Wage Growth and the Theory of Turnover

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Theories of turnover and wage dynamics have studied the impact of wage levels on turnover, but they have failed explicitly to model the role of wage growth in predicting turnover. This article presents a theory of turnover that explains why within-job wage growth reduces the likelihood of worker-firm separations. The model determines the evolution of value among jobs that differ systematically in permanent rates of wage growth and shows that the value of high wage-growth jobs increases faster. With additional assumptions about the search process, this proposition implies that high wage-growth jobs are less likely to end.

I. Introduction

Labor mobility has been a central topic in labor economics for the past several decades. The shift in focus from mobility as a mere means of allocative efficiency in the labor market to mobility as an outcome of investment decisions, as articulated in human capital and search theories, has provided important insights into the structure of interfirm mobility. In particular, wage levels have played a key role as a determinant of turnover outcomes. This theoretical literature on turnover, however, has failed explicitly to model the role of wage growth in predicting turnover. This neglect is somewhat surprising given that the idea of heterogeneous

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wage-growth rates is implicit in several widely accepted theories of turnover and wage dynamics.

This article attempts to fill this theoretical void by formalizing why wage growth on a job reduces the likelihood of worker-firm separation. The model determines the evolution of value among jobs that differ systematically in permanent rates of wage growth. The main result of the article is that the value of high wage-growth jobs increases faster than the value of low wage-growth jobs. With additional assumptions about the search process, this proposition implies that high wage-growth jobs are less likely to end than low wage-growth jobs.

The empirical literature, ahead of theory, has documented the relationship between wage growth and turnover. Bartel and Borjas (1981) were the first to find some evidence of a positive correlation between completed tenure and the slope of a job's earnings profile. In a more conclusive study, Topel and Ward (1992) find that jobs offering high wage growth are significantly less likely to end in worker-firm separations than jobs offering low wage growth, holding the current wage fixed. The model presented here is designed to explain these facts.

Note, however, that the Topel-Ward finding is a puzzle for the well-known mismatch theory of turnover—the theory that Topel and Ward adopt in their article. The mismatch theory predicts that separations should decline as a function of wage level and not as a function of wage growth (Jovanovic 1979*a*).[1] A straightforward corollary of the model presented here resolves this puzzle raised by the Topel-Ward finding.

The empirical literature on whether jobs do in fact differ in their prospects for earnings growth lacks a consensus, and the evidence is somewhat sparse.[2] Two studies based on analyses of time-series properties of within-job wage changes conclude that heterogeneity in permanent rates of wage growth among jobs is empirically unimportant (Topel 1991; Topel and Ward 1992).[3] This surprising conclusion is supported by data that fail to reject the hypothesis that within-job wages evolve as a random walk. A more recent study (Baker, Gibbs, and Holmstrom 1994) based on company as opposed to household data, however, finds strong evidence in favor of heterogeneity of wage-growth rates among jobs.[4] The evidence

[1] Topel and Ward acknowledge that their finding contradicts the mismatch theory and note that the finding would be reasonable if jobs systematically differ in their prospects for wage growth.

[2] See Gibbons (1996) and Prendergast (1996) for a more detailed review of this literature.

[3] The two studies—Topel (1991) and Topel and Ward (1992)—are based on the Michigan Panel Study of Income Dynamics and the Longitudinal Employee-Employer Data, respectively.

[4] Baker, Gibbs, and Holmstrom (1994) find that individual wage growth rates

from the Baker, Gibbs, and Holmstrom study implies that past wage growth on a job predicts future wage growth.[5] If this is so, then the role of within-job wage growth in predicting turnover becomes both meaningful and empirically relevant.

The fact that the evidence on serial correlation in wage increases is mixed, however, does raise the issue of why the empirical results differ across these studies. Gibbons and Waldman (1998) say that "perhaps only certain small groups of workers such as managerial and professional workers exhibit such serial correlation. If most groups of workers do not, then the representative cross-sections in Topel (1991), and Topel and Ward (1992) would not either" (p. 6). The samples used in these latter studies are also based on survey data that may be a lot noisier than the data used by Baker, Gibbs, and Holmstrom (1994), which come from the personnel records of a company.[6] A somewhat different consideration reveals a possible bias against finding heterogeneity of wage growth rates. For instance, jobs need to survive for a minimum of four periods in order to test for serial correlation of wage increases.[7] Hence, longer duration jobs are more likely to be sampled. If wage growth is correlated with job duration, then there is likely to be less heterogeneity of wage-growth rates in observed samples.[8] The point, as mentioned by Gibbons (1996), is that this welter of findings deserves further attention.

The model presented in this article draws on key elements of search

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are positively correlated over time. This study is based on confidential personnel records of management employees of a firm in the service industry.

