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THE EFFECTS OF LABOR MARKET EXPERIENCE, JOB SENIORITY, AND JOB MOBILITY ON WAGE GROWTH

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ABSTRACT

This paper studies the returns to seniority, the returns to experience, and the effects of seniority and experience at the time of a quit or layoff on changes in the job match specific component of wages. We show that these returns are not identified in widely used regression models that relate the wage changes of stayers, quits, and layoffs to tenure and experience. We deal with the identification of problems in two ways. First, we obtain theoretical bounds on key unidentified parameters using a simple model of wages and mobility. Second, we check the implications of assumptions about the linear tenure slope for the estimates of the returns to tenure, experience, and the effect of tenure on job match gains. We have three main empirical findings. First, there is a large return to general labor market experience that is independent of job shopping. Second, the return to tenure is probably above the Altonji and Shakotko's (1987) estimate but far below OLS estimates. Third, quits results in substantial job match gains for inexperienced workers. Layoffs are associated with the substantial job match losses for workers who have been on the job for over a year.

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I

INTRODUCTION

This paper studies the contribution of general labor market experience, job tenure (seniority) and job mobility to wage growth. We pay particular attention to the relationship between changes in the job match specific wage component resulting from a quit or a layoff and the levels of job seniority and experience when the job change occurs. There is of course a substantial literature on these issues, particularly the relationship between experience and wages over a career[1] and the relative contribution of experience, tenure, and job shopping to wage growth.[2] Several papers view job separations as voluntary quits and attempt to estimate the gain from quitting.[3] Other papers focus upon "displaced workers" and examine the relationship between labor market experience, job seniority, industry characteristics and the wage or earnings losses of workers who lose jobs due to layoffs or plant closings.[4]

Why then, do we need another paper? First, the literature is far from conclusive on the importance of seniority and general labor market experience, as a sequential reading of Mincer and Jovanovic (1981), Abraham and Farber (1987), Altonji and Shakotko (1987) and Topel (1991)

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[1] See for example, Mincer's (1974) classic work or the recent paper by Murphy and Welch (1989).

[2] See Mincer and Jovanovic (1981), Altonji and Shakotko (1987), Abraham and Farber (1987), Brown (1989), Williams (1991) and Topel (1991), to name just a few of the studies. Devine and Kiefer (1991) survey much of the literature relevant to the present paper.

[3] See Devine and Kiefer (1991).

[4] Recent examples include Hamermesh (1987), Addison and Portugal (1989), Kletzer (1989), Carrington (1990) and Topel (1990). Jacobson, LaLonde and Sullivan (forthcoming) survey the literature on dislocated workers. They also provide a detailed analysis of the earnings losses of job changers using panel data from the unemployment insurance system of the state of Pennsylvania.

will make clear. One purpose of this paper is to take yet another approach to estimating the wage-tenure profile in the presence of individual heterogeneity and job match heterogeneity. A second purpose of the paper is to provide a better understanding of what is identified and what is not identified in regression analyses of the wage changes of stayers, quits, and layoffs. We show that one cannot identify losses in specific capital or in general capital from such equations without a specific model of mobility. We provide a theoretical analysis of these issues that we supplement with simulation results. To our knowledge, simulation methods have not previously been used to study how the parameters of standard wage change regressions are affected by the job match productivity process, the magnitude of the relationship between tenure and productivity, and the division of match specific productivity components between the firm and worker. We take a small first step in this direction.

The heart of the paper is the empirical analysis of wage growth. We estimate the returns to seniority, the returns to experience, and the relationship between changes in the match specific component of wages and experience and seniority at the time of a quit or layoff. We start with a conventional wage equation in which wages are assumed to depend upon polynomials in labor market experience and tenure, a fixed individual specific error component, a fixed job match specific error component that changes only if the individual changes jobs, transitory error components, and other observed components. After taking first differences, the fixed individual effect disappears, but the change in the job match component remains in the equation for observations involving job changes. We use polynomials to approximate the expected change in the job match component conditional on a quit, a layoff, tenure, and prior experience. We then use the polynomial approximations to substitute out for the change in the job match component in the wage change equation. The coefficients on nonlinear terms in the wage-tenure profile are identified directly in the modified wage change equation and the problem of bias from fixed job match heterogeneity is eliminated. However, the four coefficients on the linear experience and tenure terms in the wage level equation and in the polynomial approximations for the expected change in the job match components in the event of a quit or layoff are underidentified by one common parameter. Without stronger assumptions one cannot identify the returns to general capital, the returns to tenure, and the relationship between tenure and the gains from quits and layoffs.

We deal with this ambiguity in three ways. First, we show what our estimates imply under a range of assumptions about the coefficient on the linear tenure term. Second, we note that upper and lower bounds for the linear tenure slope are obtained under the assumption that the change in the job match specific wage component is positively (negatively) related to prior tenure for quits (layoffs). We provide a theoretical justification and some simulations to support this assumption. Third, we calculate the implications of our model for wage growth due to general human capital accumulation, job seniority, and the change in the job match specific component of wages. We show that if one believes that the general skills accumulated over 30 years in the labor market have a nonnegative return and/or that job match gains are 0 or negative for persons who are laid off with significant amounts of seniority, then the returns to tenure must be much lower than those implied by ordinary least squares estimates of the wage level equation. However, the returns may be economically significant. While we do not solve the identification problem, we display the data in a way that makes the implications of prior beliefs about the unidentified parameters clear.

The paper proceeds as follows. In section II we present an econometric model of wages and the gain from mobility. We analyze what is identified and what is not identified in the wage growth equations that we and others have worked with. In particular, we show that one cannot unscramble the factors underlying the wage gains and losses associated with quits and layoffs without more structure. In Section III we discuss a simple theoretical model of quits and layoffs that is similar to Hall and Lazear (1984) and Hashimoto and Yu (1980). We also simulate a version of the model. We draw conclusions about the likely relationship between changes in the job match wage component and the levels of tenure and prior experience at the time of a quit or a layoff. In section IV we discuss some econometric issues. In section V we discuss our sample from the 1975-1987 waves of the Panel Study of Income Dynamics. We present the results in section VI. In Section VII we present additional results based on an alternative estimation methodology. We summarize our main empirical finding and discuss a research agenda in Section VIII.

II

AN ECONOMETRIC MODEL OF WAGES AND THE GAIN FROM MOBILITY

Following a number of earlier papers we assume that the wage of person i in job j in period t is

$$W_{it} = Z_{ijt}\Gamma + b_0 EX_{it} + b_1 EX_{it}^2 + b_2 T_{it} + b_3 T_{it}^2 + b_4 OJ_{it} + \epsilon_i + \epsilon_{ij(t)} + u_{it} + \nu_{ijt} \quad , \qquad (2.1)$$

where W_{it} is the log real wage of person i in time t, Z_{ijt} is a set of other observed wage determinants, EX_{it} and EX_{it}^2 are labor market experience and labor market experience squared, T_{it} and T_{it}^2 are tenure with the employer and tenure squared, OJ_{it} is a tenure term that equals 1 if $T_{it} \geq 1$ and equals 0 otherwise, ϵ_i is a fixed individual specific error component, $\epsilon_{ij(t)}$

is a fixed job match specific error component, u_{it} is an individual specific transitory error component that is uncorrelated across individuals, and ν_{ijt} a transitory job match error component that is uncorrelated with u_{it}. (We consider a secular time trend and economy-wide wage disturbances later.)

The variable OJ_{it} allows for the possibility that the first year on the job is of special importance, as one might expect if investment in job specific skills is large during the orientation period and the first few months on the job. Wage growth over a career reflects accumulation of experience, growth in seniority within a given firm, and movement toward job matches with higher values of $\epsilon_{ij(t)}$. Wage changes from year to year reflect changes in experience and tenure as well as changes in $\epsilon_{ij(t)}$ for those who quit or are laid off. Wage changes also reflect movements in the error component ν_{ijt}, but for now we assume these movements are small or do not have a strong relationship with turnover behavior. Equation (2.1) is incomplete as a model of wage dynamics in the absence of a model for $\epsilon_{ij(t)}$.

Use of OLS to estimate the tenure and experience parameters of (2.1) is inappropriate for two key reasons that are well known in the literature. First, the tenure variables T_{it}, T_{it}^2, and OJ_{it} are likely to be positively correlated with ϵ_i.[5] This is because for a variety of reasons one would expect low productivity (low ϵ_i) individuals to have higher quit and layoff propensities, and tenure is a negative function of past quit and layoff behavior. Individual heterogeneity in the wage equation associated with ϵ_i will bias least squares estimates of the wage-tenure profile in the positive direction.

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[5] See Altonji and Shakotko (1987) for a discussion as well as evidence that estimates of ϵ_i and $\epsilon_{ij(t)}$ enter logit models for both quits and layoffs with negative signs. Abraham and Farber (1987) find that completed job tenure has a strong positive association with the level of wages on a job. See also Bishop (1990)

Second, the tenure variables may be positively correlated with the fixed job match error component $\epsilon_{ij(t)}$. The existence of differences in match quality across firm-worker pairs (see Jovanovic (1979) and Johnson (1978)), the presence of noncompetitive elements in the wage structure, and differences across firms in the optimal compensation level for a given type (see Katz' (1986) survey of the efficiency wage literature) all imply that individual workers face a distribution of wages. Workers will be less likely to quit high wage jobs than low wage jobs. Furthermore, if firms also share in the returns to a good match, $\epsilon_{ij(t)}$ will be negatively correlated with the layoff probability. This suggests that tenure is positively correlated with $\epsilon_{ij(t)}$. The positive correlation will tend to induce a positive bias in OLS estimates of the tenure coefficient in the wage equation. However, both job matching models and conventional search models (e.g., Burdett (1978)) imply that job shopping over the course of a career will induce a positive correlation between EX_{it} and $\epsilon_{ij(t)}$. Since T_{it} and EX_{it} are positively correlated, the overall effect of $\epsilon_{ij(t)}$ on the tenure slope and experience slopes is unclear, but they are likely to be biased.

First differencing (2.1) and noting that ΔEX_{it} equals 1 leads to the wage growth equation

$$(2.2)\quad \Delta W_{it} = \Delta Z_{it}^{*}\Gamma^{*} + b_0 + b_1 \Delta EX_{it}^2 + b_2 \Delta T_{it} + b_3 \Delta T_{it}^2 + b_4 \Delta 0J_{it} + \Delta\epsilon_{ij(t)} + \Delta u_{it} + \Delta\nu_{ijt} ,$$

where Z_{it}^{*} is the subvector of Z_{it} consisting of variables which change over time and Γ^{*} is the corresponding subvector of Γ.

The $\Delta\epsilon_{ij(t)}$ may be nonzero if worker i quits or is laid off. Let

$$(2.3)\quad E(\Delta\epsilon_{ij(t)} \mid Q_{it}, PEX_{ij(t-1)}, T_{it-1})$$

be the expected value of $\Delta\epsilon_{ij(t)}$ conditional on T_{it-1}, the level of experience prior to job j ($PEX_{ij(t-1)}$),[6] and a quit between t-1 and t ($Q_{it}=1$). Let

(2.4) $E(\Delta\epsilon_{ij(t)} | L_{it}, PEX_{ij(t-1)}, T_{it-1})$

be the corresponding equation in the event of a layoff ($L_{it}=1$). Then

$$(2.5)\ \Delta\epsilon_{ij(t)} = Q_{it}\, E(\Delta\epsilon_{ij(t)} | Q_{it}, PEX_{ij(t-1)}, T_{it-1}) + L_{it}\, E(\Delta\epsilon_{ij(t)} | L_{it}, PEX_{ij(t-1)}, T_{it-1}) + Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)}$$

where $Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)}$ is an error term that is uncorrelated with $PEX_{ij(t-1)}$, T_{it-1}, Q_{it}, and L_{it}, and $Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)}$ is equal to zero if the individual does not change jobs.[7]

Substituting into (2.2) leads to

$$(2.6)\quad \Delta W_{it} = \Delta Z_{it}^{*}\Gamma^{*} + b_0 + b_1\Delta EX_{it}^2 + b_2\Delta T_{it} + b_3\Delta T_{it}^2 + b_4\Delta 0J_{it} + Q_{it}\, E(\Delta\epsilon_{ij(t)} | Q_{it}, PEX_{ij(t-1)}, T_{it-1}) + L_{it}\, E(\Delta\epsilon_{ij(t)} | L_{it}, PEX_{ij(t-1)}, T_{it-1}) + Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)} + \Delta u_{it} + \Delta\nu_{ijt}$$

Suppose that the two conditional expectation functions are well approximated by the equations

$$(2.7)\ E(\Delta\epsilon_{ij(t)} | Q_{it}, PEX_{ij(t-1)}, T_{it-1}) = \left(d_0 PEX_{ij(t-1)} + d_1 + d_2 T_{it-1} + d_3 T_{it-1}^2 + d_4 0J_{it-1}\right) Q_{it}$$

and

$$(2.8)\ E(\Delta\epsilon_{ij(t)} | L_{it}, PEX_{ij(t-1)}, T_{it-1}) = \left(g_0 PEX_{ij(t-1)} + g_1 + g_2 T_{it-1} + g_3 T_{it-1}^2 + g_4 0J_{it-1}\right) L_{it}.$$

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[6] $PEX_{ij(t-1)} = EX_{it-1} - T_{it-1}$.

[7] This does not rule out the possibility that η and ξ are correlated with turnover behavior prior to the start of job j(t-1). Also, we should probably distinguish between types of layoffs. We do not do this because our sample size is thin as is.

(We add additional nonlinear terms in $PEX_{ij(t-1)}$ in the empirical work.)

Equations (2.7) and (2.8) and the fact that $\Delta\epsilon_{ij(t)}$ is identically 0 if the individual does not change jobs implies the following equation for $\Delta\epsilon_{ij(t)}$:

$$\begin{aligned} \Delta\epsilon_{ij(t)} = \; & d_0 Q_{it} PEX_{ij(t-1)} + d_1 Q_{it} + d_2 Q_{it} T_{it-1} + d_3 Q_{it} T_{it-1}^2 + d_4 Q_{it} OJ_{it-1} \\ & + g_0 L_{it} PEX_{ij(t-1)} + g_1 L_{it} + g_2 L_{it} T_{it-1} + g_3 L_{it} T_{it-1}^2 + g_4 L_{it} OJ_{it-1} \\ & + Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)} \; . \end{aligned} \tag{2.9}$$

The terms on the first two lines are uncorrelated with the error component $Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)}$ by virtue of (2.7) and (2.8).[8] Since the change in the tenure variables are a function of past tenure, particularly for those who separate, and since the change in EX_{it}^2 will be correlated with past experience and tenure, one will obtain biased estimates of the tenure and experience slopes using equation (2.2) unless one accounts for the fact that the expectation of $\Delta\epsilon_{ij(t)}$ is a function of past tenure and experience for those who experience a quit or layoff. Furthermore, the relationship between $\Delta\epsilon_{ij(t)}$ and tenure and experience at the time of a quit or layoff is of central interest.

It is therefore natural to consider using (2.9) to substitute out for $\Delta\epsilon_{ij(t)}$ in (2.2). This leads to

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[8] Note that if $Q_{it} = L_{it} = 0$, the equation states that $\Delta\epsilon_{ij(t)} = 0$, which reflects the fact that $\epsilon_{ij(t)}$ is fixed over the course of a job.

$$\Delta W_{it} = \Delta Z_{it}^{*}\Gamma^{*} + b_0 + b_1\Delta EX_{it}^2 + b_2\Delta T_{it} + b_3\Delta T_{it}^2 + b_4\Delta OJ_{it}$$

$$(2.10) \quad + d_0 Q_{it} PEX_{ij(t-1)} + d_1 Q_{it} + d_2 Q_{it} T_{it-1} + d_3 Q_{it} T_{it-1}^2 + d_4 Q_{it} OJ_{it-1}$$

$$+ g_0 L_{it} PEX_{ij(t-1)} + g_1 L_{it} + g_2 L_{it} T_{it-1} + g_3 L_{it} T_{it-1}^2 + g_4 L_{it} OJ_{it-1}$$

$$+ Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)} + \Delta u_{it} + \Delta \upsilon_{ijt} \ .$$

In (2.10) the tenure and experience terms are uncorrelated with the error term (ignoring complications associated with the error component $\Delta u_{it} + \Delta \upsilon_{ijt}$ which are discussed below). Unfortunately, the price of this "solution" to the endogeneity of the tenure and experience terms of (2.2) is the introduction of multicollinearity into the problem. The multicollinearity arises because of the following identity for ΔT_{it}:

$$(2.11) \quad \Delta T_{it} \equiv \left[1 - Q_{it} - L_{it}\right] + \left[Q_{it} + L_{it}\right]\left[\underline{T} - T_{it-1}\right] + \left[Q_{it} + L_{it}\right]\left[T_{it} - \underline{T}\right] \ ,$$

In (2.11) $\underline{T}$ is the mean of T_{ijt} conditional on a job change in the preceding year. The identity in (2.11) establishes that except for the term $[T_{it} - \underline{T}]$, ΔT_{it} is collinear with the constant term, Q_{it}, L_{it}, $Q_{it}T_{it-1}$, and $L_{it}T_{it-1}$ in equation (2.10). The variation in $[T_{it} - \underline{T}]$ is both too small and too unreliable given measurement error for $[T_{it} - \underline{T}]$ to be used to identify the effect of ΔT_{it}. Thus, for practical purposes the linear experience slope b_0, the linear tenure slope b_2 and coefficients d_2 and g_2 on $Q_{it}T_{it-1}$ and $L_{it}T_{it-1}$ in (2.7), (2.8) and (2.10) are not identified.

To see what can be estimated, one may use (2.11) to substitute out for ΔT_{it} in (2.10). After simplification this leads to

$$\Delta W_{it} = \Delta Z_{it}^{*}\Gamma^{*} + (b_0 + b_2) + b_1\Delta EX_{it}^2 + b_3\Delta T_{it}^2 + b_4\Delta OJ_{it}$$

$$+ d_0 Q_{it} PEX_{ij(t-1)} + d_3 Q_{it} T_{it-1}^2 + d_4 Q_{it} OJ_{it-1} + g_0 L_{it} PEX_{ij(t-1)}$$

$$(2.12) \qquad + g_3 L_{it} T_{it-1}^2 + g_4 L_{it} OJ_{it-1} + [d_1 - b_2(1-\underline{T})]Q_{it}$$

$$+ [g_1 - b_2(1-\underline{T})]L_{it} + (b_2 - d_2)(-Q_{it}T_{it-1}) + (b_2 - g_2)(-L_{it}T_{it-1})$$

$$+ Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)} + \Delta u_{it} + \Delta v_{ijt} + b_2(Q_{it} + L_{it})(T_{it} - \underline{T}) \quad .$$

The term $b_2[(Q_{it} + L_{it})(T_{it} - \underline{T})]$ will be treated as part of the error term and is of little consequence.

The coefficients on the nonlinear experience and tenure variables in the wage equations (2.1) and (2.10) are all identified directly in (2.12). Unfortunately, the linear experience and tenure coefficients (b_0 and b_2) are subsumed into the constant term of the equation. When a secular trend or year effects are allowed for, these coefficients are combined with estimates of the trend or year effects as well. Note, however, that the coefficients on $-Q_{it}T_{it-1}$ and $-L_{it}T_{it-1}$ provide estimates of (b_2-d_2) and (b_2-g_2), respectively. The parameters d_2 and g_2 are the coefficients of the linear tenure term on the expected value of $\Delta\epsilon_{ij(t)}$ in the event of a quit and in the event of a layoff, respectively.

Below, we examine a model of quits and layoffs to get implications about the likely sign of d_2 and g_2. We provide some theoretical support for the assumption that the expected value of $\Delta\epsilon_{ij(t)}$ is an increasing function of tenure at the time of a quit and a decreasing function of tenure at the time of a layoff, controlling for experience at the start of the job (PEX). This would imply that $d_2 \geq 0$ and that $g_2 \leq 0$ and

$$(b_2 - d_2) \le b_2 \le (b_2 - g_2) \quad .$$

In this case, the estimated coefficients for $-Q_{it}T_{it-1}$ and $-L_{it}T_{it-1}$ provide lower and upper bounds, respectively, for b_2.

