful job experience. Being younger is not associiated with being a faster learner. The only characteristic of the employer that had a statistically significant effect on the rate of learning was establishment size.

Models of wage growth were estimated that contained measures of reported productivity in the second week and changes in reported productivity. Wage rates were found to respond to the individual's reported productivity in small establishments but not in large establishments. The elasticity of this response is low, however, under .15. The weakness of the tendency of wage rates to reflect reported individual productivity has a number of causes: errors in measurement, the high costs of measuring productivity, random year-to-year variations in true productivity, and the fact that variations in productivity not visible to other firms need not be fully compensated.

Education, experience, age, and being male all have positive statistically significant effects on both the level of the starting wage and the rate at which it grows in the first year or so of employment. The positive effects of age and maleness on wage growth contrast sharply with their lack of impact on productivity growth. Firm characteristics that have a statistically significant positive impact on wage growth are size, proportion of white-collar workers, and proportion of craftworkers. The rate of growth of employment in the local labor market and level of the local manufacturing wage also had positive and significant effects on both the level and the rate of growth of wage rates. Participation in a subsidy program had no impact on either the wage level or its rate of growth.

NOTES

1. If there is no measurement error in our productivity index and if the true elasticity of relative wages with respect to relative productivity is 1, the productivity index should explain much of the within-firm variation of relative wages, and the coefficients on variables such as education, experience, and age should be close to zero.

2. Most men and women work in occupationally segregated jobs, so the referent for our index of relative productivity is generally going to be other workers of the same sex. Under these circumstances it is not clear what a correlation between sex and the level of the index of relative productivity means.