[5] Parent (1995), using data from the National Longitudinal Survey of Youth, finds significant differences in the slopes of individual tenure-earnings profiles. This evidence also points to heterogeneity of wage-growth rates among jobs.

[6] In nationally representative survey data such as the PSID, not only is there a higher chance of reporting errors, but there are also likely to be spurious recorded wage changes due to variation in hours worked, etc. Wage measures that are "noisy" lead to spurious negative correlation of wage increases, especially in short panels.

[7] With three (observational) periods there is likely to be a spurious negative correlation of adjacent wage growth rates if wages are measured with noise.

[8] A further issue that arises is whether the serial correlation in wage increases is attached to jobs or to workers. The model in this article assumes that it is tied to the job. The main motivation is the fact that the Topel-Ward finding, namely, the negative impact of wage growth on turnover, holds despite corrections for unobserved individual heterogeneity. If past wage growth was purely an individual effect, then there should be no wage growth impact on turnover. The Baker, Gibbs, and Holmstrom (1994) study finds serial correlation before and after controlling for observable individual characteristics. This finding is compatible with either interpretation. Note, however, that their company-level data does not allow a test of individual effects because they do not observe individuals in their pre- and postemployment spells with other employers.

theory and human capital theory. While on the job, workers sample outside job offers from a stable distribution. Heterogeneity of match quality across worker-firm pairs supports a nondegenerate offer distribution (Jovanovic 1979*a*). Within-job wage growth is attributed to firm-specific learning, which is made evident by the assumption of a stationary offer distribution. A separation occurs if the value of the outside job offer exceeds the value of the current job. The formulation of the value function of a job incorporates both within-job wage growth and optimal separation decisions in the future.

The model predicts that jobs with high wage growth are less likely to end in separations. The intuition behind this result is straightforward. Consider two jobs with different growth prospects. Equilibrium in the labor market implies that the two jobs will have equal value at the time that they start. The high wage-growth job will offer a lower initial wage to compensate for the high-growth option. This equivalence, however, holds only at the beginning. In subsequent periods the value of the job with high wage growth exceeds the value of the job with low wage growth. As a consequence the job with high wage growth is less likely to end than the job with low wage growth because both jobs sample from the same offer distribution. So the model predicts a negative correlation between wage growth and job turnover. A simple extension of this argument is that if the wage levels are held constant then the value of the high wage-growth job is higher, and thus it is less likely to end. This latter implication explains the Topel-Ward finding.

The rest of the article is organized as follows. Since the model presented in this article assumes heterogeneity of wage-growth rates among jobs, Section II, entitled "Learning by Doing and Wage Growth Heterogeneity," details how different firm-specific learning opportunities generate wage-growth heterogeneity among jobs. Section III presents the model of wage growth and turnover. First, the model is stated and the well-known negative relationship between job tenure and turnover is derived. Then the central question of the paper is addressed: why within-job wage growth reduces turnover. In the final subsection, some related theory is discussed. Section IV concludes with a summary and a short discussion of some applications of the model.

II. Learning by Doing and Wage Growth Heterogeneity

This section details how different learning opportunities generate heterogeneity of wage-growth rates among jobs. The discussion highlights the equilibrium condition that prospective jobs have equal value, which then leads to implications about how initial wage levels are set across jobs with different growth prospects. The claim that labor market equilibrium can sustain heterogeneity of wage-growth rates is evaluated under two slightly different notions of firm-specific learning. The first notion is that

learning is both general and firm specific, implying that accumulated skills are transferable to some firms but not to others. The second notion is that learning is purely firm specific, implying that accumulated skills are not transferable to any outside firm.

A. General and Firm-Specific Learning

Assume that productivity in each job rises because of learning by doing and that jobs differ in the learning opportunities they provide.[9] Further assume that accumulated experience in any given job is applicable in some other jobs but not in all jobs—that learning has both general and firm-specific components. Wages at each point in time will equal productivity, because some firms compete on this accumulated knowledge. Competition for prospective workers ensures that all prospective jobs (including jobs with different growth paths) will have equal value. For example, a worker must, when she enters a firm, pay for the option of high wage growth by accepting a lower initial wage. So at this point, she is just indifferent between jobs with different wage-growth paths.[10] However, this equivalence holds only initially, because after some time has elapsed the job with high wage growth becomes more attractive. Therefore, conditional on having been on a high wage-growth job, there will be fewer switches to jobs with different wage-growth prospects.[11]

The above interpretation of the model is more applicable to industry or occupation switches than to job switches per se. Note, however, that industry or occupation switches typically entail employer changes, so that the observed negative correlation between within-job wage growth and employer changes could be interpreted in this context. The more interesting empirical question that arises is whether high wage growth in a specific industry or occupation implies fewer subsequent switches to other industries or occupations.