Equations similar to (2.12) have frequently been estimated on samples of job losers, quits and in some cases combined samples, and the coefficients relating the wage gain to tenure and experience prior to the job change have been used to draw inferences about the returns to tenure.[9] However, the above discussion makes clear that one cannot use wage change equations to decompose wage changes associated with layoffs into the effect of lost human capital, losses in the value of general human capital, the change in the value of the match specific component, etc.. One cannot do so even if the layoffs are completely exogenous to the individual, as in the case of plant closings.

There are two problems. First, there will be a relationship between initial experience and $\Delta\epsilon_{ij(t)}$ even if general skill is unchanged when a separation occurs[10]. A relationship will arise because the conditional expectation of $\Delta\epsilon_{ij(t)}$ is likely to depend upon how many years the person had the opportunity to search before finding the prior job. Second, d_2 and g_2 are not identified separately from b_2, so one cannot decompose the relationship between T_{it-1} and ΔW_{it} into the value of lost tenure and the change in the fixed job match specific wage component. One must have a model of quits and layoffs to identify the wage parameters needed to draw conclusions about what is responsible for the wage changes associated with job mobility,

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9 Recent examples include Carrington (1990), Addison and Portugal (1989), and Topel (1990).

10 By general skill we mean the location of the distribution of the wages faced by the individual.

or about the extent to which the coefficients b_2-d_2 and b_2-g_2 will be biased as estimates of the linear component of the return to tenure.[11]

In the next section, we present a simple model of quits, layoffs, and wages, and simulate a version of the model to gain intuition about the form of equations (2.7) and (2.8).

III

WAGE CHANGES ASSOCIATED WITH QUITS AND LAYOFFS: THEORETICAL CONSIDERATIONS

III.1 Theoretical Framework

Let PV_{ijt} denote the present value of earnings associated with job j and ignore the effects of the stochastic component υ_{ijt}.

(3.1) $$PV_{ijt} = PV(PEX_{ij(t)}, T_{it}, \epsilon_{ij(t)}) \cdot$$

The wage equation (2.1) implies that PV is a positive function of T_{it} and $\epsilon_{ij(t)}$. Let the utility U_{ijt} of job j be

$$U_{ijt} = PV_{ijt} + v_{ijt} \quad ,$$

where v_{ijt} summarizes the value of nonwage aspects of job j for person i. Assuming for simplicity that v_{ijt} does not depend upon $\epsilon_{ij(t)}$ and is a nondecreasing function of T_{ijt}, then U_{ijt} is an increasing function of both T_{ijt} and $\epsilon_{ij(t)}$. A person quits if he receives an offer j′ which provides a higher

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[11] See Mortensen (1987) for a theoretical model of wages and quits which incorporates a stochastic job specific wage component but does not distinguish between quits and layoffs. Topel (1986) estimates a model that is similar to Mortensen's. See also Marshall and Zarkin (1987), who estimate a joint model of wage offers and separations with cross section data. They find only a small tenure effect, but their results imply that the reservation wage which workers require to stay with their current employer increases with tenure. This is a theoretical possibility if uncertainty about future wages in a job declines with tenure (the option value of the job decreases). However, we suspect heterogeneity bias underlies the result, which would call into question the wage equation estimates.

utility level than job j after allowing for mobility costs M. That is

$$(32)\quad \begin{aligned} Q_{it} &= 1 \;\text{ if } PV(PEX_{ij'(t)},0,\epsilon_{ij'(t)}) + v_{ij't} - PV(PEX_{ij(t)},T_{it},\epsilon_{ij(t)}) - v_{ijt} > M \\ Q_{it} &= 0 \;\text{ otherwise} \end{aligned}$$

In the above equation $PEX_{ij'(t)} = PEX_{ij(t)} + T_{it}$.

The expected value of $\Delta\epsilon_{ij(t)}$ in the event of a quit depends upon the joint distribution of $\epsilon_{ij(t)}$ and $\epsilon_{ij'(t)}$ conditional on the inequality above and $PEX_{ij(t)}$. Assume that the distribution of new offers does not depend on the tenure level. Note that the left-hand side of the inequality is a negative function of T_{it} if T has a positive effect on the wage in the current job. It is a positive function of $\epsilon_{ij'(t)}$ - $\epsilon_{ij(t)}$. As a result, the expectation of $\Delta\epsilon_{ij(t)}$ conditional on a quit is likely to be a positive function of T_{it}, since the quit condition is likely to be satisfied at high values of tenure only if $\Delta\epsilon_{ij(t)}$ is large. The strength of the relationship between the values of T_{it} and $\Delta\epsilon_{ij(t)}$ that lead to a quit depends positively on the effect of T_{it} on W_{it}.[12]

This is not the whole story however. Since the probability that a worker will have received a better offer by tenure level T_{it-1} is negatively related to $\epsilon_{ij(t-1)}$ for all tenure levels even if the true tenure effect on wages is 0, the distribution of $\epsilon_{ij(t-1)}$ given PEX_{it} and survival of the job through T_{it-1} periods is stochastically increasing in T_{it-1}. To see the implication of this, suppose that $(\epsilon_{ij(t-1)}|PEX_{it}, T_{it-1})$ has a log concave distribution and stochastically dominates $(\epsilon_{ij(t-1)}|PEX_{it}, T'_{it-1})$ if $T_{it-1} > T'_{it-1}$. Both are distributed independently of new offers $\epsilon_{ij'}$. Then

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[12] The relationship is re-enforced if mobility costs rise with total experience in a given geographic location. In this case, EX_{it} might have a positive partial effect on the expectation of $\Delta\epsilon_{ij(t)}$ in the event of a quit. The tenure term will pick up the effect on the expectation of $\Delta\epsilon_{ij(t)}$ of any increase in mobility costs with tenure or with experience. This is because we control for PEX rather than actual experience EX and EX increases one for one with tenure.

$$E\{ [(\epsilon_{ij(t-1)}|PEX_{it}, T_{it-1}) - \epsilon_{ij'}] \mid [(\epsilon_{ij(t-1)}|PEX_{it}, T_{it-1}) > \epsilon_{ij'}] \} >$$
$$E\{ [(\epsilon_{ij(t-1)}|PEX_{it}, T'_{it-1}) - \epsilon_{ij'}] \mid [(\epsilon_{ij(t-1)}|PEX_{it}, T'_{it-1}) > \epsilon_{ij'}] \}.$$

Consequently, the fact that jobs with high ϵ_{ij} tend to be the ones that last and are hard to substantially improve upon means that T_{it-1} could be *negatively* related to $E(\Delta\epsilon_{ij(t)}|Q_{it},PEX_{ij(t-1)},T_{it-1})$. A net positive relationship will arise when the true tenure effect on wages or the link between mobility costs and T is sufficiently positive. This is because the requirement that $\epsilon_{ij'}$ exceed $\epsilon_{ij(t-1)}$ plus the tenure related wage component is more stringent at higher tenure levels and will offset the above negative relationship induced by the outward shift in the distribution of $\epsilon_{ij(t-1)}$ among the surviving jobs.

The implications for the coefficient on the $Q_{it}T_{it-1}$ interaction terms in (2.9) and (2.12) are as follows. The linear term d_2 must be greater than 0 to insure a positive, monotonic relationship between $T_{ij(t)}$ and $E(\Delta\epsilon_{ij(t)}|Q_{it},PEX_{ij(t-1)},T_{it-1})$. The value of d_3, d_4, etc., may further constrain d_2. For example, if the coefficient d_3 on the quadratic term is sufficiently negative then the lower bound on d_2 that insures a monotonic relationship over the relevant range of tenure may be positive. However, if tenure has a negligible relation to wages and mobility costs, then tenure could have a negative relationship to $E(\Delta\epsilon_{ij(t)}|Q_{it},PEX_{ij(t-1)},T_{it-1})$ and d_2 could be negative.

We also have some comments on the relationship between $\Delta\epsilon_{ij(t)}$ and $PEX_{ij(t-1)}$. Since individuals with more experience prior to the start of the current job had more years in which to locate jobs in the right tail of the job offer distribution, the expected value of $\epsilon_{ij(t)}$ is a positive function of $PEX_{ij(t-1)}$, and one would expect that $PEX_{ij(t-1)}$ will have a negative partial effect on the expectation of $\Delta\epsilon_{ij(t)}$. On the other hand, we mentioned earlier that costs of job changes may rise with total experience if a change in geographic location is involved. In this case, $PEX_{ij(t-1)}$ might have a positive partial effect on the expectation of $\Delta\epsilon_{ij(t)}$. Overall, the sign of the effect of

$PEX_{ij(t-1)}$ on $\Delta\epsilon_{ij(t)}$ is ambiguous, although we would expect it to be negative.[13]

We now turn to the relationship between $E(\Delta\epsilon_{ij(t)})$ and tenure and experience in the event of a layoff. We use a simple layoff model that is motivated by Hashimoto and Yu (1980) and Hall and Lazear (1984). Let V_{ijt} denote the value of worker i to firm j. This is a function of the discounted expected value of current and future productivity net of wage payments to the worker. The discount factor depends on the interest rate and the probability that the firm or the worker will terminate the match in the future. Productivity depends on EX_{it} and T_{it} as well as an individual specific productivity factor p_i, a match component $\omega_{ij(t)}$ and a time varying component e_{ijt}. Competition among firms implies that the general productivity components p_i and EX_{it} are fully reflected in wage rates (i.e., $p_i = \epsilon_i$) and to a first approximation do not affect V_{ijt}. Workers and firms share in the returns to the match component. The wage component $\epsilon_{ij(t)}$ is the worker's share s_ω of $\omega_{ij(t)}$, with

$$\epsilon_{ij(t)} = S_\omega \omega_{ij(t)} \quad .$$

We sometimes write $\omega_{ij(t)}$ as ω_{ij} for simplicity. Consequently, V_{ijt} is a positive function of ω_{ij}. In general workers may also share in the returns to the time varying component e_{ijt}, and this sharing may be reflected in ν_{ijt}. However, we assume that because of risk aversion or costs of re-contracting and information (see Hall and Lazear and Hashimoto) firms bear most of the risk associated with e_{ijt}. This implies that V_{ijt} is a positive function of e_{ijt}.

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[13] Also, more experienced workers are closer to retirement and thus when comparing jobs may give more weight (than younger workers) to wage losses from lost tenure relative to a given increase in $\epsilon_{ij(t)}$. Note that the discussion of the firm's layoff decision ignores the fact that time until retirement may affect the value of a worker to a firm even after tenure and the quality of the job match are controlled for.

(In the simulations below we vary our assumptions about how much of the time varying component is shared.) Finally, assume that firms have a share in the costs and returns to specific capital investments, so V_{ijt} is a positive function of T_{it}. This discussion suggests that the value of the worker to the firm may be written as

$$V_{ijt} = V(\omega_{ij}, T_{it}, e_{ijt}) \ .$$

The partial derivatives of V with respect to all three arguments are positive.

The firm lays off the worker if V_{ijt} falls below the cost of terminating the worker.[14] Given that V_{ijt} increases with T_{it} and V_{ijt} must be positive at the time the worker is hired, a layoff occurs in t only if (1) e_{ijt} falls sufficiently below its value at the time the worker is hired and (2) the match had not already ended due to a quit or layoff in an earlier period. The probability that a layoff occurs at time t is a negative function of ω_{ij} regardless of the value of tenure at t. The distribution of ω_{ij} and $\epsilon_{ij(t)}$ is increasing in prior experience, but we hold that constant. For any tenure value the quit probability is also a negative function of $\epsilon_{ij(t)}$ and, therefore, a negative function of ω_{ij}. Consequently both quit and layoff behavior tends to select out the lower values of ω_{ij} and $\epsilon_{ij(t)}$ from the distribution of these variables conditional on initial experience. It follows that the distribution of ω_{ij} and thus $\epsilon_{ij(t)}$ conditional on $PEX_{ij(t)}$ and T_{it} is increasing in T_{it} for the subsample of jobs which end in a layoff in t as well as for the subsample which survive additional periods.

Layoffs occur if e_{ijt} falls sufficiently given the values of $\epsilon_{ij(t)}$ and T_{it}. Following the layoff the worker locates a new job j'. Under the assumption (mentioned previously) that the offer distribution does not depend on T_{it} the

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[14] Termination costs include severance pay and unemployment insurance and other factors. However, the layoff cost is not necessarily equal to the shadow price such that layoffs occur only if they maximize the joint utility of the worker and the firm.

above discussion suggests that $E(\epsilon_{ij'(t)} - \epsilon_{ij(t)}|L_{it},PEX_{it},T_{it})$ is a negative function of T_{it}.

The above discussion is not complete under the standard assumption that firms share in the returns as well as the costs of specific capital investment. In this case, productivity net of wages will be increasing in tenure holding everything else constant. Consequently, the higher tenure, the lower ω_{ij} and e_{ijt} must be for profits on the worker to become negative. Since $\epsilon_{ij(t)}$ is positively related to ω_{ij}, the implication is that for a given value of e_{ijt} the critical value of $\epsilon_{ij(t)}$ below which a layoff occurs will fall with tenure. The value of $\epsilon_{ij(t)}$ may be such that a job match is marginal from the point of view of the firm in the first few years. If the match survives the first few years due to a set of positive or 0 shocks to productivity, the accumulation of firm specific capital will make it unlikely that the match will end in a layoff later. This tends to induce a positive relationship between tenure and $E(\Delta\epsilon_{ij(t)}|L_{it},PEX_{ij(t-1)},T_{it-1})$. To the extent that the distribution of e_{ijt} spreads out with tenure, as more relatively permanent shocks accumulate, this selection effect is mitigated. Further, it is limited because job matches with values of $\epsilon_{ij(t)}$ that would result in a layoff after tenure has been accumulated are unlikely to survive the first few years of the match. Consequently, we expect based on this discussion that $E(\Delta\epsilon_{ij(t)}|L_{it},PEX_{ij(t-1)},T_{it-1})$ will be negatively related to T_{it-1}. The implication for the parameters g_1, g_2, g_3, etc., in the approximation (2.8) is that they should be consistent with a negative monotonic relationship. This implies that g_2 will be negative.

The partial effect of prior experience $PEX_{ij(t)}$ is likely to be negative because of job search. To see this, note that job shopping over the course of a career implies that at every tenure level the expected value of $\epsilon_{ij(t)}$ is a positive function of $PEX_{ij(t)}$, for reasons discussed earlier. However, in the event of a layoff the value of $\epsilon_{ij'(t)}$ associated with the job accepted by the worker does not rise with experience. Following a layoff the worker takes the best offer received during the period of job search even though it may be dominated by the ϵ_{ij} that are associated with jobs held by the worker in the past but are no longer available to him.

III.2 A Simulation Model

In this section we present a simple simulation model of productivity, wages, and turnover that is in the spirit of the model sketched above. We then simulate the model for various parameter values and draw conclusions about the form of $E(\Delta\epsilon_{ij(t)} \mid Q_{it}, PEX_{ij(t-1)}, T_{it-1})$ and

$E(\Delta\epsilon_{ij(t)} \mid L_{it}, PEX_{ij(t-1)}, T_{it-1})$.

Assume the marginal product of worker i in firm j in job t is

$$(3.3)\qquad \begin{aligned} P_{ijt} &= Z_{ijt}\Gamma + B_0 EX_{it} + B_2 T_{it} + B_4 OJ_{it} \\ &+ \epsilon_i + \omega_{ij(t)} + u_{it} + e_{ijt}\,, \end{aligned}$$

We consider the case in which e_{ijt} is a random walk with initial condition 0 on any new job match and an innovation that is $N(0, \sigma_e^2)$. We assume that the fixed job specific productivity component ω_{ij} is drawn from a normal distribution with mean μ_ω and variance σ_ω^2 that is truncated at 0.

Assume that wages are determined according to

$$(3.4)\qquad \begin{aligned} W_{ijt} &= Z_{ijt}\Gamma + B_0 EX_{it} + S_T[B_2 T_{it} + B_4 OJ_{it}] \\ &+ \epsilon_i + S_\omega \omega_{ij(t)} + u_{it} + S_e e_{ijt}\,, \end{aligned}$$

where S_T is the worker's share of the returns to seniority, S_ω is the worker's share of the returns to the job match component of productivity, and S_e is the worker's share of the time varying match specific component of productivity. The term υ_{ijt} in (2.1) is equal to $S_e e_{ijt}$.

We assume that wages fully reflect changes in productivity associated with labor market experience EX_{it}, the person specific productivity component ϵ_i, observed person specific variables in Z_{ijt} and the unobserved person specific component u_{it}.[15] Each period (including the first period) workers costlessly receive an outside offer with job match component $\epsilon_{ij'}$, where $\epsilon_{ij'} = S_\omega \omega_{ij'}$ and the ω are distributed as discussed above. Since the effect of tenure on wages is linear after the first year and the expected value of the innovations in the random walk components on the two jobs is 0, it follows that after the first year on the alternative job the expected difference in wages on the current job and the alternative job is

$$\epsilon_{ij'} - \epsilon_{ij} - S_e e_{ijt} - S_T B_2 T_{it} \tag{3.5}$$

We assume that the worker quits if

$$\epsilon_{ij'} - \epsilon_{ij} - S_e e_{ijt} - S_T B_2 T_{it} - (1-\delta) S_T B_4 > 0$$

where the discount parameter δ on the increment in wages following the first year on the job is included because the worker may not remain on the new job to experience the increase. This quit rule is only an approximation, as we discuss below.

The firm lays off the worker if productivity in the current period minus the wage rate becomes negative:

$$P_{ijt} - W_{ijt} = (1-S_T)[B_2 T_{it} + B_4 OJ_{it}] + (1-S_\omega)\omega_{ij(t)} + (1-S_e)e_{ijt} < 0 \ .$$

In addition, we also allow for exogenous layoffs that occur with probability .02 if a layoff or a quit does not occur for other reasons. We think of these

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[15] This may not be the case if firms provide insurance against health related or other changes in productivity or if the firm has private information about the worker's general productivity.

as business failures and assume that they are independent of P_{ijt}. If the firm plans a layoff and the worker plans a quit, we treat this as a quit.

The quit rule is only an approximation to the rule that maximizes expected income given the possibility of a future quit or layoff on the current job or on the alternative job. For example, suppose S_e is 0. A worker with a high value $\epsilon_{ij(t)}$ who knows that a layoff is likely because e_{ijt} is very negative may accept an offer that is above the mean for $\epsilon_{ij(t)'}$ but below $\epsilon_{ij(t)}$ rather than run the risk that a layoff will occur later at a time when he does not have a good outside offer.[16]

III.3 Simulation Results

We simulated the model for various sets of parameter values.[17] The results are presented in Table 1. Columns 1 to 5 list the parameter values of each experiment. S_ω is the worker's share of the returns to the job match component of productivity, and S_e is the worker's share of the time varying match specific component of productivity. We set S_T to .5 and δ =.85 in all of the simulations. Column 6 and 7 report the estimated quit rate and the estimated layoff rate, with cases in which both a quit and a layoff are indicated are indicated counted as quits. Columns 8 and 9 report the exogenous layoff rate (set to .019) and the endogenous layoff rate, including

[16] We have been able to get a closed form solutions to the optimal quit and layoff rules only in the case in which careers last at most 3 periods. We suspect that closed form solutions will be difficult to obtain in multiperiod cases unless the distributions of the random variables are severely restricted. A more promising approach is to use numerical methods to solve for the layoff and quit rules in the multiperiod case, but we leave this formidable undertaking to future research. Note that we are ignoring nonpecuniary preferences for jobs and assuming mobility costs and layoff costs are 0. These assumptions should be relaxed in future work.