[9] The idea that different kinds of work activities offer a wide variety of learning opportunities is also a key element in Rosen's (1972) article.

[10] See Becker (1975, p. 55) and Mincer (1993, p. 65) for discussions on equalization of present values among jobs with different learning opportunities due to labor mobility. As a consequence, learning by doing can also be viewed as a human capital investment decision precisely for the reason that labor mobility will ensure an opportunity cost of learning.

[11] In the absence of random shocks, if accumulated experience in any given job is perfectly transferable across jobs with equal growth and nontransferable across other jobs, workers will make their choice at the outset and not switch jobs later (Weiss 1971). However, turnover implications are generated by shocks emanating from the different growth sectors, and switches to alternative sectors will be less likely if a worker is on a high wage-growth path.

B. Pure Firm-Specific Learning

The assumption that skills acquired by learning are purely firm specific makes the theory more directly relevant to modeling employer changes and to explaining the Topel-Ward fact. Under this assumption increase in productivity occurs by definition only in the current firm. Since no outside firms compete for these skills, how and whether a worker appropriates this increase in productivity become open questions. The assumption of pure or strict firm specificity, therefore, raises the issue of division of rents between the worker and the firm, and thus introduces a potential wedge between wages and productivity. The division of firm-specific rents notwithstanding, long-run equilibrium considerations do impose some constraints on the structure of wage dynamics that firms offer prospective workers. As argued earlier, competitive labor markets ensure the equality of present values of prospective jobs. So high wage-growth jobs will have lower initial wages (to compensate for the growth option), and vice versa. However, if future wage increases are due to anticipated increases in firm-specific skills, then the question is why would firms not renege on such contracts, since there are no competitors for these skills. The answer, at least in part, must lie with reputation repercussions. If firms pay less than the promised wage increases, then workers are unlikely to sample such firms in the future. Hence, if firms offer a wage contract with growth prospects, long-run equilibrium considerations imply that such contracts will be binding even though wage growth is due to increases in firm-specific productivity.

The above argument still leaves open the issue of wage determination when employment relationships generate rents. If the direct correspondence between productivity and wages is broken, then it is important to clarify the context in which different learning opportunities might or might not imply heterogeneity of wage-growth rates among jobs. A few comments are noteworthy. The first is that an arrangement where workers get all of the rents associated with accumulation of specific skills is compatible with some sensible definitions of equilibrium (Jovanovic 1979*b*, pp. 1250–51). If such arrangements prevail, then the issue of division of rents is sidestepped, and different learning opportunities among jobs will indeed lead to heterogeneity of wage-growth rates.

A second comment dates back to Beckers' (1962) original idea of sharing the costs and returns of firm-specific investments (between the worker and the firm) as a means of providing mutual insurance to each party's investment. If firm-specific rents are shared in some well-defined sense (see, e.g., Parsons 1972; Hashimoto 1981), then different learning opportunities are likely to lead to heterogeneity of wage-growth rates among jobs.[12]

[12] In an ongoing research project with Brendan O'Flaherty, we also ask how

The problem with these sharing models is that they do not allow for renegotiation of the wage in response to an outside offer.[13] Mortensen (1978) questioned the general validity of this sharing hypothesis and proposed two alternative employment agreements that hinged on the idea of wage renegotiation—namely, matching alternative offers and contingent compensation.[14] More recently, Malcomson (1997) surveyed a variety of efficient solutions, including ex post renegotiation of wage contracts, when an employment relationship generates rents. It is important to note that in employment agreements that allow renegotiation, turnover is not affected by marginal wage changes, but it is affected by the total value of the rent or surplus (Mortensen 1978).[15] Thus high-learning jobs are likely to have lower quit rates than low-learning jobs because in high-learning jobs more rents are generated. The question is whether firm-specific learning will also lead to wage growth on the job if wages are renegotiated in response to outside offers. With wage renegotiation, it is unlikely that wages will increase deterministically with tenure (as it is assumed in the theory presented in Sec. III). But average wage growth is likely to be higher in high-learning jobs than in low-learning jobs. With wage renegotiation, wages will be bid up to the point where the value of an outside offer equals the value of the current job. Because more rents

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specific rents are split between workers and firms. We argue that division of firm-specific rents is determined by a stationary distribution of outside offers. The model is essentially one of monopsony. The lower a wage a firm pays to a specifically trained worker, the more profit it makes and the more eager it is to have her stay, but the more likely she is to leave. Preliminary results indicate that trustworthy firms will postpone payment of wages for as long as they can. If firms are not trustworthy, however, then even if marginal product is increasing, wages need not be increasing. But rising marginal product always implies a falling turnover rate.

[13] For example, Hashimoto (1981) argues that transaction costs of evaluating a worker's productivities in the firm and elsewhere in the postinvestment period are likely to prevent employment agreements that entail renegotiation of the employment contract.

[14] Mortensen's critique of the sharing hypothesis is based on the fact that it leads to inefficiently high turnover. If the worker and the employer, when terminating an employment match, do not take into consideration the capital loss imposed on each the other, then the joint wealth of the worker and the employer is not maximized, and the resulting turnover would be inefficiently high. So the question that motivates Mortensen is whether these alternative employment agreements will induce both the worker and the employer to pursue joint wealth maximizing search behavior. He argues that the counteroffer mechanism leads to inefficiently high search intensity but concludes that an ex ante agreement by each party to compensate the other as a precondition to separation (contingent compensation) is joint wealth maximizing.

[15] Under such efficient contracts the turnover rates would also typically be lower than the turnover rates associated with the sharing hypothesis.

are generated in high-learning jobs, average wage increases in each period will be higher in such jobs. Thus it is plausible that different learning opportunities will lead to heterogeneity of wage-growth rates among jobs. In this context, the observed (average) wage growth on a job could be interpreted as the contractual wage growth that reflects renegotiation.[16]

A somewhat obvious point is that if firms appropriate all the rent then different learning opportunities will not generate heterogeneity of wage-growth rates. A final and more interesting point is that if skills acquired on the job are more valuable in outside firms (than in the firm in which they are acquired), then contrary to the theory presented here, high within-job wage growth could lead to higher quit rates.[17]

III. The Model

A. Job Tenure and Turnover

The worker's wage at time t on the job is denoted by x_t. Assume that within-job wages grow deterministically as follows:

$$x_{t+1} = g(x_t), \tag{1}$$

where $g(x_t) > x_t$ for all $t \geq 0$. Wage growth is due to accumulation of firm-specific human capital.[18] In each time period, the worker receives an outside job offer σ from a stable offer distribution.[19] The value σ is fully

[16] This conjecture is not formalized in this article. Clearly, other factors, including search intensity, will affect the dynamics of wage increases when there is wage renegotiation.

[17] Felli and Harris (1996) make the same assumption to argue why wages increase with tenure. However, their model also suggests a possible link between wage growth and turnover. If a worker is paid the value of her alternative match, then accumulation of skills that are specific to the alternative match implies increasing wages in the current firm—the so-called tenure effect on wages. But the worker will switch to the alternative employer when wages reach the value of the current match. Hence, high within-job wage growth would make quits more likely for a given match value in the current job.

[18] The presentation in this section proceeds on the assumption that wages equal productivity. This assumption is uncontroversial if productivity increases are viewed as industry or sector specific (see Sec. II A). Under this interpretation, the turnover generated in the model refers to sector changes, and not necessarily to employer changes. However, if productivity increases are due to purely firm-specific factors, then the issue of division of rents makes the implications for wage growth less clear cut. Section II details these issues.

[19] Heterogeneity of match quality across worker-firm pairs underlies the assumption that job offers are sampled from a random distribution, which then allows an equilibrium interpretation of the standard search model (Jovanovic 1979*a*).

determined at the time the worker receives a job offer.[20] Let $\Phi(\sigma)$ denote the cumulative distribution function of σ, and assume that $\Phi(\sigma)$ is strictly increasing. The stationarity of the distribution of σ makes it evident that within-job wage growth is due to firm-specific factors. The worker behaves optimally: if the outside job value exceeds the current job value then the worker quits, but otherwise the worker stays.[21] With the further assumptions of a constant discount factor β and an infinitely lived worker, the job value at time t is

$$W(x_t) = x_t + \beta \int \max\{\sigma, W[g(x_t)]\} d\Phi(\sigma). \tag{2}$$

The job value is the current wage x_t, plus the (discounted) maximum of the next period job value ($W[g(x_t)]$) and the outside job value σ. Since σ is random, the expected value of this maximum function is the relevant object. With the further assumption that the wage growth function g is bounded, the first result is stated below.

LEMMA 1. There exists a unique and increasing function W that satisfies equation (2).

Proof Sketch. Consider an arbitrary function $W_0 : R^+ \to R^+$, where W_0 is increasing in x. Then define a new function, $TW_0 : R^+ \to R^+$, where $TW_0(x) \equiv x + \beta \int \max\{\sigma, W_0[g(x)]\} d\Phi(\sigma)$. If the mapping T is a contraction operator, then the existence and the uniqueness of the value function W are assured (Stokey and Lucas 1989). Blackwell's sufficient conditions for a contraction are used to verify that T is, indeed, a contraction operator. Since the monotonicity property of W_0 is preserved under repeated iterates of T, and because the iterates converge to a unique function W, it follows that W is also an increasing function.[22] This proves lemma 1.