[17] For each set of parameter values we use the model to generate data on 37 year careers for 5,000 individuals. The results in columns 10 to 19 of the table are based on separate regressions for quits and layoffs of the generated data on $\Delta\epsilon_{ij(t)}$ and Δv_{ijt} on an intercept, a cubic in T_{it-1}, a cubic in $PEX_{ij(t-1)}$, and OJ_{t-1}.

cases in which the model implies that the worker would quit. The numbers in bold in columns 10-19 are the mean of $\Delta\epsilon_{ij(t)} + \Delta\upsilon_{ijt} = S_{\omega}\Delta\omega_{ij(t)} + S_{e}\Delta e_{ijt}$. The numbers in italics are the job match gain, $\Delta\epsilon_{ij(t)} = S_{\omega}\Delta\omega_{ij(t)}$. The third set of numbers are the change in the random walk component, $\Delta\upsilon_{ijt} = S_{e}\Delta e_{ijt}$. Although much of the theoretical discussion focuses on $\Delta\epsilon_{ij(t)}$, we have elected to show the sum of the components because we argue in the next section that our estimates are likely to reflect the relationship between the sum of the components and job seniority and previous experience. When S_e is 0 this reduces to $\Delta\epsilon_{ij(t)}$ and $\Delta\upsilon_{ijt} = S_e e_{ijt} = 0$. Our main results are as follows. First, when the effect of tenure on productivity is 0 so that wages do not rise with seniority, (model 1, 5, 9, 13), there is a negative relationship between tenure at the time of a quit and $\Delta\epsilon_{ij(t)} + \Delta\upsilon_{ijt}$ in all instances and between tenure and $\Delta\epsilon_{ij(t)}$ in all instances except model 13, where the relationship is strongly negative when tenure is between 0 and 10 but turns positive when tenure is between 10 and 20. These results are basically consistent with the theoretical argument above when mobility costs and wages are unrelated to tenure. We have also estimated the 16 specifications with S_T set to .25 (instead of .5), so that the effect of tenure on wages is small even in the case in which B_4 is .1 and B_2 is .02. (Recall that $b_2 = S_T B_2$.) In this case the relationship between tenure and the expected wage gain associated with a quit is small in absolute value and often negative.

Second, when the effect of tenure on productivity is positive, so that wages do rise with seniority, the overall gain $\Delta\epsilon_{ij(t)} + \Delta\upsilon_{ijt}$ is a positive function of tenure at the time of a quit once tenure is greater than 0. The same is true of the fixed job match component $\Delta\epsilon_{ij(t)}$ in all cases except row 14, where the relationship is initially negative and then turns up. The magnitude of the relationship between $\Delta\epsilon_{ij(t)} + \Delta\upsilon_{ijt}$ is positively related to the effect of tenure on the wage rate, which is determined by S_T times B_2

and S_T times B_4. For example, the mean of the job match gain for a quit with 10 years of seniority is between .061 and .102 when the effect of tenure is 0, between .173 and .230 when the product of S_T and the linear tenure slope B_2 is .01 and the product of S_T and first year increase in productivity (B_4) is .05. The gain is between .382 and .436 when S_T times the linear tenure slope is .03 and S_T times the effect of the first year on the job is .05. The increase is approximately equal to the increase in the value of tenure that is given up in a quit. The relationship between $\Delta\epsilon_{ij(t)}$ and tenure is also positively related to the effect of tenure on the wage rate.[18]

The other main result is that the expected values of both $\Delta\epsilon_{ij(t)}$ and $\Delta\epsilon_{ij(t)} + \Delta\upsilon_{ijt}$ in the event of a layoff are negatively related to tenure on the previous job for all of the specifications through ten years of seniority, although there is a slight increase in the gain between 10 years of seniority and 20 years for several of the models. We do not understand the reason for this up turn, but suspect that it is related to the mix of endogenous and exogenous layoffs at the various tenure levels. Relatively few layoffs occur at high tenure levels. Not surprisingly, the endogenous layoff rate and the quit rate are strongly affected by the sharing parameters and the tenure parameters.

There are many ways in which the simulation model could be generalized. However, the basic finding for the cases that we have examined is that the relationship between wage growth and tenure understates the returns to tenure in the event of a quit except when the return to tenure is close to 0. The return to the first year of tenure may be overstated. The relationship between wage growth and tenure will overstate the returns to

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[18] An increase in the worker's share S_ω of the match specific error component from .5 to .8 tends to increase the gain in $\Delta\epsilon_{ij(t)} + \Delta\upsilon_{ijt}$ from quitting as well as the gain in $\Delta\epsilon_{ij(t)}$, which is not surprising. (Compare models 1-4 with 5-8 and 10-12 with 13-16). However, the tenure profile of the job match gain is not very sensitive to S_ω.

tenure in the event of a layoff, except possibly at high tenure levels. These conclusions are basically consistent with the theoretical arguments made above about the sign of d_2 and g_2.

IV
ECONOMETRIC ISSUES

This section discusses two possible sources of bias in the estimation of (2.12). The first is measurement error in the tenure variables. The second is the effect of the time varying error component $\Delta\upsilon_{ijt}$.

IV.1 Measurement Error

Measurement error in the tenure variables is a serious possibility, although the information on tenure and job changes is more complete in the 1980's than it is in the early years of the PSID, which we exclude from the analysis. Tenure with employer was not asked in 1975, 1979, and 1980 and was not asked of workers older than 45 in 1978. Furthermore, the responses are often inconsistent across years, and some workers who report a separation appear to go back to an employer in a subsequent year and report tenure as if the separation never occurred. As discussed in the data section and the data appendix, we have tried to make the best use of the available information. Despite our efforts, we believe that there is still significant measurement error in our estimates of the level of tenure, and it is likely that we miss some separations entirely and infer some separations that never happened. The resulting measurement error in the tenure variables is likely to bias downward both least squares estimates based on equation (2.1) and estimates based on (2.12).[19]

IV.2 Variation in ν_{ijt}

The time varying job match specific error component $\Delta\nu_{ijt}$ may also induce bias. If ν_{ijt} is serially uncorrelated, then this variable is unlikely to have a large effect on mobility decisions, since it does not have a large effect on the present value of the earning stream associated with a particular job. However, job specific changes in product demand or production technology as well as personnel shifts may induce serially correlated shifts in the job specific component of the worker's marginal product. Also, the firm may gradually learn about the match specific component of productivity.[20] In the discussion of layoffs above, these factors were represented by e_{ijt}. These shifts may be partially reflected in W_{it} through the term ν_{ijt}.

One may argue along the lines of Section III that the expected value of $\Delta\epsilon_{ij(t)} + \Delta\nu_{ijt}$ is an increasing function of T_{it-1} in the event of a quit when the tenure slope of wages is substantial. The simulations support this argument. The relationship between the expected value of $\Delta\nu_{ijt}$ and T_{it-1} is

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[19] Difficulties with the tenure data are well known. Brown and Light (1992) provide a thorough and somewhat harrowing account of the quality of the data on job seniority and job mobility from the PSID, although they also emphasize the many advantages of this data set. Altonji and Shakotko (1987) use a complicated but quite different procedure to construct the tenure and job separation used in their study. However, they use data from 1968-1974, during which the tenure values were bracketed and did not smooth the tenure responses, although they did eliminate large changes in tenure in some instances. They report that smoothing the tenure values or limiting their analysis to 1975-1981 did not make much difference in their estimates. However, Topel (1991) argues that measurement error in the Altonji and Shakotko tenure series is a major source of the discrepancy between his findings and Altonji and Shakotko's. Brown and Light (1992) report obtaining results similar to Altonji and Shakotko's for various treatments of the tenure data, although they criticize Altonji and Shakotko's methodology. We are in the process of re-examining the issue.

[20] See Bishop (1990), who analyzes the relationship between productivity and turnover.

less clear in the event of a layoff. First, to the extent that wages are heavily influenced by firm specific shocks to productivity, layoffs are unlikely to result from them. Furthermore, to the extent that firms provide wage insurance against shocks which affect productivity of workers not only in the current firm but in other firms, $E(\Delta\nu_{ijt})$ could be a negative function of tenure, as wages in the spot market for new hires are not protected from a shift in product demand or productivity affecting an industry or occupation. The simulations suggest a negative relationship.

One may reinterpret the parameters d_2 and g_2 in equation (2.12) as measuring the effect of T_{it-1} on the conditional expectation of $(\Delta\epsilon_{ij(t)} + \Delta\nu_{ijt})$ in the event of a quit and in the event of a layoff. If the combined effect of T_{it-1} on the two variables is positive for a quit and nonpositive for a layoff, then one may still obtain bounds on the b_2 from the coefficients on $-Q_{it}T_{it-1}$ and $-L_{it}T_{it-1}$. The simulations support this view.

Unfortunately, even in this case the coefficient estimates for ΔT^2_{it} and $\Delta 0J_{ijt}$ will be biased due to the fact that the expectation $\Delta\nu_{ijt}$ for those who do not separate is a function of T_{it}. Bull and Jovanovic (1985) note that if workers tend to enter firms during periods of strong demand, ν_{ijt} may be expected to revert toward its mean value as time goes on. In this case it will be negatively correlated with tenure.[21] Furthermore, Altonji and Shakotko (1987) note that the size of the decline in ν_{ijt} necessary to induce a quit (holding the value of the alternative offer fixed) increases with tenure if wages rise with tenure. This is a second reason why the expected value of $\Delta\nu_{ijt}$ conditional on continuation of the job declines with T_{it}. Consequently, the coefficient b_4 on $\Delta 0J_{it}$ will be biased downward and the coefficient b_3 on ΔT^2_{it} will have a positive bias. The estimates of the sum of the effects of

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[21] They do not provide evidence on the quantitative significance of the issues. In our simulations we assume that e_{ijt} is a random walk with initial condition 0 at the start of the job, so there is no reversion to the mean.

experience, tenure, and economy wide changes will also be biased. Resolution of this problem is left to future work.

Finally, a more general note of caution is in order. The wage model excludes differences across individuals and across job matches in the level of firm specific and general wage growth which occurs, such as might arise from variation across individuals, firms, and job matches in the optimal rate of investment in general human capital and specific human capital. Such variation has been emphasized in both formal and informal theoretical discussions of earnings dynamics.[22] Recent data sets which contain information on training suggest that these differences may be important.[23] Also, the matching literature and recent papers by Gibbons and Katz (1989) and Farber and Gibbons (1991) stress the role of information revelation in wage growth within firms, and the wage gains associated with layoffs. We do not deal with these issues here.

V

DATA

The sample is based upon the 1975-1987 waves of the Panel Study of Income Dynamics. The study is limited to white male heads of household. For a given year the sample contains individuals who were between the ages of 18-60 inclusive, were employed, temporarily laid off, or unemployed at the time of the survey, were not from Alaska or Hawaii, and were household heads in that year. Individuals who were not household heads in at least 3 years between 1975-1987 are excluded from the analysis

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22 See, for example, Mincer and Jovanovic (1981), Jovanovic (1979) and Bartel and Borjas (1981).

23 See, for example, Barron, Black and Loewenstein (1989), Brown (1989), Altonji and Spletzer (1991) and Lynch (1992).

entirely, as are individuals who never worked at least 1000 hours or were never employed at the survey date. After an individual retires, any further information is excluded from the analysis. All of the observations from the current job are excluded if the worker reports being self employed or employed by the government. Observations with missing data on the variables in the wage equation are excluded for the particular sample year.

Two different samples are used in the analysis. They correspond to the two wage measures. The first wage measure (WAGE1) is the log of the reported hourly wage for the job held at the time of the survey (deflated by the implicit price deflator with a base year of 1982). The variable WAGE1 is only available for hourly workers in 1975, is truncated at $9.98 prior to 1978 and underestimates wage growth to the extent that paid vacations and holidays rise with tenure and experience. When WAGE1 is used T, T^2, OLDJOB, and union status refer to the same survey date as the reported wage. The second wage measure is the log of real labor earnings during the year divided by annual hours (WAGE2). For the average hourly earnings sample T_{it}, T^2_{it}, and OJ_{it} refer to the time of the survey in the preceding year (typically in March or April). The WAGE2 sample ends in 1986 because we do not have a 1987 calendar year observation for this variable. For those who change jobs during the year, average hourly earnings is presumably an average of the wage on each of the jobs weighted by the portion of the year spent in each. This may potentially lead to biases, particularly in the analysis of a first difference equation such as (2.12). For this reason, we prefer WAGE1 to WAGE2. To reduce the influence of measurement error and outliers, we have set the wage rates to missing when they are less than 1.50 in 1982 dollars. We have set the wage changes involving an increase of 800% or a fall to less than 1/8th of the previous years value to missing as well.

The PSID does not allow employers to be precisely identified across surveys, so employer tenure, quits and layoffs must be inferred. In the Appendix we document the procedures used to infer employer tenure, quits, and layoffs. Briefly, we determine the starting and stopping dates of all jobs held by the individual from information about the reason for leaving the previous employer, employment status, and other variables indicating a change in employers. Although within a job tenure should increase one for one with time, the reported data often fail to satisfy this criterion as tenure sometimes remains constant, falls or jumps dramatically from one survey to the next. We solve this problem in three steps. First, we weight the reported data within a job with a measure of how consistent the data point is with the tenure reports on the job. Second, we estimate the initial tenure on a job using the weighted data. Third, we increase tenure by one year for each subsequent year of the job. If this process results in an estimate of initial tenure less than zero, initial tenure is set to one month. If this process results in an estimate of initial tenure which is greater than two years, the current job and all subsequent jobs are excluded from the sample. We implemented this last rule to exclude jobs with large tenures which we have identified as starting during the sample period. This might have occurred due to an inability to identify a return to a previous employer. When the reason for job changes is unavailable or we are unable to classify the job change into a quit or a layoff based on the reason given, we have excluded the observation from the analysis.

Within a job, tenure and experience should increment identically. We ensure this by first estimating the initial level of experience in the year before the worker entered the sample. This is done using the reports of accumulated years of experience for workers in the year they became a head, and in 1974, 1976 and 1985 if they follow the year the worker became a head. Current experience is then obtained by incrementing initial experience whenever the individual is observed to be employed.[24]

We use a number of standard control variables from the PSID that do not require discussion. We set education to the mean of the values reported for the person.

VI
RESULTS

VI.1 Some Descriptive Statistics

The WAGE1 sample consists of 9883 wage change observations on 1789 individuals. The 10th percentile, the mean, and the 90th percentile of the number of observations per person are 1, 5.52 and 11 respectively. There are a total of 2686 jobs in the sample, and the mean number of wage change observations per job is 3.70. In the entire sample 61.1% of the individuals never change jobs, 24.3% change jobs once, and the remaining 14.6% change jobs more than once. 70.5% of the sample never quits a job, 20.8% quit once, and 8.6% quit more than one job. Similarly, 84.5% of the sample is never laid off, 11.8% are laid off once, and 3.7% are laid off more than once.[25] [26]

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24 Unfortunately, our procedures do not guarantee that the initial experience must increase between jobs. In 60 job changes it falls by a small amount. The results in Table 5 and 6 are virtually unchanged when these observations are eliminated.

25 Of the 549 individuals with eight or more observations, 66.7% never change jobs, 17.7% change jobs once, and 14.6% move more than once. It should be kept in mind that some of the individuals may have had separations that we identified but could not classify into a quit or a layoff. These observations are excluded, so our descriptive statistics understate quits and layoffs.

26 The WAGE2 sample has 1921 individuals who have 2904 jobs matches. The average number of observations on each person is 5.45 with an average of 3.61 observations per job. 60.7% of this sample never change jobs, 23.8% change jobs once, and 15.5% change jobs more than once.

To provide a feel for the data, we begin with the means and standard deviations for the full sample, for stayers, for quits, for all layoffs, and for layoffs due to a plant closing in Table 2. The overall mean of ΔWAGE1 (the change in the reported wage at the survey) is .0251. The mean is .0379 for movers and .0235 for stayers. After a quit there is a mean wage increase of .0797, while a layoff reduces wages by -.0489 with standard errors of .0127 and .0195 respectively. Interestingly, the point estimate of mean wage growth for layoffs due to plant closings is only -.0036 although its standard error is .0354. There are some differences between the results for ΔWAGE1 and ΔWAGE2[27].

Since we are seeking to explain wage changes, we present the means of most of the variables in the previous period. For the full sample the mean of last period's experience (EX_{it-1}) is 16.98, experience at the start of the job held last period ($PEX_{ij(t-1)}$) is 8.42, tenure (T_{it-1}) is 8.55, and OJ_{it-1} ($T_{it-1} > 1$) is 1 in 85.4% of the cases. The quit rate, layoff rate, and layoff rate due to plant closing are .0751, .0366, and .0111. The total separation rate including separations for which reason is unknown is .1237.

The mean of the current log wage is 2.32 for stayers and 2.03 for movers. This difference may in part reflect a larger difference in experience (17.6 versus 12.1), current tenure (8.55 + 1) versus essentially 0), higher union status among stayers, and a slightly higher probability of living in an SMSA and living in a city of more than 500,000. Education differences are small.

It is also important to get a feeling for the distribution of quits and layoffs. In Tables 3a, 3b, 3c, and 3d we present the overall separation rate excluding observations that we cannot classify into quits or layoffs, the quit

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[27] The low value of the mean of ΔWAGE2 for quits is due in part to the influence of a few very large wage losses.

rate, the total layoff rate, and the rate of layoff due to plant closings. As is well known from previous studies, the quit and layoff rates have strong negative relationships to tenure, although this relationship is probably overstated by individual heterogeneity in turnover probabilities. The negative relationship between turnover and tenure is evident for our sample in the last row of the tables.

From the last column of the table, we observe that turnover, quit, and layoff rates all decline with experience. What is perhaps less well known is that the relationship between labor market experience and the separation variables is less dramatic when tenure is held constant.[28] Within tenure categories, the quit probability falls only modestly. There is little relationship in the 0 to 1 tenure category (column 1 of table 3b), although the relationship is negative in the other categories and strong in the 3 to 5 category and 6 to 14 category. Layoffs have little relationship with experience within tenure categories. Layoffs due to plant closing are also weakly negatively related to tenure. This may reflect heterogeneity across firms in the plant closing probability, and the possibility that individuals with a propensity to change jobs sort into firms that are relatively unstable.[29]

In Tables 4a-4e we present the means of change in the log wage, ΔWAGE1, by experience and tenure category for stayers, movers, quits, and layoffs. The purpose of the tables is to see whether returns to tenure, experience, and job mobility stand out in the data. Standard errors of the

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[28] See Mincer and Jovanovic (1981) and Topel and Ward (1991).

[29] We have computed the quit, layoff and layoff due to plant closings rates broken down by the 1 digit industry of the job held in the previous period. The quit rates varied from a low of .0429 (.0058) in the Transportation, Communications and other Public Utilities to a high of 0.1354 (.0105) in Services. The quit rate in manufacturing was .0463 (.0032). Similarly, the layoff rate varied from .0186 (.0038) in Transportation, Communications and other Public Utilities to a high of .0848 (.0218) in Agriculture, Forestry and Fisheries. The layoff rate in manufacturing was .0312 (.0026). Standard errors are in parentheses.

means and standard deviations are also presented.

Consider first wage growth for stayers in Table 4a. Holding lagged tenure constant between 0 and 1, the wage growth for stayers falls from .057 when experience is between 0 and 5 to .011 for experience greater than 20. This is consistent with a strong effect of experience on wages that diminishes with time in the labor market. The pattern is similar in the 1-3 and 3-6 tenure categories. In contrast, wage growth within jobs has only a weak relationship to tenure when labor market experience is held constant. These results are potentially consistent with a substantial but relatively constant return to each year of additional tenure. However, they are inconsistent with the view that a large effect of tenure on wages in the early years on a job is responsible for the drop in quits with tenure discussed above.