A direct implication of lemma 1 is that the quit region decreases with time on the job.

PROPOSITION 1. $1 - \Phi[W(x_{t+1})] < 1 - \Phi[W(x_t)]$ for all $t \geq 0$.

[20] Jobs are treated as inspection goods where match quality can be learned prior to purchase (Jovanovic 1979*b*).

[21] All separation decisions, like in Jovanovic's (1979*b*) model, are worker initiated; hence, they are all quits. But, as Jovanovic notes, "these quits also account for all the turnover generated by the model, and, therefore, their empirical counterpart is total separations" (1979*b*, p. 1251). The reason is that the model presented here is silent about the division of firm-specific rents between the worker and the firm. As a consequence the distinction between quits and layoffs lacks theoretical force.

[22] The details of those proofs that are omitted from this article are available upon request.

Proof. Since $g(\cdot)$ is strictly increasing, $x_{t+1} > x_t$, and it follows from lemma 1 that $W(x_{t+1}) > W(x_t)$. Because $\Phi(\cdot)$ is also strictly increasing, $\Phi[W(x_{t+1})] > \Phi[W(x_t)]$, which proves the proposition. Proposition 1 states the well-known negative relationship between job tenure and turnover.

B. Wage Growth and Turnover

This section addresses the central question of the paper, namely, why within-job wage growth reduces the likelihood of a worker-firm separation. It is shown that the turnover rate is lower in a job with high wage growth than it is in a job with low wage growth. This proposition holds not only if the current wage is fixed, but also in all periods subsequent to when the values of the two jobs are equal. Although the first result is sufficient to explain the Topel-Ward finding, the second (and stronger) result, implied by equilibrium considerations of competitive labor markets, leads to a wider applicability of the theory.

Consider a high wage-growth job and a low wage-growth job, and let x and y denote the wages of the two jobs, respectively. Further, let (i) x satisfy the difference equation $x_{t+1} = h(x_t)$, (ii) y satisfy the difference equation $y_{t+1} = l(y_t)$, and (iii) $h(z) > l(z) > z$ for all z. The first inequality in iii says that wages grow faster in the first job than they do in the second job, and the second inequality says that wages grow on both jobs. Proposition 1 ensures that the value functions corresponding to the high wage-growth job and the low wage-growth job (denoted by H and L, respectively) exist, that they are unique, and that they are increasing in wages. The major theoretical result is given in the following proposition.

PROPOSITION 2. If $H(x_s) = L(y_\tau)$ then $H(x_{s+t}) > L(y_{\tau+t})$ for all $t > 0$.

Note that x_{s+t} and $y_{\tau+t}$ denote the wage levels, and s and τ denote the length of tenure in the high wage-growth job and the low wage-growth job, respectively. The proof of proposition 2 is in the appendix.

The equality of the value functions represents the equilibrium condition. Closer inspection of this condition also helps to clarify the relationship between wage growth and wage levels among jobs. In particular, consider a high wage-growth job and a low wage-growth job that start at the same time, ($s = \tau = 0$). Equilibrium in the labor market, $H(x_0) = L(y_0)$, implies that start wages in the high wage-growth job will be lower than the start wages in the low wage-growth job ($x_0 < y_0$). So the worker pays for the growth option in terms of a lower starting wage. Proposition 2, however, says that in all subsequent periods the value of the high wage-growth job will exceed the value of the low wage-growth job. Figure 1 presents these results visually, where job 1 and job 2 denote the high wage-growth job and low wage-growth job, respectively. An immediate consequence of proposition 2, given below, addresses the central question of the paper.

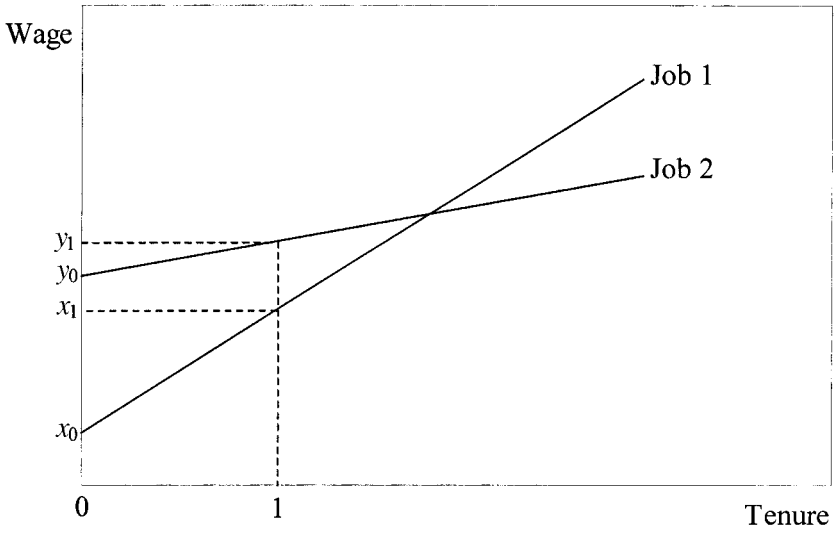

FIG. 1.—High and low wage-growth jobs. At tenure = 0 both job 1 and job 2 have equal value—$H(x_0) = L(y_0)$. But at tenure = 1 the value of job 1 exceeds the value of job 2, $H(x_1) > L(y_1)$, even though the wage level in job 1 may be less than the wage level in job 2—$x_1 < y_1$.

PROPOSITION 3. $1 - \Phi[H(x_{s+t})] < 1 - \Phi[L(y_{\tau+t})]$ for all $t > 0$.

Proof. Since $H(x_s) = L(y_\tau)$, proposition 2 ensures that $H(x_{s+t}) > L(y_{\tau+t})$. Since $\Phi(\cdot)$ is strictly increasing, $\Phi[H(x_{s+t})] > \Phi[L(y_{\tau+t})]$, which proves proposition 3.

The corollary to proposition 2—that the value of the high wage-growth job exceeds the value of the low wage-growth job at every point of tenure—is proposition 3, which says the turnover rate will be uniformly lower for the high wage-growth job than for the low wage-growth job.

C. Related Theory

Theories of wage dynamics and turnover generally include two postulates. The first is that a significant component of learning capacity is specific to an employment relationship. The second is that this component increases in importance as the relationship ages (for theories based on human capital considerations, see Becker [1975]; Jovanovic [1979*b*]; and Mincer and Jovanovic [1981]; for theories based on learning and search, see Jovanovic [1979*a*]; for theories based on agency, see Lazear [1981]; Salop and Salop [1976]).[23] Such theories are designed to account for two facts: the positive correlation between tenure and wages, and the

[23] See Topel (1991) for a comprehensive survey of this literature.

negative correlation between tenure and job turnover.[24] Although the idea of heterogeneous wage growth rates is implicit in several of these earlier models, the theoretical literature on job turnover has failed explicitly to model the role of wage growth in predicting turnover. This neglect is somewhat surprising given that the study of the effects of wage growth on turnover is a natural extension of several of these earlier theories.

A first example is the Mincer and Jovanovic conjecture that large specific capital investors will have steeper tenure-turnover profiles and, eventually, lower levels of turnover (Mincer and Jovanovic 1981). If workers finance investments in firm-specific skills through reductions in initial wages, then, indeed, a link between within-job wage growth and turnover is established. Hence, the model presented here can be interpreted as a formalization of their conjecture.

Jovanovic's (1979*b*) article "Firm-Specific Capital and Turnover" is the first theoretical work that integrates the idea of specific human capital with the theory of job matching. In that sense, this article closely resembles his. In Jovanovic's model, match quality determines expected job duration, which in turn is the critical determinant of the worker's level of investment in specific human capital. His major results are that specific human capital on a given job grows and, as a consequence, turnover declines with tenure.[25] Although the proposition that wages are a monotonically increasing function of job tenure cannot be proved, the complementarity between match quality and investment in specific human capital suggests a connection between wage growth on a job and turnover. A good match implies a larger investment, and, if workers finance investment through reduced initial wages, then a more steeply inclined wage profile is likely to be associated with a lower turnover rate as well.

The role of within-job wage growth in predicting turnover is implicit in other theories of turnover and wages as well. An example from the agency literature is Lazear's (1981) bonding model of within-job earnings profiles. In this model, workers are paid less than the value of marginal products when they are young and more than the value of marginal products when they are old. Lazear claims that such an age-earnings profile is optimal because back-loading payments alters the worker's incentives to reduce work effort on the job.[26] An interesting corollary of

[24] Mincer and Jovanovic (1981) provide evidence on both facts.

[25] This account of duration dependence should be distinguished from the account in Jovanovic's (1979*a*) matching model, where jobs are treated as experience goods. Learning about match quality over the duration of a job leads to the predicted negative relationship between tenure and turnover because the individual worker's assessments about match quality change; hence, so do the worker's own quit probabilities.