Looking at job changers in Table 4b, we observe that for all movers there is a sharp drop in wage growth with years in the labor market, holding tenure constant. The drop is most dramatic when tenure is less than 1. For quits in Table 4c, wage growth drops dramatically with experience when tenure on the previous job is less than 1 but does not vary much with experience in the higher tenure categories relative to the sampling errors of the cell means. For layoffs in Table 4d there is also a substantial drop in wage growth at higher experience levels within each tenure category (with the exception of the 3 to 6 category). In sum, tables 4a-4e reveal that wage growth within and across jobs tends to fall as experience increases, holding tenure constant.

Holding experience constant and reading across the rows, we observe that mean wage growth for job changers drops with tenure on the previous job. Table 4b shows that for all movers in the 5 to 10 year experience range wage growth is .100 if tenure on the previous job is less than 1 and .008 if tenure is between 6 and 15 years. These results are consistent with a seniority effect on wages. The same general pattern is present for quits, layoffs and plant closings. However, the standard errors of the means in the tables are quite large. Overall, the evidence is consistent with a modest positive return to tenure, although the large standard errors, differences in the detailed results by type of separation, and failure to hold constant the job match term make it dangerous to infer too much from the tables. Our theoretical discussion and simulations suggests that the relationship between tenure and the wage gains following quits are likely to understate the returns to tenure and the relationship between tenure and that the wage gains following layoffs are likely to overstate the wage changes of quits.

In sum, the descriptive statistics indicate a drop in turnover with tenure, a decline in wage growth with experience holding tenure constant, and modest wage growth within jobs that is negatively related to experience holding tenure constant but only weakly related to tenure holding experience constant. We also find a negative relationship between wage changes for movers and tenure prior to the move. The results are potentially consistent with a role for experience, tenure, and job match gains via mobility in wage growth over a career. We now turn to the formal econometric analysis.

VI.2 Estimates of the Wage Growth Equations

In Table 5 we report estimates of equation (2.12) using ΔWAGE2 as the dependent variables (standard errors in parentheses).[30] All equations include the change in time between the first differenced observations (1 in

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[30] The standard errors allow for arbitrary person specific patterns of heteroskedasticity and serial correlation over time for each person and are based on a variant of the White (1984) procedure.

almost all cases), the change in the square and cube of experience.[31] Since the change in education minus 12 times experience is also included, the coefficient on time is the sum of the effect of an additional year of experience, an additional year of tenure, and the secular time trend for an individual with 12 years of education.[32] We also include interactions between Q_{it} and L_{it} and the level, square and cube of $PEX_{ij(t-1)}$. We vary the specification for the tenure variables.

Column 1 is the most restrictive of the three specifications. It excludes the first year change in the dummy $0J_{it}$ and the interaction of OJ_{it-1} and T_{it-1}^2 with Q_{it} and L_{it} from the wage equation. The coefficient on $-Q_{it}T_{it-1}$ is .0109 (.0052). This coefficient is an estimate of the linear tenure slope b_2 minus the coefficient d_2 which relates tenure to the expected change in the job match component $\epsilon_{ij(t)}$ in the event of a quit. We argued above that d_2 will be positive unless the true effect of tenure on wages and mobility costs is small. Consequently, we view .0109 as a lower bound on the tenure slope for this wage specification. The coefficient on $-L_{it}T_{it-1}$ provides an upper bound on the tenure slope. This coefficient is .0153 (.0059). Since the estimate of b_3, the coefficient on tenure squared in the wage equation is very small, these results indicate that 10 years of tenure leads to an increase in the log wage of between .104 and .149.

In column 2 we add ΔOJ_{it} and the interaction between OJ_{it-1} and Q_{it} and L_{it} to the equation. ΔOJ_{it} enters with a coefficient of .029 (.0104), suggesting that the first year on the job leads to a wage increase 2.9 percent

[31] All of the equations also include the change in 3 location variables, the change in union membership, the change in marital status, the change in the SMSA dummy, the change in city size dummy, and the change in a dummy for health limitation as control variables, but coefficients on these variables are not displayed.

[32] The coefficient on the education times the change in experience should be interpreted as the sum of an interaction between education and a time trend and education and experience.

above that implied by the linear and quadratic tenure terms. The lower and upper bounds on the tenure slope b_2 are .0041 and .0060, respectively. Since the coefficient on ΔT^2_{it} is .00018, the specification suggests that ten years of job seniority leads to an increase in the log wage of between .088 and .107.

In column 3 of the table, the expected value of $\Delta\epsilon_{ij(t)}$ conditional on a quit or a layoff is permitted to depend on T^2_{it-1}. This has little effect on the coefficient on $\Delta 0J_{it}$. Unfortunately, the standard errors for this specification are large (.0095 and .0165). When one evaluates the $L_{it}T^2_{it-1}$ term at 5 years of tenure one concludes that g_2 must be at least -.003 to guarantee a monotonically decreasing relationship between $\Delta\epsilon_{ij(t)}$ between 1 and 5 years of tenure. If one uses this value as an upper bound on g_2 one obtains .009 as the upper bound on the tenure slope b_2.

One obtains somewhat different results using the ΔWAGE1 dependent variable in Table 6. Note that a priori we believe that ΔWAGE1 is a superior wage change measure. For the simple specification in column 1, the estimate of b_2 - d_2 from the coefficient on $-Q_{it}T_{it-1}$ is .010 (.0043) and the estimate of b_2 - g_2 based on the coefficient on $-L_{it}T_{it-1}$ is .0084 (.0050). The point estimate is inconsistent with our expectation that $g_2 < 0 < d_2$, although the standard errors are large enough that there is little evidence against this hypothesis. In column 2 the estimate of b_2 - d_2 from the coefficient on $-Q_{it}T_{it-1}$ is .0023 (.0053). However, the coefficient on $-L_{it}T_{it-1}$ is -.0023 (.0057). The point estimate is again inconsistent with our expectation that $g_2 < 0 < d_2$, although one cannot reject this hypothesis. The coefficient on $L_{it}OJ_{it-1}$ is -.099 (.042) suggesting that wage changes following layoffs are much lower for jobs lasting less than a year than for jobs lasting more than a year. Overall, the results using ΔWAGE1 suggest a small value of b_2. The coefficient on the ΔT^2_{it} and ΔOJ_{it} are .00014 and .0077 respectively. When these estimates are combined with the low values for b_2, the results suggest that the effect of 10 years of tenure on the wage level is modest. The results for the more general specification in column 3 are in the same range.

VI.3 Summarizing the Effects of Job Seniority and Experience

We provide evidence on the contribution of experience and tenure to wage growth by evaluating the experience and tenure coefficients at various values of experience and tenure. As noted above, the linear experience coefficient b_0, the linear tenure coefficient b_2, the job match gain parameters d_2 and g_2, and the time trend are not separately identified. Consequently, in Table 7 we present estimates of the value of experience and tenure under alternative assumptions about the linear tenure and experience slopes. We take our estimate of the time trend from an OLS regression of the log wage level on a cubic in experience, the interaction of education minus 12 and the time trend, the interaction of education minus 12 and experience, OJ_{it}, T_{it} and T_{it}^2, and a set of controls. This estimate is .00168 for WAGE1 and .000832 for WAGE2. It will be biased if the OLS estimates of the tenure and experience are biased. However, our analysis of alternatives to OLS suggests that the time trend estimate is insensitive to the estimation procedure even though the tenure and experience coefficients are not.

The first three columns of Table 7 are based on WAGE2. In column 1 we set the linear slope to the "lower bound" implied by the coefficient of .0041 on $-Q_{it}T_{it-1}$ using the specification in Table 5, column 2. We use this specification because of the large standard errors on the coefficients of $-Q_{it}T_{it-1}$ and especially $L_{it}T_{it-1}$ in Table 5, column 3. The results indicate that 2 years of tenure are worth .038 (.014) and 10 years are worth .088 (.052). They also indicate that for a high school graduate 10 years of experience are worth .356 (.079) and 30 years are worth .369 (.155).

These estimates are the effect of experience on wages holding the job match constant. That is, they do not include the increase in $\epsilon_{ij(t)}$ over a career.

In the second column of Table 7 we set the linear slope to the "upper bound" implied by the estimate .0060 of the coefficient (b_2-g_2) on $-L_{it}T_{it-1}$. The results are very similar to those in column 1.[33] In the third column we set b_2 to .0164, which is the highest value consistent with a nonnegative return to 30 years of experience. In this case, the return to 10 years of tenure is .211. While this is a substantial return, it is well below the OLS estimate of .345 based upon a level specification analogous to (2.1). We would rule out the possibility that the return to 30 years of experience is 0, particularly if the return to tenure is large.

In columns 4 and 5 of Table 7 we repeat the analysis for the WAGE1 measure using the specification in Table 6, column 2. We report results for the b_2 estimate of .0023 based on the $-Q_{it}T_{it-1}$ coefficient in column 2 of Table 6. (We do not use the layoff coefficient, which implies b_2 is 0 given our assumption about g_2). The results imply a return to ten years of seniority of .044 and a return to 30 years of experience of .393. In column 5 we repeat our experiment of setting b_2 to the highest value that is consistent with a nonnegative return to 30 years of experience (.0154). In this case the return to 10 years of tenure is .175. While this estimate is presumably extreme, it is well below the estimate of .267 implied by OLS estimation of (2.1).

Given sampling variation we view these results as tentatively suggesting that the value of 10 years of tenure is between .03 and .15. We revise up the lower bound in light of the estimates in Section VII. OLS

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[33] When we use the coefficient of .012 on $L_{it}T_{it-1}$ and the other coefficients for the specification in Table 5, column 3, 10 years of tenure is worth .175, but 30 years of experience is worth only .144. The latter number seems implausibly low. The standard errors are very large.

estimation of (2.1) appears to dramatically overstate the return to tenure, assuming that the return to general labor market experience is not negative.

VI.4 Decomposing the Wage Gains Associated with Quits and Layoffs

In Tables 8a and 8b we decompose the wage changes associated with quits and layoffs into 3 components. The first is the value of the tenure given up due to the quit or layoff. The second is the value of the change in total labor market experience over the interval of the job change, which we take to be one year. We do this using the estimates of the coefficients on the nonlinear tenure and experience terms, the estimate of the combined effect of the time trend, the linear experience term, and the linear tenure term and by experimenting with the alternative assumptions about b_2 used above. For the reasons discussed previously, we set the linear time trend for ΔWAGE1 to .00168 and the linear time trend for ΔWAGE2 to .000832.

The third wage change component is the change in the job match component $\Delta\epsilon_{ij(t)}$. (Note, however, that our estimates may reflect a mixture of $\Delta\epsilon_{ij(t)}$ and the change between jobs in ν_{ijt}.) Our choice of b_2 implies a choice for d_2 and g_2, and we impose this in the calculations. For example, if we set b_2 to the coefficient $(b_2 - d_2)$ on $-Q_{it}T_{it-1}$, then we set d_2 to 0. We present estimates for various values of experience prior to the job ($PEX_{ij(t-1)}$) and T_{it-1}.

We begin with the results for ΔWAGE1 in Table 8a using the specification from Table 6, column 2. When b_2 is .0023 the loss of ten years of seniority is associated with a wage loss of .044. However, persons who quit a job with initial experience 1 and 10 years of tenure experience a job match gain of .069. The results indicate that the job match gain is largest for persons who quit with less than one year on the job. The sum of the change in the job match and the value of lost tenure declines with seniority. However, the sum remains positive through 10 years of tenure when previous experience (PEX) is less than 10. The gain in the job match and the overall gain associated with the quit declines with PEX, which is consistent with our theoretical discussion. The expected gain is negative when previous experience is greater than 20 and tenure is 2 or more.

The job match gain for layoffs is negative in almost all cases when b_2 is .0023. It has a negative relationship with prior experience through ten years, which is consistent with our theoretical discussion. However, the experience effect becomes positive after that point. Relatively few layoffs occur at high levels of prior experience and so it is dangerous to extrapolate out to 30 years.

The losses are relatively small when tenure on the previous job is 0. They are between -.13 and -.092 when tenure is 2 and decline monotonically with tenure thereafter. As we have noted earlier, the evidence for ΔWAGE1 is that g_2 is positive, which runs counter to our expectation.

We have already noted that an estimate of b_2 in excess of .0154 implies that the return to 30 years of labor market experience is negative. The results in the table also have implications for estimates of the returns to seniority. If the true value of b_2 is as large as .02 then the results imply that persons who are laid off at high tenure levels achieve substantial job match gains. For example, if b_2 is .02, the estimate of the job match gain is .12 for someone with 5 years of prior experience and 10 years of tenure. The fact that the wage losses of workers who experience layoffs are relatively modest at all tenure and prior experience levels suggests that either the returns to seniority are modest or that the returns to tenure are large and persons who have several years of seniority when they are laid off find jobs with higher job match components than their previous ones. The latter interpretation seems implausible to us. We have not investigated a third possibility, which is that the returns to tenure are large but the stochastic wage component ν_{ijt} is negative prior to a layoff for workers with several years of seniority.[34]

We now briefly discuss the results for ΔWAGE2 in Table 8b. When one uses the lower bound estimate of .0041 for b_2, the implied job match gain is about 1 percent for quits when previous experience is equal to 1. The job match gain is about 5 percent when prior experience is 5 or 10, drops at 20 and then increases. We doubt that estimates at the higher levels of previous experience are very reliable.

The results for layoffs indicate substantial declines in the job match component when previous experience is low. These losses are smaller at high experience levels. The size of the loss rises with seniority.

The lower panel of Table 8b assumes that the tenure slope parameter is set to the upper bound of .0060, which is the coefficient on $-L_{it}T_{it-1}$ in Table 5, column 2. In this case, the job match gain associated with a quit increases with tenure. For example, when prior experience is 5 years the gain is .0491 for a worker who quits when tenure is 0 and .0674 for a worker with 10 years of tenure. The sum of the match gain and the value of lost tenure is typically positive at the low tenure levels and negative in all cases in which tenure is greater than or equal to 5. For workers with little prior labor market experience the layoffs are associated with substantial job match losses that rise between 0 and two years of tenure and then decline. The losses are small for more experienced workers and in some cases are positive. Once again, if b_2 is as large as .02, the estimates would imply substantial job match gains for workers who suffer layoffs with 10 years of tenure and more than 5 years of prior experience. This seems unlikely.

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[34] Hamermesh (1987) finds little evidence of this in the PSID for the early years of our sample. Topel (1991) does not find a link between wage growth and years remaining on a job in the PSID. Jacobson, LaLonde and Sullivan (forthcoming) do find that earnings growth is lower prior to a separation, but reductions in work hours could drive these results.

VI.5 A Decomposition of Wage Growth Over a Career

A key goal of the paper is measure the contribution of the accumulation of seniority, accumulation of general experience, and growth in $\Delta\epsilon_{ij(t)}$ to wage growth over a career. We present estimates for the first 10 and first 30 years in the labor market. We evaluate the effects of experience at 10 years and 30 years and the effects of tenure using the distribution of tenure for persons with experience between 9 and 11 years and between 27 and 33 years.[35] We evaluate growth in $\Delta\epsilon_{ij(t)}$ from quits by using our estimates of the parameters of variants of (2.9) to compute the expected value of $\Delta\epsilon_{ij(t)}$. The expected value is evaluated over the distribution of prior experience and tenure for the quits that occur at each labor market experience level. We then multiply the estimate of the job match gain per quit by the quit probability at that labor market experience level.[36] We do the same for layoffs. We then accumulate the results for quits and for layoffs from 1 year to 10 years of experience. We decompose wage growth over the first 30 years of experience in an analogous way.

The results are in Table 9. The bottom panel presents the results for ΔWAGE1 when we use the estimates in Table 6, column 2. The column headings identify the values of the linear experience slope parameter, b_0, and the linear tenure slope b_2. The row headings indicate the source of wage growth. In the first column b_2 is set to the lower bound of .0023. In this case, the model predicts that the log wage increases by .53 in the first 10 years and by .68 in the first 30 years. The accumulation of tenure from 0

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[35] We work with the distribution of tenure over intervals of experience values to reduce sampling error in the distribution of tenure 10 and at 30 years of experience.

[36] We inflate the quit and layoff probabilities to reflect separations that could not be classified. We assume that the unclassified category contains the same experience specific mix of quits and layoffs as the separations that we could classify.

years contributes only .019 to wage growth over the first 10 years in the labor market and .088 over the first 30 years. The mean of tenure is 4.02 when experience is 10 and 15.2 when experience is 30. In contrast, experience is responsible for increases of .30 over the first 10 years and .39 over the first 30 years.

Mobility also plays an important role. Workers experience an average of 2.85 quits during the first 10 years of experience that lead to an average increase in the job match component of wages of .27. The corresponding figures for 30 years are 4.89 quits and a job match gain of .33. Workers experience 1.19 layoffs in the first 10 years and suffer a job match loss of .061 as a result. The corresponding figures for the first 30 years are 2.35 layoffs and a loss of .129.[37]

The top panel displays a corresponding set of results for WAGE2 based on the coefficient in column 2 of Table 5. When the tenure slope is set to the lower bound of .0041, tenure accumulated during the first 10 years and the first 30 years in the labor market contributes .044 and .149 (respectively) to wage growth on average. In contrast, the return to 10 years of experience is .356 and the return to 30 years is .369. Mobility has an important effect on wage growth, but quits and layoffs are partially offsetting. Quits increase the job match component by .06 over the first ten years and .12 over the first 30 years in the labor market, respectively. Layoffs result in substantial job match losses. When b_2 is set to the

[37] The second column of the bottom half of Table 9 reports the decomposition when b_2 is set to .0154, which is the largest value that is consistent with a nonnegative value for 30 years of experience. These results suggest that the accumulation of tenure and job match gains associated with quits account for essentially all of the growth in wages over a career. However, a large return to specific human capital seems incongruous with the corresponding estimate that 30 years of general experience has no value in the labor market.

coefficient of .0060 in column 2 (the coefficient on $-L_{it}T_{it-1}$ in Table 5, column 2) the estimated return to tenure rises slightly.[38]

As a check on the analysis we estimate a wage growth equation analogous to (2.2) with all tenure and job change terms excluded and compute the total effect of 10 and 30 years of experience implied by this model. These estimates combine the contributions of accumulated tenure, experience, and mobility. In the case of ΔWAGE1, when the secular time trend is set to .00168 and education is set to 12, the simple wage change equation implies that the log wage increases by .415 after the first 10 years in the labor market and by .558 over the first 30 years. These estimates are lower than the estimates of .533 and .678 implied by summing the returns to general experience, tenure, and job match gains from quits and layoffs. On the other hand for ΔWAGE2 (with the secular time trend set to .00083) the corresponding simple wage change equation implies an increase in the log wage of .402 during the first 10 years and .532 during the first 30 years of labor market experience, which compare to .323 and .461 for the model in column 1. These estimates are somewhat above the estimates implied by the model. There are a number of possible explanations for the discrepancy, including sampling error, mispecification of the wage growth equations (such as failure to include interactions between experience and tenure---see below), and the fact that mobility is underrepresented in the sample used to directly estimate the total effect of experience on wages. Nevertheless, the discrepancy suggests that the career decompositions that we present should be treated with caution.

[38] When we set b_2 to .0164 in column 3, we find that seniority plays a small role in wage growth over the first 10 years in the labor market, but induces an increase in the log wage of .294 after 30 years. However, these estimates imply no return to 30 years of experience and that the increase in general experience from 10 years to 30 years (holding tenure and the job match component constant) leads to a wage decline of .173. We prefer the estimates in column 1 or 2.

VI.6 Other Results

We modified our basic wage change specifications in a number of ways. Since one might expect the gains and losses from turnover to be related to labor market conditions, we added the current and lagged value of unemployment and the interactions of these variables with Q_{it} and L_{it} to the model in column 2 of Tables 5 and 6. This made little difference. When ΔWAGE2 is the dependent variable only the lagged unemployment rate is statistically significant. When ΔWAGE1 is the dependent variable the coefficient on $Q_{it}T_{it-1}$ falls to -.0049 and the coefficient on $L_{it}T_{it-1}$ falls to -.0025.[39]

We have also estimated specifications that include the change in the product of $PEX_{ij(t-1)}$ and T_{it} and the products of $PEX_{ij(t-1)}$, T_{it-t} and the quit and layoff indicators. There are a number of reasons why the tenure slopes might depend upon experience and why one might expect the effect of tenure on the previous job on $E(\Delta\epsilon_{ij(t)})$ to depend on experience. Our *preliminary* findings suggest that tenure slopes are positively related to the prior experience at the start of the job. They also suggest that the interaction between prior experience and tenure at the time of the separation is positively related to the job match gain both for quits and for layoffs. We leave a thorough analysis of this specification to future research.

VII
AN ALTERNATIVE ESTIMATION METHOD

In this section we outline an alternative way to estimate the parameters of the wage growth model. Equation (2.1) implies the following

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[39] The current unemployment rate has a positive relationship the to wage change for stayers. Oddly enough, wage gains of associated with quits and layoffs are both positively associated with increases in the county unemployment rate, and the effect is statistically significant in the case of layoffs.

equation for the deviation of W_{ijt} from the mean of the wage for job j.

$$\tilde{W}_{ijt} = \tilde{Z}_{ijt}\Gamma + b_0\tilde{EX}_{ijt} + b_1\tilde{EX}^2_{ijt} + b_2\tilde{T}_{ijt} + b_3\tilde{T}^2_{ijt} + b_4\tilde{OJ}_{ijt} + \tilde{u}_{ijt} + \tilde{\nu}_{ijt} \quad , \tag{7.1}$$

where the symbol ~ denote deviations from the sample mean of the observations on job j. We make the j subscript explicit to emphasize the fact that the observations refer to a particular job. Taking the means of both sides of (2.1) and taking differences across jobs for jobs that end between t-1 and t leads to

$$\Delta\bar{W}_{ij(t)} = \Delta\bar{Z}^*_{ij(t)}\Gamma^* + b_0\ \Delta\bar{EX}_{ij(t)} + b_1\Delta\bar{EX}^2_{ij(t)} + b_2\Delta\bar{T}_{ij(t)} + b_3\Delta\bar{T}^2_{ij(t)} + b_4\Delta\bar{OJ}_{ij(t)} + \Delta\epsilon_{ij(t)} + \Delta\bar{u}_{ij(t)} + \Delta\bar{\nu}_{ij(t)} \quad , \tag{7.2}$$

If a separation occurs between t-1 and t then

$$\Delta\bar{T}_{ij(t)} = \Delta\bar{EX}_{ij(t)} - T_{ijt-1} + (T_{ijt} - \underline{T}) + (\underline{T} - 1) \tag{7.3}$$

where $\underline{T}$ is the mean of T_{ijt} at the survey date following the start of a new job. Combining equations (7.2), (7.3) and (2.9) leads to

$$\begin{aligned} \Delta\bar{W}_{ijt} = {} & \Delta\bar{Z}^*_{ijt}\Gamma^* + (b_0 + b_2)\Delta\bar{EX}_{ij(t)} + b_1\Delta\bar{EX}^2_{ijt} + b_3\Delta\bar{T}^2_{ijt} + b_4\Delta\bar{OJ}_{ijt} \\ & + d_0Q_{it}PEX_{ij(t-1)} + d_3Q_{it}T^2_{it-1} + d_4Q_{it}OJ_{it-1} + g_0L_{it}PEX_{ij(t-1)} \\ & + g_3L_{it}T^2_{it-1} + g_4L_{it}OJ_{it-1} + \left[d_1 - b_2(1-\underline{T})\right]Q_{it} \\ & + \left[g_1 - b_2(1-\underline{T})\right]L_{it} + (b_2-d_2)(-Q_{it}T_{it-1}) + (b_2-g_2)(-L_{it}T_{it-1}) \\ & + Q_{it}\eta_{ij(t)} + L_{it}\xi_{ij(t)} + \Delta\bar{u}_{ij(t)} + \Delta\bar{\upsilon}_{ij(t)} + b_2(Q_{it} + L_{it})(T_{ijt} - \underline{T}) \quad . \end{aligned} \tag{7.4}$$

We jointly estimate (7.1) and (7.4) after imposing cross equation restrictions on the coefficients that appear in both equations.[40] We use a weighted least squares procedure (WLS) in which the weights are proportional to the error variances of OLS residuals for the within job observations, the observations on quits, and the observations on layoffs. We report the WLS standard errors after verifying for one of the models (column 3, Table 10) that standard errors that allow for an arbitrary person specific error covariance matrix are similar.

Why use the alternative estimator? It is likely to be more efficient for three reasons. First, many previous empirical studies using the PSID have found that the wage error term includes a substantial component that is uncorrelated across time periods. Consequently, the variance of the first difference of the error term when the job does not change is likely to be larger than the deviation from the job mean. Second, the variance of deviations from the job means of the nonlinear tenure and experience variables is larger than the variances (within jobs) of the first differences of the corresponding variables. Third, averaging the observations across jobs should reduce the effect of a white noise error component on the variance of the error term. These gains might be offset to some extent by complications involving a near random walk component in either u_{ijt} or ν_{ijt}.

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40. The estimation is easily performed using standard regression packages by first combining the two equations into one model in which the dependent variable is set equal to either $\hat{W}_{ijt}$ or to $\Delta W_{ij(t)}$ and the linear restrictions on the parameters are imposed in the usual way. We foolishly included separate interactions between education and time and education and experience. These are technically identified because the change in time and the change in experience are not perfectly collinear across jobs. However, these coefficients are very poorly determined, and we have much more confidence in the sum of the coefficients than the separate coefficients. Note that in the first difference analysis we included only the interaction of education and experience and interpret the coefficient as the sum of the interaction of education with time and education with experience. Imposing the same constraint on the estimates in Table 10 and 11 has little effect on the other parameters.

However, we suspect that reducing the influence of the white noise error component is most important.

We also suspect that use of (7.4) instead of first differences will reduce bias from minor errors in the dating of job changes. In the case of ΔWAGE2, the current wage used to form the wage change measures used in the first difference analysis may refer in part to the previous job. Downward bias in b_4 from measurement error in OJ_{ijt} may also be reduced.

On the other hand, it is possible that variation within jobs in ν_{ijt} may have a more serious effect on the tenure and experience slopes than variation in $\Delta\nu_{ijt}$ if movements in ν are highly persistent. Furthermore, the effect of changes in the job mean of ν_{ijt} on the estimates of the relationship between tenure and prior experience and the change in the job match component are unclear. In summary, there are both advantages and disadvantages to the alternative procedure.

Tables 10 and 11 report joint estimates of (7.1) and (7.4) for the specifications of the effects of experience and tenure used in the corresponding columns of Tables 5 and 6 for the first difference estimator. Space limitations preclude a detailed discussion. However, a few points should be made. First, when ΔWAGE2 is the dependent variable and OJ_{ijt} and the interactions between OJ_{ijt-1} and Q_{it} and L_{it} are excluded, (Table 10, column 1) the coefficient on $-Q_{it}T_{it-1}$ is .0135 and the coefficient on $-L_{it}T_{ijt-1}$ is .0162. These estimates are slightly larger than the corresponding estimates based on the first difference specification (Table 5, column 1). The standard errors are about 25 percent smaller. When OJ_{ijt} and its interaction with Q_{it} and L_{it} are added in column 2 the coefficient on $-Q_{it}T_{ijt-1}$ rises to .0097 (.0050) The coefficient on $-L_{it}T_{ijt-1}$ falls to .0087 (.0048) These estimates do not satisfy the bounds on $b_2 - d_2 < b_2 - g_2$ but the evidence against these bounds is weak.

It should also be pointed out that the coefficient b_4 on OJ_{ijt} is .064 in columns 2 and 3 of table 10, which is considerably larger than the estimate of .029 using the first difference approach. (Table 5 columns 2 and 3.) This might be due to a reduction in the influence of measurement error.

The results for WAGE1 in Table 11 suggest a somewhat larger effect of tenure than those in Table 6.

In Table 12 we examine the implications of the estimates for the effects of tenure and experience on wages. In column 1 we work with specification in Column 2 of Table 10 for the wage variable WAGE2. We use the coefficient of .0098 on $-Q_{it}T_{it-1}$ as a "lower bound" estimate of b_2 despite the fact that the coefficient on $-L_{it}T_{it-1}$ is slightly lower for that specification and so the estimate is inconsistent with our expectation that $g_2 < 0 < d_2$.[41] This specification implies that 10 years of tenure raises the log wage by .166 (.049). Ten and 30 years of experience are worth .299 (.053) and .395 (.146) respectively. The estimates using the coefficient on $L_{it}T_{it-1}$ as the estimate of b_2 are very similar (column 2). In Table 12, column 3 we report the implied returns to tenure and experience when we set b_2 to the maximum value (.0229) that is consistent with a nonnegative value for 30 years of labor market experience. In this case, 10 years of tenure is worth .298, but accepting this substantial value requires one to accept that the 30 years of experience is worth 0. This seems unreasonable.

Columns 4, 5 and 6 of table 12 report an analogous set of results for WAGE1 using the specification in column 2 of Table 11. When we set b_2 to the coefficient of.0103 (.0046) on $Q_{it}T_{it-1}$, which is an estimate of $(b_2 - d_2)$, we find that 10 years of tenure raises the log wage by .119 (.045).

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[41] We do not use the estimates in column 3 because if one sets b_2 to the coefficient on $Q_{it}T_{it-1}$ (-.0193) the estimates imply that the return to 30 years of labor market experience is only .107. As is the case with the first difference specification, the standard errors are very large when OJ_{it-1} and a quadratic in T_{it-1} are interacted with Q and L.

The value of 10 years of experience is .245 (.05) and the value of 30 years of experience is .394 (.14). The value of 10 years of tenure is .069 (.042) when we use the coefficient of .0053 on $L_{it}T_{it-1}$, which is an estimate of $b_2 - g_2$. Note the estimates are not consistent with our argument that $g_2 > 0$, $b_2 < 0$. When we set b_2 to .0236, which is the value at which the return to 30 years of experience becomes 0, the return to 10 years of tenure is .250. Overall, the estimates of the return to tenure are somewhat larger than those using the first difference approach in Table 7 but are less than half the value of estimates based on OLS estimation of (2.1).

We have computed the job match gains and losses associated with quits and layoffs implied by the model for various values of prior experience and tenure at the time of the separation. The results are analogous to those in Table 8, but we omit the table. Using the specification in column 2 of Table 10 and coefficient on $Q_{it}T_{it-1}$ as the estimate of b_2, we obtain a small negative decline in the job match component in the event of a layoff that *declines* with tenure once tenure is greater than 1. A tenure coefficient as large as .02 would imply that persons who suffer layoffs experience job match gains at most tenure and prior experience levels. A value this large would imply that persons who quit experience job match losses when experience is low. As noted earlier in our discussion of Table 8, the gains and losses from quits and layoffs place a further constraint on the return to tenure.

In Table 13 we present career decompositions analogous to those in Table 9. For WAGE2, with b_2 set to the coefficient on $-Q_{it}T_{it-1}$, we find that tenure and experience contribute .090 and .299 to wage growth during the first 10 years in the labor market. (column 1). Quits and layoffs contribute .059 and -.085 respectively. The total is .362. During the first 30 years the accumulation of tenure and experience are responsible for increases of .223 and .395 respectively, while the job match gains from quits and layoffs roughly cancel out.

The results for WAGE1 suggest a considerably smaller role for seniority and a much larger role for mobility. Over the first 10 years in the labor market the contribution of tenure and experience are .058 and .245 respectively, while the contribution of quits, and layoffs are .311 and -.004. The total is .610. Over the first 30 years the contributions of tenure and experience are .149 and .394. The contributions of quits and layoffs are .324 and -.051. The total is .816. To summarize, the results for the alternative estimator are generally consistent with those based on the first difference estimator, although the estimates of the return to tenure are a bit higher. For both estimators the results for WAGE1 and WAGE2 indicate that general skill accumulation is important in wage growth over a career. However, the results for the two wage variables differ with respect to the relative importance of tenure accumulation and job match gains from mobility in wage growth over a career.

VIII
DISCUSSION AND CONCLUSIONS

In this paper we estimate the returns to seniority, the returns to experience, and the relationship between changes in the match specific component of wages and experience and seniority at the time of a quit or layoff. We also estimate the contribution of general labor market experience, job tenure (seniority) and job mobility to wage growth over a career. The word "estimate" is a bit misleading, since Section II shows that these returns are not identified in the regression models relating the wage changes of stayers, quits, and layoffs to tenure and experience that we and others have used. Specifically, we show that the coefficients on the linear experience and tenure terms in the wage level equation and the coefficients on the linear tenure and linear experience terms in the polynomial approximations for the expected change in the job match components in the event of a quit or layoff are all underidentified by one common parameter.

We deal with the identification problem in two ways. First, we attempt to get "a priori" information on the unidentified parameters by analyzing a simple structural model of wages, quits and layoffs. The analysis suggests that if the effect of tenure on wages is substantial, then the relationship between the change in the job match component and tenure at the time of a quit will be positive, while the relationship between the change in the job match component and tenure at the time of a layoff will be negative. With these sign restrictions one can find a range of estimates for all of the unidentified parameters from the regression parameters that are identified.

Second, the fact that the model is identified if one knows the linear tenure slope of wages means that we can check the implications of various assumptions about this slope for the returns to tenure, the returns to experience and the effect of tenure on job match gains.

The empirical analysis suggests the following conclusions. First, there is a large return to general labor market experience that is independent of job shopping. Second, the weight of the evidence suggests an economically significant tenure effect on the log wage that is somewhat above the .07 estimate suggested by Altonji and Shakotko (1987) but far below OLS estimates for our sample and also well below Topel's (1991) of .246 for an earlier sample. The range from .07 to .15 seems most reasonable to us. The range of estimates that we present reflects the fact that our model is fundamentally underidentified as well as differences across estimation methods and choice of dependent variable. We show that estimates of the return to tenure that are substantially above our "bounds" estimates imply a 0 or negative return to general labor market experience. They also imply that senior workers who lose their jobs experience job match gains, which we find counterintuitive.

Our preferred estimates of the effect of tenure and prior experience on the job match gains associated with quits and layoff are based on the survey wage rate (WAGE1). These estimates suggest that quits result in substantial job match gains when prior experience is less than 10. They also indicate that the sum of the change in the job match and the value of lost tenure declines with seniority but remains positive through 10 years of tenure when previous experience PEX is less than 10.

Layoffs are associated with substantial job match losses for workers who have been on the job over a year. The estimates of the relationship between these losses and prior experience and tenure is quite sensitive to the choice of dependent variable. In the case of WAGE1, the losses have a weak U-shaped relationship to prior experience. The losses are much larger for workers with more than a year of seniority.

What are the sources of wage growth over a career? General labor market experience is a key factor. Combining our first difference results and results using the within job and across job estimator suggests that the accumulation of 15 years of tenure by the average worker over 30 years leads to a log wage increase of perhaps .11. Job match gains from quits contribute .326 but are partially offset by losses of .13 from layoffs over a career. However, the results using average hourly earnings over the year (WAGE2) suggest a smaller role for job match gains and a larger role for tenure. The sensitivity of the magnitudes to the choice of dependent variable and the discrepancy between the total wage growth predicted by the model and predictions based on simple wage growth regressions is cause for concern.

There is a long research agenda. First, we have identified a number of shortcomings of our empirical specification that should be investigated. Interactions between tenure and experience should be high on this list, as well as treatment of the stochastic job specific error component. The fact that the point estimates of d_2 and g_2 violate our sign restrictions in many cases is a cause for concern (although sampling error may explain this), as is the discrepancy between our career decompositions and total wage growth over a career.

Second, the adequacy of the tenure and mobility measures and the overall fit of the model need further investigation.

Third, it would be useful to expand the prototype simulation model in several directions. The model should be modified to incorporate nonpecuniary job characteristics and mobility costs. Optimal quit and layoff rules should replace the adhoc rules that we work with. More detailed simulations would provide a better guide to interpreting the wage growth equations that are so prevalent in the literature.

Finally, one could formally estimate a greatly expanded version of the simulation model of wages and mobility by choosing parameters that are consistent with the empirical distribution of quits, layoffs, wages, tenure, and experience.

APPENDIX

This appendix discusses the procedures used to identify the sequence of jobs held by the individual over the sample period, a tenure measure, an experience measure, and the quit, layoff, and separation indicators.

Job Definition

The PSID does not identify the employers of individuals. We identified the sequence of jobs (employers) held by each individual as follows. The crucial questions used in the creation of the job indicator are a current employment status question and questions about why the worker left his last job. If the worker was currently employed and was in his current position less than one year, he was asked the reason for leaving his previous job. If the worker was not employed, he was also asked the reason for leaving his last job. Denote the responses to these questions with the variable REASON. We make sure that REASON is consistent with the reported job tenure for that year. Employed individuals in the 1984-87 waves of the PSID employed individuals were asked what they were doing before taking their current position. We also used this information.

We count jobs from 1975 or the year that the person became a head of household. The individual is classified as in a job in 1975 if he was currently employed and hours worked were positive. For the remaining years we sequentially determine job changes using the following criterion:

No job change if:

(1) The worker was currently employed, was employed last period, and there are data on REASON.

(2) REASON indicates a promotion and (1) the worker was currently employed and was also employed last period or (2) the worker was currently employed, was not employed last period, and the reported tenure value is large.

(3) The worker was currently employed, REASON is available, and reported tenure is large.

(4) In 1984-1987, if the worker was currently employed, was employed last period, and the worker reported the employers in the two periods were the same.

An employer change if:

(1) REASON is missing but the worker was currently employed, was not employed last period, and reported tenure is between 1 and 1.5 years. We count these observations as employer changes for the following reason.

Reported tenure could exceed 1 on a job that started after the previous interview if the time between surveys is more than a year (as it is in some cases) or if there is minor reporting error in tenure. REASON is not asked if reported job tenure is greater than one year.

(2) The worker was currently employed, REASON indicates a separation, and the reported tenure is small.

(3) In 1984-87, if the worker was currently employed and the worker reported his previous position was with another employer.

We modify the above criteria to handle gaps in the questions asked in the PSID. In particular, we do not use jobs which we determined to start and end in 1975. We omit these jobs because tenure with employer was not asked in 1975. Also, for individuals over 45 in 1978, and for all individuals in 1979 and 1980, tenure with employer was not asked. If REASON indicates a separation during this period they cannot be checked against the reported tenure numbers. Therefore, we do not record employer changes if employer tenure in 1981 is within (1) .7 of a year to being consistent with 1978 employer tenure (if available) or (2) .7 of a year of being consistent with the 1977 employer tenure value if 1978 is not available.

Job (Employer) Tenure

Tenure should increase by one year for each year spent with the current employer. Unfortunately, the reported employer tenure values in the PSID often rise by substantially more or substantially less than 1 year. (See Brown and Light (1992).) We create a tenure measure (STEN) which increases by one for each year spent with an employer.

Reported tenure with the employer is asked in 1976-1977, in 1978 for workers less than 45 years old, and in 1981-1987. For each year on the current job, we define a variable (IGAP) which indicates how consistent the reported tenure values are with all of the other reported tenure values on the job (using the job definitions constructed above). Specifically, for each year on a job, say at time period (i), we computed:

$$IGAP_i = \sum_{t=1}^{T} \mid tenure_t - tenure_i - (t-i) \mid$$

$IGAP_i$ will be large if the reported tenure in period (i) is inconsistent with the other reported tenure values on a job.

For example, suppose we observe a job for three years and in 1981 reported tenure was 1, in 1982 it was 4 and in 1983 it was 3. Then, the 1981 report is off by 2 years from the 1982 report but is exactly consistent with the 1983 report. The 1982 report is off by 2 years from both the 1981 report and the 1983 report. IGAP is sum of the absolute values of the sum of these deviations. Therefore, IGAP would be 2 in 1981, 4 in 1982, and 2 in 1983. In this case, we have less confidence in the 1982 tenure report.