[26] An implication of this age-earnings profile, also shared by the human capital

the bonding model, mentioned by Lazear, is that age-earnings profiles will be steeper in firms (or presumably in jobs) with high monitoring costs. Hence, monitoring cost differentials are another potential source of wage-growth heterogeneity among firms. With further assumptions about market clearing and explicit considerations of cost of effort, the model presented here could be rewritten to ask whether jobs with high monitoring costs are less likely to end.

The idea that workers are indifferent between high wage-growth jobs and low wage-growth jobs at the point of hiring, even though they get a surplus later in the high wage-growth jobs, has a striking similarity with the efficiency wage model in Akerlof and Katz (1989).[27] Akerlof and Katz note that the implicit bonding in upward sloping age-earnings profiles still creates incentives for workers to shirk early in their careers, and that only later do they have incentives not to shirk because by that time their "trust funds" would have accumulated sufficiently. Thus, with increasing earnings profiles, layoffs due to shirking are less likely as the employment relationship ages. In this article the same observation is shown to have implications for voluntary quits.[28]

A final point is that the search aspect of the model is similar to Burdett (1978), where workers sample from a wage offer distribution and quit because they find a better wage offer. His model predicts a negative relationship between (working) age and turnover, and a positive relationship between age and the average wages of a given cohort of workers. The model seemingly also implies a negative tenure-turnover profile. This implication, however, is a consequence of the negative age effect on turnover. For a cohort of workers who start working for a new employer, the age composition increases with tenure due to heterogeneity of prior work experience. The predicted negative effect of tenure on turnover is therefore an artifact of heterogeneity of prior work experience. The finding of tenure effects (Mincer and Jovanovic 1981), independent of the age effects, however, rejects this simple search account of the observed negative relationship between job tenure and turnover. The model in this article generates the same age effects on turnover and wages as Burdett's model.

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model, is that there are fewer worker-firm separations when workers are old than when they are young.

[27] This model is presented as an analogue of the bonding model, and it is largely concerned about efficiency wage issues. This Akerlof and Katz rendition of the bonding model shows why Lazear-type earnings profiles are only second best to explicit up-front performance bonds.

[28] However, the model as it is presented in this article is not well suited to deal with the agency problem because the cost of effort is not included in the definition of job value. In general the dynamics of effort elicited from the worker will differ across high and low wage-growth jobs.

IV. Conclusion

The Topel-Ward finding, that jobs offering higher wage growth are significantly less likely to end in a worker-firm separation, is a puzzle for the mismatch theory of turnover. The puzzle is resolved by a model that explicitly appeals to systematic differences in wage-growth rates among jobs. The main theoretical result is that if two jobs start with equal value then in all subsequent periods the value of the high-growth job will exceed the value of the low-growth job. With some additional assumptions about the search process, this result leads to the proposition that high wage-growth jobs are less likely to end in worker-firm separations.

The idea that jobs differ in their prospects for wage growth can also be extended to study the role of prior mobility in predicting turnover and wages (Munasinghe and Sigman 1998). A pure search model (Burdett 1978) implies that prior mobility is not a predictor of job value, holding work experience constant. That is, on average movers do as well as stayers. A simple model of firm-specific training (Becker 1975) also cannot predict a priori whether stayers do better than movers. However, in the presence of jobs with different within-job wage growth rates, stayers are more likely to do better than movers. Note that prior mobility is a proxy for the wage-growth rates of prior jobs because, from proposition 2, it is known that the value of low wage-growth jobs increases less rapidly than the value of high wage-growth jobs. Hence, prior jobs with low wage-growth rates lead to higher prior mobility and a lower current job value. This conjecture could provide a unified explanation of two extensively documented facts: (1) the positive correlation between prior mobility and turnover, and (2) the negative correlation between prior mobility and wages. Standard interpretations of these findings rely on ad hoc appeals to nonbehavioral accounts of worker heterogeneity (Bartel and Borjas 1981; Mincer and Jovanovic 1981).

The model also provides a theoretical underpinning to systematic differences in tenure-wage profiles, and corresponding tenure-turnover profiles, across many job and worker characteristics found in cross-sectional analyses (Munasinghe 1995). For example, workers in large firms have steeper tenure-wage profiles than workers in small firms. As the model would predict, workers in large firms also have relatively lower turnover rates.

Appendix

PROPOSITION 2. If $H(x_s) = L(y_\tau)$ then $H(x_{s+t}) > L(y_{\tau+t})$ for all $t > 0$.

Proof of Proposition 2. The proof proceeds in two steps. First, a preliminary result is established, namely, that $H(z) > L(z)$ for each z. That is, the value of the high wage-growth job exceeds the value of the low wage-growth job, holding the current wage z fixed. Second, even if

the current wage of the high wage-growth job is less than the current wage of the low wage-growth job ($x_s < y_\tau$), such that the current values of the two jobs are equal [$H(x_s) = L(y_\tau)$], it is shown that in all future periods the value of the high wage-growth job will exceed the value of the low wage-growth job [$H(x_{s+t}) > L(y_{\tau+t})$ for all $t > 0$], which then completes the proof of proposition 2.