The next step is to estimate the initial tenure level for the current job using the reported tenure values, taking account of the internal consistency of these tenure values. First, we create a weight equal to $(1 + IGAP_i^2)^{-1}$. This weight is normalized so that the sum of the weights for a given job equals one. Using the reported tenure values and the weights, we create an average weighted tenure level for each job. Then we calculate a second weight (IGAP2) that equals the inverse of one plus the square of the quantity obtained by dividing IGAP by the average weighted tenure. We then normalize IGAP2 to sum to one for each job. The relative values of IGAP2 for various tenure reports are less sensitive to differences in IGAP in high tenure jobs than in low tenure jobs.

Finally, the tenure level when the job is first observed in the sample is estimated by a weighted regression of the tenure reports for each job on a job specific intercept and time elapsed since the job is first observed, with the coefficient on time elapsed restricted to one and with IGAP2 as the weight. We use the job specific intercept as the estimate of tenure when the job is first observed. If estimated initial tenure is less than one month, initial tenure is set to one month. We use the estimate of tenure when the job is first observed to estimate tenure values for later observations on the job by adding one for each year spent on the current job.

For jobs that begin within the sample, we check whether the imputed initial tenure is too large (greater than 2). If it is and the initial tenure value and tenure at the end of the previous job is consistent with no change, we infer that no job change occurred, change our job definitions, and "re-smooth" tenure. If the initial tenure and final tenure on the previous jobs are not consistent and initial tenure is too large, we exclude the job and all subsequent jobs from the sample.

The outcome of this process is a smoothed tenure value which incorporates all of the reported tenure values from the survey, is reasonably consistent with our job definitions, and increases by one year for each year on the job.

Creating a Measure of Experience

We create an experience variable as follows. To measure pre-sample experience, we use responses to a question about the total number of years spent working after the age of eighteen. The question was asked of all households heads in 1974, 1976 and a subset who satisfied an employment condition in 1985. It is also asked in the year that a person becomes a household head. (A person who became a household head in 1975 and remained in the sample through 1985 might have 3 reports.) During the years that the person is in the sample we require that experience increase by 1 for each year the worker is in a job or worked positive hours. We use the data on growth in experience within the sample, the report of total experience, and the year of the report to estimate experience of the worker prior to entering the sample. (We average the different estimates of pre-sample experience for persons who have multiple experience reports.)[42]. Experience in year t is the sum of the estimate of experience prior to entering the sample and growth in experience between the entry year and year t. We also ensured that experience is greater than or equal to tenure for all observations. Our procedure guarantees that within a job, experience and tenure increase by 1 for each year.

Quits and Layoffs

If we infer a job change and REASON was "quit, resigned, retired, pregnant, needed more money, just wanted a change", then we set $Q_{it} = 1$, and to 0 otherwise. If we inferred a job change and REASON was "company folded, changed hands, moved out of town employer or went out of business", "strike or lockout" or "laid off or fired" then we set $L_{it}=1$ and to 0 otherwise. We code a separation when we inferred a job change and REASON is available, regardless of whether we could classify the job change as a quit or layoff.

[42] If the estimate of initial experience was less than zero, we set initial experience to the value implied by the earliest reported level of experience.

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TABLE 1
Simulation Results

$S_T = .5$, ω_{ij} drawn from N(.25,.25) truncated at 0 for all models.[c]

Mean of $\Delta\epsilon_{ij(t)} + \Delta v_{ijt}$[e]
Mean of $\Delta\epsilon_{ij(t)}$
Mean of Δv_{ijt}

Model	Share Params.[a,b] S_ω	S_e	SD Prod. Shock σ_e	Tenure[d] Params. OJ B_4	T B_2	Turnover Rates[e] QUIT	LAYF	LAYF EXOG.	LAYF ENDOG.	Quits: Tenure on Previous Job 0	1	5	10	20	Layoffs: Tenure on Previous Job 0	1	5	10	20
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1	0.5	0.0	0.09	0.0	0.00	0.126	0.034	0.019	0.028	**0.109**	**0.089**	**0.076**	**0.068**	**0.070**	**-0.016**	**-0.060**	**-0.118**	**-0.157**	**-0.180**
2	0.5	0.0	0.09	0.1	0.02	0.123	0.028	0.019	0.031	**0.167**	**0.137**	**0.157**	**0.198**	**0.296**	**0.078**	**-0.066**	**-0.130**	**-0.171**	**-0.176**
3	0.5	0.0	0.09	0.1	0.06	0.062	0.023	0.019	0.012	**0.178**	**0.169**	**0.265**	**0.398**	**0.684**	**0.072**	**-0.078**	**-0.107**	**-0.123**	**-0.120**
4	0.5	0.0	0.03	0.1	0.02	0.119	0.017	0.019	0.002	**0.168**	**0.136**	**0.158**	**0.199**	**0.302**	**-0.022**	**-0.101**	**-0.144**	**-0.169**	**-0.169**
5	0.8	0.0	0.09	0.0	0.00	0.170	0.086	0.019	0.107	**0.174**	**0.142**	**0.114**	**0.102**	**0.111**	**-0.042**	**-0.143**	**-0.233**	**-0.290**	**-0.308**
6	0.8	0.0	0.09	0.1	0.02	0.143	0.048	0.019	0.056	**0.238**	**0.185**	**0.192**	**0.227**	**0.335**	**0.013**	**-0.138**	**-0.242**	**-0.299**	**-0.287**
7	0.8	0.0	0.09	0.1	0.06	0.082	0.031	0.019	0.024	**0.247**	**0.219**	**0.302**	**0.436**	**0.832**	**0.043**	**-0.109**	**-0.178**	**-0.217**	**-0.211**
8	0.8	0.0	0.03	0.1	0.02	0.120	0.017	0.019	0.002	**0.240**	**0.183**	**0.194**	**0.227**	**0.328**	**-0.078**	**-0.147**	**-0.217**	**-0.261**	**-0.269**
9	0.5	.5	0.09	0.0	0.00	0.126	0.017	0.019	0.003	**0.102**	**0.084**	**0.069**	**0.061**	**0.061**	**-0.102**	**-0.124**	**-0.186**	**-0.241**	**-0.312**
										0.112	*0.088*	*0.058*	*0.040*	*0.037*	*-0.082*	*-0.095*	*-0.115*	*-0.128*	*-0.139*
										-.010	-.004	0.011	0.022	0.025	-0.021	-0.029	-0.072	-0.113	-0.174
10	0.5	0.5	0.09	0.1	0.02	0.128	0.017	0.019	0.008	**0.160**	**0.116**	**0.133**	**0.173**	**0.279**	**-0.055**	**-0.121**	**-0.185**	**-0.235**	**-0.269**
										0.162	*0.121*	*0.099*	*0.086*	*0.098*	*-0.037*	*-0.087*	*-0.122*	*-0.143*	*-0.145*
										-.002	-.004	0.034	0.088	0.182	-0.019	-0.034	-0.064	-0.092	-0.125
11	0.5	0.5	0.09	0.1	0.06	0.068	0.018	0.019	0.002	**0.168**	**0.146**	**0.244**	**0.382**	**0.612**	**-0.040**	**-0.109**	**-0.148**	**-0.168**	**-0.158**
										0.169	*0.151*	*0.172*	*0.188*	*0.222*	*-0.033*	*-0.086*	*-0.107*	*-0.115*	*-0.107*
										-.001	-.006	0.072	0.194	0.390	-0.008	-0.024	-0.042	-0.053	-0.052

(continued)

TABLE 1—Continued

Mean of $\Delta\epsilon_{ij(t)} + \Delta v_{ijt}$[e]
Mean of $\Delta\epsilon_{ij(t)}$
Mean of Δv_{ijt}

Model	Share Params.[a,b] S_ω	S_e	SD Prod. Shock σ_e	Tenure[d] Params. OJ B_4	T B_2	Turnover Rates[e] QUIT	LAYF	LAYF EXOG.	LAYF ENDOG.	Quits: Tenure on Previous Job 0	1	5	10	20	Layoffs: Tenure on Previous Job 0	1	5	10	20
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
12	0.5	0.5	0.03	0.1	0.02	0.120	0.017	0.019	0.000	**0.165**	**0.130**	**0.152**	**0.194**	**0.299**	**-0.048**	**-0.101**	**-0.149**	**-0.178**	**-0.181**
										0.165	*0.131*	*0.144*	*0.176*	*0.230*	*-0.042*	*-0.093*	*-0.137*	*-0.162*	*-0.161*
										-.001	-.001	0.008	0.018	0.069	-0.006	-0.009	-0.013	-0.017	-0.020
13	0.8	0.5	0.09	0.0	0.00	0.123	0.032	0.019	0.033	**0.171**	**0.138**	**0.108**	**0.093**	**0.095**	**-0.059**	**-0.101**	**-0.186**	**-0.255**	**-0.336**
										0.177	*0.146*	*0.122*	*0.113*	*0.128*	*-0.039*	*-0.111*	*-0.192*	*-0.237*	*-0.240*
										-.006	-.007	-.013	-.020	-0.033	-0.020	0.010	0.006	-0.018	-0.096
14	0.8	0.5	0.09	0.1	0.02	0.124	0.018	0.019	0.008	**0.235**	**0.172**	**0.179**	**0.211**	**0.309**	**-0.096**	**-0.152**	**-0.234**	**-0.297**	**-0.347**
										0.238	*0.174*	*0.160*	*0.154*	*0.174*	*-0.077*	*-0.136*	*-0.205*	*-0.245*	*-0.244*
										-.002	-.002	0.019	0.057	0.135	-0.020	-0.019	-0.030	-0.053	-0.104
15	0.8	0.5	0.09	0.1	0.06	0.077	0.018	0.019	0.002	**0.242**	**0.203**	**0.286**	**0.415**	**0.711**	**-0.089**	**-0.158**	**-0.214**	**-0.245**	**-0.239**
										0.244	*0.207*	*0.243*	*0.298*	*0.399*	*-0.075*	*-0.135*	*-0.174*	*-0.194*	*-0.187*
										-.002	-.005	0.043	0.118	0.312	-0.014	-0.023	-0.040	-0.051	-0.052
16	0.8	0.5	0.03	.0.1	0.02	0.120	0.017	0.019	0.000	**0.240**	**0.183**	**0.193**	**0.230**	**0.328**	**-0.098**	**-0.163**	**-0.235**	**-0.280**	**-0.290**
										0.240	*0.184*	*0.189*	*0.218*	*0.305*	*-0.091*	*-0.154*	*-0.224*	*-0.266*	*-0.272*
										-.001	-.001	0.005	0.012	0.023	-0.007	-0.009	-0.011	-0.014	-0.018

[a] S_ω is the worker's share of the returns to the job match component of productivity.

[b] S_e is the worker's share of the time varying match specific component of productivity.

[c] S_T is the worker's share of the return to tenure.

[d] B_2 is the effect of tenure T on productivity. The wage parameter b_2 is $S_T B_2$. B_4 is the effect of OJ (tenure greater than 1) on productivity. The wage parameter $b_4 = S_T B_4$.

[e] Column 6-9 report the estimated quit rate, layoff rate, exogenous quit rate, and endogenous quit rate.(LAYF EXOG and LAYF ENDOG sum to more than LAYOFF because in some cases both LAYF EXOG and LAYF ENDOG occur and because cases in which QUIT is 1 and LAYF EXOG and/or LAYF ENDOG are 1 are counted asquits, with LAYOFF set to 0.)
The numbers in bold in columns 10-19 are the mean of $\Delta\epsilon_{ij(t)} + \Delta v_{ijt} = S_\omega \Delta\omega_{ij(t)} + S_e \Delta e_{ijt}$. The numbers in italics are the job match gain, $\Delta\epsilon_{ij(t)} = S_\omega \Delta\omega_{ij(t)}$. The third set of numbers are the change in the random walk component, $\Delta v_{ijt} = S_e \Delta e_{ijt}$. Although much of the theoretical discussion focuses on $\Delta\epsilon_{ij(t)}$,we display the sum of the components because our estimates are likely to reflect the relationship between the sum of the components and job seniority and previous experience. (See the discussion in Section IV below.) When S_e is 0, $S_\omega \Delta\omega_{ij(t)} + S_e \Delta e_{ijt} = \Delta\epsilon_{ij(t)} + \Delta v_{ijt} = \Delta\epsilon_{ij(t)}$ and $\Delta v_{ijt} = S_e \Delta e_{ijt} = 0$, so we display only one set of numbers.

Table 2

Descriptive Statistics

VARIABLE	SAMPLE: N	Overall 9883	Mover	Stayer	Quit	Layoff	Plant Closing
Wage1	MEAN	2.2884	2.0311	2.3208	2.0729	1.9470	2.0832
	STD	0.4614	0.4984	0.4462	0.5005	0.4851	0.5348
ΔWage1	MEAN	0.0251	0.0379	0.0235	0.0797	-0.0489	-0.0036
	STD	0.2071	0.3590	0.1790	0.3462	0.3701	0.3710
ΔWage2	MEAN	0.0270	0.0119	0.0288	0.0487	-0.0661	-0.0632
	STD	0.2565	0.4207	0.2293	0.4057	0.4415	0.4037
EX_{it-1}	MEAN	16.9782	12.0831	17.5957	11.6345	13.0254	15.0048
	STD	10.3574	8.2343	10.4335	7.6687	9.2435	9.9207
$PEX_{ij(t-1)}$	MEAN	8.4234	9.3295	8.3091	9.0985	9.8059	9.8373
	STD	7.7286	7.6508	7.7313	7.3536	8.2345	7.8532
T_{it-1}	MEAN	8.5548	2.7536	9.2866	2.5360	3.2196	5.1675
	STD	8.6351	4.1980	8.7732	3.4632	5.3862	7.8083
OJ_{it-1}	MEAN	0.8536	0.5086	0.8971	0.5121	0.5055	0.5727
	STD	0.3535	0.5002	0.3038	0.5002	0.5007	0.4969
Educ-12	MEAN	0.7349	0.7679	0.7308	1.0176	0.2404	0.2828
	STD	2.5086	2.4245	2.5192	2.4539	2.2764	2.2740
$Union_{t-1}$	MEAN	0.2938	0.1310	0.3144	0.0984	0.1989	0.1909
	STD	0.4555	0.3375	0.4643	0.2980	0.3997	0.3948
Married in t -1	MEAN	0.8755	0.8121	0.8835	0.8073	0.8232	0.9000
	STD	0.3301	0.3908	0.3208	0.3947	0.3820	0.3014
Live in SMSA, t-1	MEAN	0.6296	0.5971	0.6337	0.6132	0.5635	0.5909
	STD	0.4829	0.4907	0.4818	0.4873	0.4966	0.4939
Live in City>500,000 in t-1	MEAN	0.2137	0.1969	0.2158	0.1927	0.2044	0.2364
	STD	0.4099	0.3979	0.4114	0.3947	0.4038	0.4268

* Summary statistics for ΔWAGE1 regression sample. The sample size is 9883. The summary statistics in the table for ΔWAGE2 are for the 8923 cases with nonmissing data that are in the ΔWAGE1 sample.

Table 3a

Separation Rates, by Experience and Lagged Tenure

Experience Level		Tenure Last Year					
		0≤ T <1	1≤ T <3	3≤ T <6	6≤ T<15	T >=15	all tenure
0≤ E_{it}<5	Mean	0.3964	0.1276	0.1750	.	.	0.2444
	N	169	196	40	.	.	405
5≤ E_{it}<10	Mean	0.3908	0.1474	0.0913	0.0672	.	0.1752
	N	476	685	690	238	.	2089
10≤ E_{it}<20	Mean	0.3706	0.1438	0.0962	0.0420	0.0082	0.1150
	N	510	723	780	1691	122	3826
E_{it} ≥20	Mean	0.3607	0.1029	0.0661	0.0449	0.0142	0.0567
	N	219	340	333	913	1758	3563
all E_{it} category	Mean	0.3792	0.1363	0.0906	0.0450	0.0138	0.1120
	N	1374	1944	1843	2842	1880	9883

Table 3b

Quit Rates By Experience and Lagged Tenure

Experience Level		Tenure Last Year					
		0≤ T <1	1≤ T <3	3≤ T <6	6≤ T<15	T ≥15	all tenure
0≤ E_{it}<5	Mean	0.2308	0.0867	0.1750	.	.	0.1556
	N	169	196	40	.	.	405
5≤ E_{it}<10	Mean	0.2626	0.1066	0.0580	0.0672	.	0.1216
	N	476	685	690	238	.	2089
10≤E_{it}<20	Mean	0.2490	0.0968	0.0744	0.0284	0.0082	0.0795
	N	510	723	780	1691	122	3826
E_{it} ≥20	Mean	0.2420	0.0647	0.0450	0.0241	0.0051	0.0340
	N	219	340	333	913	1758	3563
all E_{it} category	Mean	0.2504	0.0936	0.0651	0.0303	0.0053	0.0751
	N	1374	1944	1843	2842	1880	9883

Table 3c

Layoff Rates by Experience and Lagged Tenure

Experience Level		Tenure Last Year					
		$0 \leq T < 1$	$1 \leq T < 3$	$3 \leq T < 6$	$6 \leq T < 15$	$T \geq 15$	all tenure
$0 \leq E_{it} < 5$	Mean	0.1657	0.0408	0.0000	.	.	0.0889
	N	169	196	40	.	.	405
$5 \leq E_{it} < 10$	Mean	0.1239	0.0409	0.0333	0.0000	.	0.0527
	N	476	685	690	238	.	2089
$10 \leq E_{it} < 20$	Mean	0.1196	0.0470	0.0218	0.0136	0.0000	0.0353
	N	510	723	780	1691	122	3826
$E_{it} \geq 20$	Mean	0.1187	0.0382	0.0210	0.0208	0.0091	0.0227
	N	219	340	333	913	1758	3563
all E_{it} category	Mean	0.1266	0.0427	0.0255	0.0148	0.0085	0.0366
	N	1374	1944	1843	2842	1880	9883

Table 3d

Layoffs Due to Plant Closing, by Experience and Lagged Tenure

Experience Level		Tenure Last Year					
		$0 \leq T < 1$	$1 \leq T < 3$	$3 \leq T < 6$	$6 \leq T < 15$	$T \geq 15$	all tenure
$0 \leq E_{it} < 5$	Mean	0.0355	0.0102	0.0000	.	.	0.0198
	N	169	196	40	.	.	405
$5 \leq E_{it} < 10$	Mean	0.0294	0.0073	0.0101	0.0000	.	0.0124
	N	476	685	690	238	.	2089
$10 \leq E_{it} < 20$	Mean	0.0392	0.0152	0.0038	0.0047	0.0000	0.0110
	N	510	723	780	1691	122	3826
$E_{it} \geq 20$	Mean	0.0274	0.0088	0.0120	0.0099	0.0068	0.0095
	N	219	340	333	913	1758	3563
all E_{it} category	Mean	0.0335	0.0108	0.0076	0.0060	0.0064	0.0111
	N	1374	1944	1843	2842	1880	9883

Table 4a

Log Wage Change (ΔWAGE1) by Tenure and Experience, STAYERS

Experience Level		Tenure last Year				
		$0 \le T < 1$	$1 \le T < 3$	$3 \le T < 6$	$6 \le T < 15$	$T \ge 15$
$0 \le E_{it} < 5$	Mean	0.05748	0.07954	0.05249	.	.
	Std. Error	0.01670	0.01275	0.03395	.	.
	Std. Dev.	0.16870	0.16674	0.19501	.	.
$5 \le E_{it} < 10$	Mean	0.04611	0.06708	0.03032	0.00607	.
	Std. Error	0.01263	0.00653	0.00622	0.01214	.
	Std. Dev.	0.21504	0.15775	0.15572	0.18095	.
$10 \le E_{it} < 20$	Mean	0.02228	0.02257	0.02826	0.01964	-0.01723
	Std. Error	0.01278	0.00768	0.00685	0.00460	0.01951
	Std. Dev.	0.22897	0.19098	0.18193	0.18506	0.21464
$E_{it} \ge 20$	Mean	0.01134	0.02333	0.02194	0.00713	0.01129
	Std. Error	0.01832	0.01077	0.00943	0.00558	0.00392
	Std. Dev.	0.21673	0.18813	0.16636	0.16463	0.16327

Table 4b

Log Wage Change (ΔWAGE1) by Tenure and Experience, QUITS AND LAYOFFS

Experience Level		Tenure last Year				
		$0 \le T < 1$	$1 \le T < 3$	$3 \le T < 6$	$6 \le T < 15$	$T \ge 15$
$0 \le E_{it} < 5$	Mean	0.16354	-0.02228	0.03245	.	.
	Std. Error	0.03771	0.07358	0.11879	.	.
	Std. Dev.	0.30865	0.36792	0.31430	.	.
$5 \le E_{it} < 10$	Mean	0.10035	0.07671	-0.02761	0.00827	.
	Std. Error	0.02922	0.03304	0.04503	0.07260	.
	Std. Dev.	0.39850	0.33205	0.35745	0.29041	.
$10 \le E_{it} < 20$	Mean	0.05398	0.02808	-0.01093	0.00764	0.00552
	Std. Error	0.02944	0.03262	0.03602	0.03896	.
	Std. Dev.	0.40477	0.33262	0.31194	0.32830	.
$E_{it} \ge 20$	Mean	0.02384	-0.02727	0.00768	-0.10808	-0.12098
	Std. Error	0.03731	0.04821	0.04270	0.05972	0.07665
	Std. Dev.	0.33165	0.28522	0.20026	0.38238	0.38324

Table 4c

Log Wage Change (ΔWAGE1) by Tenure and Experience, QUITS

Experience Level		Tenure last Year				
		0≤ T < 1	1≤ T < 3	3≤ T < 6	6≤ T<15	T ≥15
$0 \leq E_{it} < 5$	Mean	0.26138	-0.00849	0.03245	.	.
	Std. Error	0.03712	0.10512	0.11879	.	.
	Std. Dev.	0.23183	0.43343	0.31430	.	.
$5 \leq E_{it} < 10$	Mean	0.14516	0.10841	0.04439	0.00827	.
	Std. Error	0.03531	0.03925	0.05262	0.07260	.
	Std. Dev.	0.39475	0.33538	0.33280	0.29041	.
$10 \leq E_{it} < 20$	Mean	0.04939	0.07372	0.04255	0.04355	0.00552
	Std. Error	0.03464	0.03890	0.03740	0.04221	.
	Std. Dev.	0.39033	0.32548	0.28485	0.29244	.
$E_{it} \geq 20$	Mean	0.08530	0.07068	0.05036	-0.06679	-0.05571
	Std. Error	0.04578	0.04953	0.05517	0.08793	0.10583
	Std. Dev.	0.33329	0.23230	0.21366	0.41242	0.31750

Table 4d

Log Wage Change (ΔWAGE1) by Tenure and Experience, LAYOFFS

Experience Level		Tenure last Year				
		0≤ T < 1	1≤ T < 3	3≤ T < 6	6≤ T<15	T ≥15
$0 \leq E_{it} < 5$	Mean	0.02726	-0.05159	.	.	.
	Std. Error	0.06658	0.06449	.	.	.
	Std. Dev.	0.35233	0.18240	.	.	.
$5 \leq E_{it} < 10$	Mean	-0.00285	-0.00593	-0.15283	.	.
	Std. Error	0.05137	0.05935	0.07744	.	.
	Std. Dev.	0.39460	0.31404	0.37139	.	.
$10 \leq E_{it} < 20$	Mean	0.06682	-0.06588	-0.19339	-0.06730	.
	Std. Error	0.05618	0.05696	0.08234	0.08118	.
	Std. Dev.	0.43877	0.33212	0.33948	0.38930	.
$E_{it} \geq 20$	Mean	-0.10144	-0.19305	-0.08377	-0.15590	-0.15769
	Std. Error	0.05811	0.08260	0.05283	0.08013	0.10525
	Std. Dev.	0.29628	0.29780	0.13977	0.34928	0.42100

Table 4e

Log Wage Changes (ΔWAGE1) by Tenure and Experience, PLANT CLOSINGS

Experience Level		Tenure last Year				
		$0 \leq T < 1$	$1 \leq T < 3$	$3 \leq T < 6$	$6 \leq T < 15$	$T \geq 15$
$0 \leq E_{it} < 5$	Mean	0.05423	-0.01102	.	.	.
	Std. Error	0.03532	0.20827	.	.	.
	Std. Dev.	0.08652	0.29454	.	.	.
$5 \leq E_{it} < 10$	Mean	0.11723	-0.04636	-0.06336	.	.
	Std. Error	0.08923	0.17462	0.18204	.	.
	Std. Dev.	0.33388	0.39047	0.48162	.	.
$10 \leq E_{it} < 20$	Mean	0.10751	-0.08066	-0.15644	0.11488	.
	Std. Error	0.12401	0.08602	0.10428	0.08809	.
	Std. Dev.	0.55459	0.28530	0.18062	0.24917	.
$E_{it} \geq 20$	Mean	-0.03765	0.14261	-0.12274	-0.14621	-0.14783
	Std. Error	0.07968	0.04803	0.08383	0.10481	0.11931
	Std. Dev.	0.19518	0.08319	0.16766	0.31442	0.41331

Table 5

WAGE GROWTH EQUATIONS: (Dep Variable: ΔWAGE2, Change in log earnings/hour)[1 2]

VARIABLE	Mean (Std. Dev.)	(1)	(2)	(3)
ΔTIME	1.0330	0.0704	0.0614	0.0609
	(0.2826)	(0.0093)	(0.0098)	(0.0098)
$\Delta T_{it}^2/100$	0.1416	−0.0045	0.0181	0.0254
	(0.3976)	(0.0166)	(0.0190)	(0.0217)
ΔOJ_{it}	0.0551		0.0291	0.0297
	(0.3989)		(0.0104)	(0.0107)
$\Delta EX_{it}^2/100$	0.3573	−0.2601	−0.2397	−0.2404
	(0.2267)	(0.0531)	(0.0525)	(0.0526)
$\Delta EX_{it}^3/1000$	1.2583	0.0349	0.0308	0.0303
	(1.3759)	(0.0079)	(0.0077)	(0.0076)
$\Delta\{EX_{it}*(Educ - 12)\}$	0.7777	0.0040	0.0040	0.0040
	(2.6425)	(0.0009)	(0.0009)	(0.0009)
Q_{it}	0.0788	−0.0213	−0.0092	−0.0095
	(0.2695)	(0.0464)	(0.0492)	(0.0497)
L_{it}	0.0373	−0.1820	−0.1424	−0.1398
	(0.1894)	(0.0661)	(0.0705)	(0.0709)
$Q_{it}*T_{it-1}$	0.1938	−0.0109	−0.0041	−0.0030
	(1.2228)	(0.0052)	(0.0068)	(0.0095)
$Q_{it}*T_{it-1}^2/10$	0.1533			0.0003
	(2.2342)			(0.0036)
$Q_{it}*OJ_{it-1}$	0.0386		−0.0009	−0.0026
	(0.1927)		(0.0361)	(0.0403)
$Q_{it}*PEX_{ij(t-1)}$	0.7011	0.0182	0.0170	0.0170
	(3.1101)	(0.0124)	(0.0125)	(0.0125)
$Q_{it}*PEX_{ij(t-1)}^2/100$	0.1016	−0.1489	−0.1444	−0.1445
	(0.6739)	(0.0927)	(0.0939)	(0.0941)
$Q_{it}*PEX_{ij(t-1)}^3/1000$	0.1977	0.0316	0.0314	0.0314
	(1.8743)	(0.0191)	(0.0194)	(0.0194)
$L_{it}*T_{it-1}$	0.1119	−0.0153	−0.0060	−0.0120
	(1.1465)	(0.0059)	(0.0072)	(0.0165)
$L_{it}*T_{it-1}^2/10$	0.1327			0.00302
	(2.6189)			(0.00668)
$L_{it}*OJ_{it-1}$	0.0189		−0.0542	−0.0377
	(0.1362)		(0.0499)	(0.0625)
$L_{it}*PEX_{ij(t-1)}$	0.3767	0.0346	0.0321	0.0320
	(2.4832)	(0.0179)	(0.0179)	(0.0178)
$L_{it}*PEX_{ij(t-1)}^2/100$	0.0631	−0.2236	−0.2126	−0.2107
	(0.5876)	(0.1330)	(0.1333)	(0.1333)
$L_{it}*PEX_{ij(t-1)}^3/1000$	0.1374	0.0418	0.0405	0.0401
	(1.6990)	(0.0272)	(0.0274)	(0.0274)
R-Squared		0.0311	0.0328	0.0329
MSE		0.071046	0.070940	0.070960

1. The mean and standard deviation of the dependent variable are 0.0273 and 0.2691. The sample size is 10466. See the text for a list of additional control variables that are included in all of the models. The equations are variants of equation (2.12).
2. The standard errors allow for arbitrary person specific error covariance patterns.

Table 6
WAGE GROWTH EQUATIONS: (Dep. Variable: ΔWAGE1, Change in log reported wage)[1 2]

VARIABLE	Mean (Std. Dev.)	(1)	(2)	(3)
ΔTIME	1.0334	0.0519	0.0487	0.0488
	(0.2921)	(0.0073)	(0.0078)	(0.0077)
$\Delta T_{it}^2/100$	0.1462	-0.0096	0.0139	0.0105
	(0.3747)	(0.0172)	(0.0181)	(0.0141)
ΔOJ_{it}	0.0501		0.0078	0.0074
	(0.3920)		(0.0084)	(0.0084)
$\Delta EX_{it}^2/100$	0.3590	-0.1665	-0.1621	-0.1613
	(0.2290)	(0.0398)	(0.0401)	(0.0403)
$\Delta EX_{it}^3/1000$	1.2676	0.0214	0.0189	0.0190
	(1.3840)	(0.0059)	(0.0059)	(0.0058)
$\Delta\{EX_{it}*(Educ - 12)\}$	0.7514	0.0039	0.0039	0.0039
	(2.6674)	(0.0008)	(0.0008)	(0.0008)
Q_{it}	0.0751	0.0877	0.1033	0.1045
	(0.2635)	(0.0360)	(0.0373)	(0.0384)
L_{it}	0.0366	-0.0898	-0.0446	-0.0455
	(0.1879)	(0.0561)	(0.0587)	(0.0586)
$Q_{it}*T_{it-1}$	0.1904	-0.0101	-0.0023	-0.0038
	(1.1602)	(0.0043)	(0.0053)	(0.0091)
$Q_{it}*T_{it-1}^2/10$	0.1382			0.0005
	(1.6726)			(0.0045)
$Q_{it}*OJ_{it-1}$	0.0385		-0.0391	-0.0362
	(0.1923)		(0.0312)	(0.0363)
$Q_{it}*PEX_{ij(t-1)}$	0.6831	0.0041	0.0030	0.0029
	(3.1311)	(0.0091)	(0.0091)	(0.0092)
$Q_{it}*PEX_{ij(t-1)}^2/100$	0.1027	-0.0851	-0.0791	-0.0783
	(0.7106)	(0.0652)	(0.0654)	(0.0658)
$Q_{it}*PEX_{ij(t-1)}^3/1000$	0.2087	0.0205	0.0196	0.0195
	(2.0937)	(0.0124)	(0.0125)	(0.0125)
$L_{it}*T_{it-1}$	0.1179	-0.0084	0.0023	0.0056
	(1.1940)	(0.0050)	(0.0057)	(0.0139)
$L_{it}*T_{it-1}^2/10$	0.1439			-0.0016
	(2.6882)			(0.0058)
$L_{it}*OJ_{it-1}$	0.0185		-0.0988	-0.1085
	(0.1348)		(0.0419)	(0.0525)
$L_{it}*PEX_{ij(t-1)}$	0.3592	0.0150	0.0113	0.0114
	(2.4229)	(0.0158)	(0.0157)	(0.0157)
$L_{it}*PEX_{ij(t-1)}^2/100$	0.0600	-0.1140	-0.0913	-0.0922
	(0.5835)	(0.1086)	(0.1084)	(0.1081)
$L_{it}*PEX_{ij(1-1)}^3/1000$	0.1326	0.0218	0.0180	0.0182
	(1.7188)	(0.0204)	(0.0205)	(0.0204)
R-Squared		0.0493	0.0513	0.0514
MSE		0.0415	0.0414	0.0414

1. The mean and standard deviation of the dependent variable are 0.0251 and 0.2071. The sample size is 9883. See the text for a list of additional control variables that are included in all of the models. The equations are variants of equation (2.12).
2. The standard errors allow for arbitrary person specific error covariance patterns.

Table 7[1]

Estimates of the Return to Tenure and Experience

	Dep Var: ΔWAGE2			Dep Var: ΔWAGE1	
	Assumption about linear tenure coefficient (b_2) and linear experience coefficient (b_0)				
	b_0=.0565 b_2=.0041	b_0=.0546 b_2=.0060	b_0=.0442 b_2=.0164	b_0=.0447 b_2=.0023	b_0=.0316 b_2=.0154
	(1)	(2)	(3)	(4)	(5)
2 Years of Tenure	0.0381 (0.0139)	0.0418 (0.0151)	0.0627	0.0129 (0.0116)	0.0391
5 Years of Tenure	0.0542 (0.0289	0.0636 (0.0321)	0.1157	0.0226 (0.0234)	0.0881
10 Years of Tenure	0.0883 (0.0519)	0.1072 (0.0595)	0.2114	0.0442 (0.0419)	0.1753
15 Years of Tenure	0.1315 (0.0704)	0.1598 (0.0841)	0.3161	0.0729 (0.0584)	0.2694
5 Years of Experience	0.2263 (0.0474)	0.2169 (0.0492)	0.1648	0.1855 (0.0370)	0.1200
10 Years of Experience	0.3559 (0.0793)	0.3371 (0.0844)	0.2328	0.30416 (0.0627)	0.1731
30 Years of Experience	0.3693 (0.1551)	0.3127 (0.1866)	0.0	0.3932 (0.1325)	0.0

1. See the text. The results in columns 1, 2, and 3 are calculated using the wage coefficients in Table 5 column 2. The time trend in wages is set to .00083. The results in columns 4 and 5 use the coefficients from Table 6, column 2 for the calculations. The time trend in wages is .00168. In column 1 and column 4 the source of the estimate of b_2 is the coefficient on $-Q_{it}T_{it-1}$, which is an estimate of $(b_2 - d_2)$. In column 2 the source is the coefficient on $-L_{it}T_{it-1}$, which is an estimate of $(b_2 - g_2)$. In columns 3 and 5 the coefficients are set so that the value of 30 years of experience is 0. White standard errors are in parentheses. We do not report standard errors for the cases in columns 3 and 5 in which b_2 and b_0 are chosen so that the value of 30 years of experience is 0.

Table 8a

Decompositions of Wage Changes Associated with Quits and Layoffs, by Prior Experience and Tenure at Time of the Separation

Dependent variable: ΔWAGE1 (Change in log wage/hour)

(b_2 set to coefficient on $-Q_{it}T_{it-1}$)

		Quit or Layoff			Quits		Layoffs	
		ΔT	ΔEX	ΔT+ΔEX (1+2)	$\Delta\epsilon_{ij(t)}$	Total (3+4)	$\Delta\epsilon_{ij(t)}$	Total (3+6)
$PEX_{ij(t-1)}$	T_{it-1}	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	0	0.00000	0.04000	0.04000	0.1078	0.14786	-0.03184	0.00816
1	2	-0.01287	0.03408	0.02122	0.0687	0.08996	-0.12151	-0.10029
1	5	-0.02256	0.02606	0.00351	0.0687	0.07225	-0.10778	-0.10427
1	10	-0.04424	0.01495	-0.02929	0.0687	0.03945	-0.08488	-0.11417
1	20	-0.10838	0.00123	-0.10715	0.0687	-0.03841	-0.03910	-0.14625
5	0	0.00000	0.02862	0.02862	0.1034	0.13209	-0.00613	0.02249
5	2	-0.01287	0.02361	0.01075	0.0643	0.07509	-0.09580	-0.08505
5	5	-0.02256	0.01694	-0.00561	0.0643	0.05874	-0.08207	-0.08767
5	10	-0.04424	0.00810	-0.03614	0.0643	0.02821	-0.05917	-0.09531
5	20	-0.10838	-0.00108	-0.10947	0.0643	-0.04513	-0.01339	-0.12286
10	0	0.00000	0.01694	0.01695	0.0764	0.09342	-0.00211	0.01484
10	2	-0.01287	0.01307	0.00020	0.0373	0.03756	-0.09177	-0.09157
10	5	-0.02256	0.00810	-0.01445	0.0373	0.02290	-0.07804	-0.09249
10	10	-0.04424	0.00209	-0.04215	0.0373	-0.00479	-0.05515	-0.09729
10	20	-0.10838	-0.00143	-0.10982	0.0373	-0.07246	-0.00936	-0.11918
20	0	0.00000	0.00209	0.00209	0.0067	0.00884	-0.03646	-0.03437
20	2	-0.01287	0.00048	-0.01239	-0.0323	-0.04476	-0.12613	-0.13852
20	5	-0.02256	-0.00108	-0.02364	-0.0323	-0.05602	-0.11240	-0.13604
20	10	-0.04424	-0.00143	-0.04567	-0.0323	-0.07805	-0.08950	-0.13518
20	20	-0.10838	0.00636	-0.10201	-0.0323	-0.13439	-0.04372	-0.14573
30	0	0.00000	-0.00143	-0.00143	0.0140	0.01262	-0.03739	-0.03882
30	2	-0.01287	-0.00077	-0.01365	-0.0250	-0.03871	-0.12705	-0.14070
30	5	-0.02256	0.00105	-0.02150	-0.0250	-0.04657	-0.11332	-0.13482
30	10	-0.04424	0.00636	-0.03787	-0.0250	-0.06293	-0.09042	-0.12830
30	20	-0.10838	0.02550	-0.08288	-0.0250	-0.10794	-0.04464	-0.12752

Notes: These tables are based on the estimates in Table 6, column 2 and so assume the linear experience coefficient (b_0) is .04474, the linear tenure coefficient (b_2) is .0023, and the linear time coefficient is .00168. Column 1 contains the wage change due to the change in tenure in the event of a quit or layoff. Column 2 contains the wage change due to the change in experience. Column 3 is the sum of Columns 1 and 2. Column 4 is the change in the job match component in the event of a quit. Column 5 is the sum of columns 3 and 4 and is the total predicted wage change for a quit. Columns 6 and 7 are analogous to columns 4 and 5 but refer to layoffs. (Column 7 is the sum of columns 3 and 6).

Table 8b

Decompositions of Wage Changes Associated with Quits and Layoffs, by Prior Experience and Tenure at Time of the Separation.