Step 1. The proof that $H(z) > L(z)$ for each z proceeds by considering a candidate value function $W_0 : R^+ \to R^+$, where W_0 is increasing in z. Then define two new functions: (1) $T_h(W_0)(z) \equiv z + \beta \int \max\{\sigma, W_0[h(z)]\} d\Phi(\sigma)$, and (2) $T_l(W_0)(z) \equiv z + \beta \int \max\{\sigma, W_0[l(z)]\} d\Phi(\sigma)$. Note that the above formulation makes it clear that the workers in the two jobs sample σ from the same Φ. This assumption makes sense because wage growth on both jobs is entirely due to the accumulation of firm-specific human capital. Below a preliminary result and a corollary are stated (without proof).

LEMMA A1. If $h(z) > l(z)$ and $W_0 \uparrow$ then $T_h(W_0)(z) > T_l(W_0)(z)$.

Lemma A1 says that the mappings T_h and T_l lead to a higher candidate value function for the high wage-growth job than for the low wage-growth job, holding the wage level z fixed.

COROLLARY A1. $T_h^n(W_0)(z) > T_l^n(W_0)(z)$ for all $n > 0$.

Corollary A1 says that the inequality of the candidate value functions is preserved under repeated iterates of T_h and T_l, respectively. Since T_h and T_l are contraction operators, $T_h^n(W_0)(z) \to H(z)$ and $T_l^n(W_0)(z) \to L(z)$, as $n \to \infty$ (see lemma 1 in Sec. III). Because the iterates converge to unique functions, the inequality holds across the two value functions, which proves that $H(z) > L(z)$ for each z. The value of the high wage-growth job exceeds the value of the low wage-growth job, holding wages fixed. An immediate consequence of this result is given below.

COROLLARY A2. If $x = y$ then $1 - \Phi[H(x)] < 1 - \Phi[L(y)]$.

The high wage-growth job is less likely to end in a separation than the low wage-growth job, holding the current wage fixed. This result, in particular, explains the Topel-Ward finding.

Step 2. Since $H(z) > L(z)$ for each z (from step 1), the condition $H(x_s) = L(y_\tau)$ implies $x_s < y_\tau$ (since both H and L are increasing functions). The wage level of the high wage-growth job is less than the wage level of the low wage-growth job to compensate for the higher value of the high wage-growth job. The following lemma states, however, that the value of the high wage-growth job will exceed the value of the low wage-growth job in the subsequent time period.

LEMMA A2. If $H(x_s) = L(y_\tau)$ then $H(x_{s+1}) > L(y_{\tau+1})$.

Proof of Lemma A2. Rewrite $H(x_s) = L(y_\tau)$ fully: $x_s + \beta \int \max\{\sigma, H[h(x_s)]\} d\Phi(\sigma) = y_\tau + \beta \int \max\{\sigma, L[l(y_\tau)]\} d\Phi(\sigma)$. Since $x_s < y_\tau$, subtracting x_s and y_τ from either side of the latter equation implies that $\int \max\{\sigma, H[h(x_s)]\} d\Phi(\sigma) > \int \max\{\sigma, L[l(y_\tau)]\} d\Phi(\sigma)$. Because the workers in the high wage-growth job and the low wage-growth job sample their σ from the same distribution Φ, it follows that $H[h(x_s)] > L[l(y_\tau)]$. Since $x_{s+1} = h(x_s)$ and $y_{\tau+1} = h(y_\tau)$, the inequality can be rewritten as $H(x_{s+1}) > L(y_{\tau+1})$, which proves lemma A2. Note, if $x_{s+1} < y_{\tau+1}$, then the same argument can be applied to

show $H(x_{s+2}) > L(y_{\tau+2})$. More generally, if $x_{s+n} < y_{\tau+n}$, it can be shown that $H(x_{s+n+1}) > L(y_{\tau+n+1})$ for all $n \geq 0$.

The above result, together with the earlier result from step 1, proves proposition 2: if $H(x_s) = L(y_\tau)$, then $H(x_{s+t}) > L(y_{\tau+t})$ for all $t > 0$. The value of the high wage-growth job exceeds the value of the low wage-growth job in all periods subsequent to when the current values of the two jobs are equal. Since outside offers arrive from the same offer distribution, the obvious implication as stated in proposition 3 is that the turnover rate is lower in the high wage-growth job than it is in the low wage-growth job.

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