Dependent Variable: ΔWAGE2 (Change in log earnings/hour)

(b_2 set to coefficient on $-Q_{it}T_{it-1}$)

		Quit or Layoff			Quits		Layoffs	
		ΔT	ΔEX	ΔT+ΔEX	$\Delta\epsilon_{ij(t)}$	Total (3+4)	$\Delta\epsilon_{ij(t)}$	Total (3+6)
$PEX_{ij(t-1)}$	T_{it-1}	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	0	0.00000	0.04950	0.04950	0.01044	0.05995	-0.10822	-0.05872
1	2	-0.03807	0.04084	0.00277	0.00952	0.01229	-0.16617	-0.16340
1	5	-0.05420	0.02923	-0.02497	0.00952	-0.01544	-0.17183	-0.19679
1	10	-0.08832	0.01358	-0.07474	0.00952	-0.06522	-0.18125	-0.25599
1	20	-0.18374	-0.00384	-0.18758	0.00952	-0.17806	-0.20010	-0.38768
5	0	0.00000	0.03291	0.03292	0.04755	0.08048	-0.02571	0.00721
5	2	-0.03807	0.02573	-0.01234	0.04663	0.03430	-0.08366	-0.09599
5	5	-0.05420	0.01634	-0.03785	0.04663	0.00878	-0.08931	-0.12717
5	10	-0.08832	0.00439	-0.08393	0.04663	-0.03729	-0.09874	-0.18267
5	20	-0.18374	-0.00563	-0.18938	0.04663	-0.14274	-0.11759	-0.30697
10	0	0.00000	0.01634	0.01635	0.05154	0.06789	0.01091	0.02726
10	2	-0.03807	0.01101	-0.02706	0.05061	0.02356	-0.04704	-0.07410
10	5	-0.05420	0.00439	-0.04980	0.05061	0.00082	-0.05269	-0.10250
10	10	-0.08832	-0.00293	-0.09126	0.05061	-0.04064	-0.06212	-0.15337
10	20	-0.18374	-0.00372	-0.18746	0.05061	-0.13684	-0.08097	-0.26843
20	0	0.00000	-0.00293	-0.00293	0.00749	0.00457	-0.02230	-0.02523
20	2	-0.03807	-0.00456	-0.04264	0.00657	-0.03606	-0.08025	-0.12289
20	5	-0.05420	-0.00563	-0.05984	0.00657	-0.05326	-0.08590	-0.14574
20	10	-0.08832	-0.00372	-0.09205	0.00657	-0.08547	-0.09533	-0.18737
20	20	-0.18374	0.01397	-0.16977	0.00657	-0.16319	-0.11418	-0.28394
30	0	0.00000	-0.00372	-0.00372	0.05086	0.04714	0.00484	0.00112
30	2	-0.03807	-0.00166	-0.03973	0.04994	0.01021	-0.05311	-0.09284
30	5	-0.05420	0.00281	-0.05139	0.04994	-0.00145	-0.05877	-0.11015
30	10	-0.08832	0.01397	-0.07435	0.04994	-0.02441	-0.06819	-0.14254
30	20	-0.18374	0.05015	-0.13358	0.04994	-0.08364	-0.08704	-0.22063

(b_2 set to coefficient on $-L_{it}T_{it-1}$)

		Quit or Layoff			Quits		Layoffs	
		ΔT	ΔEX	ΔT+ΔEX	$\Delta\epsilon_{ij(t)}$	Total (3'+4')	$\Delta\epsilon_{ij(t)}$	Total (3'+6')
$PEX_{ij(t-1)}$	T_{it-1}	(1')	(2')	(3')	(4')	(5')	(6')	(7')
1	0	0.00000	0.04761	0.04762	0.01232	0.05995	-0.10634	-0.05872
1	2	-0.04184	0.03895	-0.00289	0.01517	0.01229	-0.16052	-0.16340
1	5	-0.06363	0.02734	-0.03628	0.02083	-0.01544	-0.16052	-0.19679
1	10	-0.10718	0.01170	-0.09547	0.03025	-0.06522	-0.16052	-0.25599
1	20	-0.22144	-0.00572	-0.22717	0.04910	-0.17806	-0.16052	-0.38768
5	0	0.00000	0.03103	0.03103	0.04944	0.08048	-0.02383	0.00721
5	2	-0.04184	0.02385	-0.01799	0.05229	0.03430	-0.07800	-0.09599
5	5	-0.06363	0.01446	-0.04916	0.05794	0.00878	-0.07800	-0.12717
5	10	-0.10718	0.00251	-0.10466	0.06737	-0.03729	-0.07800	-0.18267
5	20	-0.22144	-0.00752	-0.22896	0.08622	-0.14274	-0.07800	-0.30697
10	0	0.00000	0.01446	0.01446	0.05342	0.06789	0.01279	0.02726
10	2	-0.04184	0.00912	-0.03271	0.05627	0.02356	-0.04138	-0.07410
10	5	-0.06363	0.00251	-0.06111	0.06193	0.00082	-0.04138	-0.10250
10	10	-0.10718	-0.00481	-0.11199	0.07135	-0.04064	-0.04138	-0.15337
10	20	-0.22144	-0.00560	-0.22705	0.09020	-0.13684	-0.04138	-0.26843
20	0	0.00000	-0.00481	-0.00482	0.00938	0.00457	-0.02041	-0.02523
20	2	-0.04184	-0.00645	-0.04829	0.01223	-0.03606	-0.07459	-0.12289
20	5	-0.06363	-0.00752	-0.07115	0.01788	-0.05326	-0.07459	-0.14574
20	10	-0.10718	-0.00560	-0.11278	0.02731	-0.08547	-0.07459	-0.18737
20	20	-0.22144	0.01208	-0.20935	0.04616	-0.16319	-0.07459	-0.28394
30	0	0.00000	-0.00560	-0.00561	0.05274	0.04714	0.00672	0.00112
30	2	-0.04184	-0.00354	-0.04539	0.05559	0.01021	-0.04746	-0.09284

30	5	-0.06363	0.00092	-0.06270	0.06125	-0.00145	-0.04746	-0.11015
30	10	-0.10718	0.01208	-0.09509	0.07067	-0.02441	-0.04746	-0.14254
30	20	-0.22144	0.04826	-0.17317	0.08952	-0.08364	-0.04746	-0.22063

Notes: This table presents results based on Column 2 of Table 5. Two different assumptions about the linear experience and tenure coefficients. In columns 1-5, the linear experience coefficient (b_0) is .05648, the linear tenure coefficient (b_2) is .0041, and the linear time coefficient is .000832. Column 1 contains the wage change due to the change in tenure in the event of a quit or layoff. Column 2 contains the wage change due to the change in experience. Column 3 is the sum of Columns 1 and 2. Column 4 is the change in the job match component in the event of a quit. Column 5 is the sum of columns 3 and 4 and is the total predicted wage change for a quit. Columns 6 and 7 are analogous to columns 4 and 5 but refer to layoffs. (Column 7 is the sum of column 3 and 6). The lower panel of the table repeats the calculations under the assumptions that the linear experience coefficient (b_0) is .05459, the linear tenure coefficient (b_2) is .00599, and the linear time coefficient is .000832.

Table 9

A Decomposition of Wage Growth Over the Career[1]
Results using ΔWAGE2, Table 5, column 2. Time trend = .00083

	Experience Level (Mean of Var)	experience (b_0) and tenure coefficients (b_2) b_0=.0565 b_2=.0041 (1)	b_0=.0546 b_2=.0060 (2)	b_0=.0442 b_2=.0164 (3)
Accumulated Effect of Tenure	10 Years (4.02)	0.0437	0.0512	0.0932
	30 Years (15.19)	0.1493	0.1780	0.3364
Accumulated Effect of Experience	10 Years (10)	0.3559	0.3371	0.2328
	30 Years (30)	0.3693	0.3127	0.0000
Accumulated Effect of Quits	10 Years (2.85)	0.0568	0.0671	0.1242
	30 Years (4.89)	0.1204	0.1465	0.2913
Accumulated Effect of Layoffs	10 Years (1.19)	−0.1326	−0.1281	−0.1033
	30 Years (2.35)	−0.1908	−0.1759	−0.0931
Total	10 Years	0.3238	0.3273	0.3468
	30 Years	0.4482	0.4614	0.5346

Table 9, continued

Results using ΔWAGE1, Table 6, column 2. Time trend = .00168

experience (b_0) and tenure coefficients (b_2)

	Experience Level (Mean of Var)	b_0=.0470 b_2=.0023 (1)	b_0=.0316 b_2=.0154 (2)
Accumulated Effect of Tenure	10 Years (4.02)	0.0187	0.0714
	30 Years (15.19)	0.0875	0.2867
Accumulated Effect of Experience	10 Years (10)	0.3042	0.1731
	30 Years (30)	0.3932	0.0000
Accumulated Effect of Quits	10 Years (2.85)	0.2707	0.3424
	30 Years (4.89)	0.3257	0.5077
Accumulated Effect of Layoffs	10 Years (1.19)	-0.0606	-0.0294
	30 Years (2.35)	-0.1288	-0.0248
Total Career Effect	10 Years	0.5330	0.5575
	30 Years	0.6776	0.7696

1. See Text for details.

Table 10

Restricted Weighted Least Squares Estimates of the Models for W_{ijt} and $\Delta W_{ij(t)}$

Wage Measure: WAGE2

Variable: Within Job	Variable: Across Job	(1)	(2)	(3)
$\widetilde{EX}_{ijt}$	$\Delta\overline{EX}_{ijt}$	0.0610	0.0531	0.0529
		(0.0033)	(0.0034)	(0.0034)
$\widetilde{T}_{ijt}^2/100$	$\Delta\overline{T}_{ij(t)}^2/100$	−0.0090	0.0050	0.0055
		(0.0054)	(0.0056)	(0.0057)
$\widetilde{OJ}_{ijt}$	$\Delta\overline{OJ}_{ij(t)}$		0.0636	0.0636
			(0.0067)	(0.0067)
$\widetilde{EX}_{ijt}^2/100$	$\Delta\overline{EX}_{ij(t)}^2/100$	−0.1611	−0.1402	−0.1398
		(0.0178)	(0.0178)	(0.0178)
$\widetilde{EX}_{ijt}^3/1000$	$\Delta\overline{EX}_{ij(t)}^3/1000$	0.0178	0.0142	0.0141
		(0.0027)	(0.0027)	(0.0027)
$\widetilde{EX}_{ijt}$* (Educ−12)	$\Delta\overline{EX}_{ijt}$* (Educ−12)	0.0233	0.0179	0.0193
		(0.0427)	(0.0425)	(0.0427)
$\widetilde{TIME}_{ijt}$* (Educ−12)	$\Delta\overline{TIME}_{ijt}$* (Educ−12)	−0.0172	−0.0119	−0.0132
		(0.0425)	(0.0424)	(0.0425
	Q_{ijt}	−0.0130	−0.0246	−0.0176
		(0.0447)	(0.0476)	(0.0480)
	L_{ijt}	−0.1211	−0.0886	−0.0889
		(0.0600)	(0.0634)	(0.0636)
	Q_{ijt}*T_{ijt-1}	−0.0135	−0.0098	−0.0193
		(0.0042)	(0.0050)	(0.0104
	Q_{ijt}*$T_{ijt-1}^2/100$			0.0439
				(0.0422)
	Q_{ijt}*OJ_{ijt-1}		0.0501	0.0725
			(0.0357)	(0.0416)
	Q_{ijt}*$PEX_{ij(t-1)}$	0.0181	0.0165	0.0155
		(0.0123)	(0.0124)	(0.0124)
	Q_{ijt}*$PEX_{ij(t-1)}^2/100$	−0.1659	−0.1597	−0.1534
		(0.0937)	(0.0938)	(0.0940)
	Q_{ijt}*$PEX_{ij(t-1)}^3/1000$	0.0379	0.0373	0.0361
		(0.0194)	(0.0194)	(0.0194)
	L_{ijt}*T_{ijt-1}	−0.0162	−0.0087	−0.0069
		(0.0042)	(0.0048)	(0.0132)
	L_{ijt}*$T_{ijt-1}^2/100$			−0.0062
				(0.0468)
	L_{ijt}*OJ_{ijt-1}		−0.0291	−0.0340
			(0.0461)	(0.0559)
	L_{ijt}*$PEX_{ij(t-1)}$	0.0161	0.0122	0.0121
		(0.0167)	(0.0167)	(0.0167)
	L_{ijt}*$PEX_{ij(t-1)}^2/100$	−0.0938	−0.0771	−0.0766
		(0.1261)	(0.1256)	(0.1256)
	L_{ijt}*$PEX_{ij(t-1)}^3/1000$	0.0168	0.0147	0.0147

(0.0255)	(0.0254)	(0.0254)

Notes. The sample consists of 14474 total observations, with 13243 observations on equation (7.1) and 1227 observations on equation (7.4). The equations are estimated jointly by restricted weighted least squares using the OLS residuals to estimate weights for the within job observations, quits, and layoffs. The variables in the first column refer to equation (7.1) and the variables in the second column refer to equation (7.4).

Table 11

Restricted Weighted Least Squares Estimates of the Models for W_{ijt} and $\Delta W_{ij(t)}$

Wage Measure: WAGE1

Variable: Within Job	Variable: Across Job	(1)	(2)	(3)
$\widetilde{EX}_{ijt}$	$\Delta\overline{EX}_{ijt}$	0.0483	0.0454	0.0455
		(0.0033)	(0.0034)	(0.0034)
$\widetilde{T}_{ijt}^2/100$	$\Delta\overline{T}_{ij(t)}^2/100$	-0.0154	-0.0092	-0.0096
		(0.0054)	(0.0056)	(0.0057)
$\widetilde{OJ}_{ijt}$	$\Delta\overline{OJ}_{ij(t)}$		0.0252	0.0253
			(0.0071)	(0.0071)
$\widetilde{EX}_{ijt}^2/100$	$\Delta\overline{EX}_{ij(t)}^2/100$	-0.1079	-0.1007	-0.1008
		(0.0177)	(0.0178)	(0.0178)
$\widetilde{EX}_{ijt}^3/1000$	$\Delta\overline{EX}_{ij(t)}^3/1000$	0.0124	0.0110	0.0111
		(0.0026)	(0.0027)	(0.0027)
$\widetilde{EX}_{ijt}$*(Educ-12)	$\Delta\overline{EX}_{ijt}$*(Educ-12)	0.0069	0.0057	0.0081
		(0.0396)	(0.0394)	(0.0396)
$\widetilde{TIME}_{ijt}$*(Educ-12)	$\Delta\overline{TIME}_{ijt}$*(Educ-12)	-0.0025	-0.0011	-0.0035
		(0.0395)	(0.0393)	(0.0395)
	Q_{ijt}	0.1091	0.1209	0.1202
		(0.0398)	(0.0426)	(0.0434)
	L_{ijt}	-0.0490	0.0025	0.0008
		(0.0561)	(0.0592)	(0.0593)
	$Q_{ijt}*T_{ijt-1}$	-0.0149	-0.0103	-0.0097
		(0.0038)	(0.0047)	(0.0103)
	$Q_{ijt}*T_{ijt-1}^2/100$			-0.0035
				(0.0501)
	$Q_{ijt}*OJ_{ijt-1}$		-0.0179	-0.0190
			(0.0330)	(0.0385)
	$Q_{ijt}*PEX_{ij(t-1)}$	-0.0035	-0.0057	-0.0055
		(0.0105)	(0.0106)	(0.0107)
	$Q_{ijt}*PEX_{ij(t-1)}^2/100$	-0.0559	-0.0437	-0.0448
		(0.0767)	(0.0769)	(0.0773)
	$Q_{ijt}*PEX_{ij(t-1)}^3/1000$	0.0174	0.0155	0.0157
		(0.0150)	(0.0150)	(0.0151)
	$L_{ijt}*T_{ijt-1}$	-0.0123	-0.0053	0.0011
		(0.0038)	(0.0043)	(0.0116)
	$L_{ijt}*T_{ijt-1}^2/100$			-0.0249
				(0.0416)
	$L_{ijt}*OJ_{ijt-1}$		-0.0917	-0.1093
			(0.0431)	(0.0522)
	$L_{ijt}*PEX_{ij(t-1)}$	0.0081	0.0031	0.0033
		(0.0157)	(0.0156)	(0.0156)
	$L_{ijt}*PEX_{ij(t-1)}^2/100$	-0.0754	-0.0457	-0.0481
		(0.1181)	(0.1173)	(0.1174)
	$L_{ijt}*PEX_{ij(t-1)}^3/1000$	0.1508	0.0101	0.0106

(0.0238)	(0.0236)	(0.0236)

Notes. The sample consists of a total of 13995 observations with 12849 observations on equation (7.1) and 1046 observations on equation (7.4). The equations are estimated jointly by restricted weighted least squares using the OLS residuals to estimate weights for the within job observations, quits, and layoffs. The variables in the first column refer to equation (7.1) and the variables in the second column refer to equation (7.4).

Table 12[1]

Estimates of the Return to Tenure and Experience

	Wage Measure: WAGE2			Wage Measure: WAGE1		
	Assumption about linear tenure coefficient (b_2) and linear experience coefficient (b_0)					
	b_0=.0425 b_2=.0097	b_0=.0435 b_2=.0087	b_0=.0293 b_2=.0229	b_0=.0335 b_2=.0103	b_0=.0385 b_2=.0053	b_0=.0203 b_2=.0236
	(1)	(2)	(3)	(4)	(5)	(6)
2 Years of Tenure	0.0833 (0.0115)	0.0812 (0.0111)	0.1096	0.0454 (0.0111)	0.0355 (0.0106)	0.0717
5 Years of Tenure	0.1135 (0.0249)	0.1084 (0.0238)	0.1794	0.0744 (0.0234)	0.0495 (0.0218)	0.1401
10 Years of Tenure	0.1660 (0.0486)	0.1558 (0.0462)	0.2978	0.1190 (0.0454)	0.0692 (0.0418)	0.2505
15 Years of Tenure	0.2210 (0.0723)	0.2057 (0.0684)	0.4187	0.1590 (0.0675)	0.0843 (0.0617)	0.3562
5 Years of Experience	0.1791 (0.0278)	0.1842 (0.0268)	0.1132	0.1435 (0.0264)	0.1684 (0.0250)	0.0777
10 Years of Experience	0.2987 (0.0526)	0.3089 (0.0505)	0.1669	0.2448 (0.0498)	0.2946 (0.0466)	0.1134
30 Years of Experience	0.3954 (0.1457)	0.4260 (0.1378)	0.0	0.3943 (0.1363)	0.5438 (0.1243)	0.0

1. See the text. The results in columns 1, 2, and 3 are calculated using the wage coefficients in Table 10, column 2. The time trend in wages is set to .00083. The results in column 4, 5, and 6 are based on the wage coefficients from Table 11, column 2. The time trend in wages is .00168. Standard errors from the restricted weighted least squares regression are in parentheses. We do not report standard errors for the cases (column 3 and 6) in which b_2 and b_0 are chosen so that the value of 30 years of experience is 0.

Table 13

A Decomposition of Wage Growth Over the Career[1]

Results using WAGE2, Table 10, column 2. Time trend = .00083

	Experience Level (Mean of Var)	b_0=.0425 b_2=.0097 (1)	b_0=.0435 b_2=.0087 (2)	b_0=.0293 b_2=.0229 (3)
		experience (b_0) and tenure coefficients (b_2)		
Accumulated Effect of Tenure	10 Years (4.02)	0.0895	0.0854	0.1425
	30 Years (15.19)	0.2230	0.2076	0.4233
Accumulated Effect of Experience	10 Years (10)	0.2988	0.3089	0.1669
	30 Years (30)	0.3954	0.4260	0.0000
Accumulated Effect of Quits	10 Years (2.85)	0.0589	0.0534	0.1311
	30 Years (4.89)	0.1251	0.1110	0.3082
Accumulated Effect of Layoffs	10 Years (1.19)	-0.0850	-0.0874	-0.0536
	30 Years (2.35)	-0.1286	-0.1367	-0.0239
Total	10 Years	0.3623	0.3604	0.3869
	30 Years	0.6151	0.6080	0.7077

Table 13, continued
Results using WAGE1, Table 11, column 2. Time trend = .00168

experience (b_0) and tenure coefficients (b_2)

	Experience Level (Mean of Var)	b_0=.0335 b_2=.0103 (1)	b_0=.0203 b_2=.0236 (2)
Accumulated Effect of Tenure	10 Years (4.02)	0.0585	0.1118
	30 Years (15.19)	0.1492	0.3505
Accumulated Effect of Experience	10 Years (10)	0.2449	0.1124
	30 Years (30)	0.3943	0.0000
Accumulated Effect of Quits	10 Years (2.85)	0.3114	0.3839
	30 Years (4.89)	0.3242	0.5082
Accumulated Effect of Layoffs	10 Years (1.19)	-0.0044	0.0271
	30 Years (2.35)	-0.0514	0.0537
Total Career Effect	10 Years	0.6104	0.6353
	30 Years	0.8164	0.9094

1. See Text for details.