Non-Wage Job Characteristics And The Case of The 
Missing Margin

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Abstract

Job search models typically describe jobs in terms of wages without accounting for other characteristics, but empirical evidence suggests non-wage characteristics are an important determinant of job choice. For instance, workers in the NLSY79 report moving from a higher paying job to a lower paying job in 33% of voluntary job-to-job transitions. I estimate an equilibrium-based job search model that accounts for hiring wages, on-the-job wage growth, non-wage job characteristics, and measurement error. This model provides the first known estimate of the cumulative importance of all non-wage characteristics in job market decisions. I find that variation across jobs in non-wage characteristics is roughly twice as important as variation in hiring wages.

I use the model and estimated parameters to measure how workers value the better non-wage characteristics and on-the-job wage growth potential that result when unemployment insurance enables them to search longer. Accounting for these previously unmeasured benefits more than triples my estimate of the program’s value to workers.

1 Introduction

Job search models typically describe jobs in terms of wages without accounting for other characteristics, but empirical evidence suggests that workers also care about other job characteristics. We see the importance of non-wage characteristics in the NLSY79, where workers
move to a lower paying job in 33% of voluntary job transitions without an intervening unemployment spell. Workers reject their highest wage offer in 24% of the unemployment spells for which we observe multiple wage offers. The survey asks workers why they rejected the offer, and the answers emphasize the importance of location, scheduling, appropriate use of the worker’s skills and a supportive workplace environment. This paper answers the question, “How important are non-wage characteristics and variation in on-the-job wage growth to labor market behavior?” I use these results to show that non-wage characteristics have important welfare implications in an application to unemployment insurance (UI).

This paper extends both the compensating differential and job search literatures. The compensating differential literature uses the relationship between wages and observed job characteristics to estimate how workers value these non-wage characteristics. A smaller literature extends this hedonic approach to job-search models. By accounting for all non-wage characteristics, this paper offers a more general search model and a more complete accounting of the value workers receive when UI facilitates better matching. Section 2 discusses the relevant compensating differential and job search literatures in greater detail before introducing the UI literature related to my policy analysis.

Section 3 describes the NLSY79 data used in this paper and provides statistical evidence that observed job choices are inconsistent with static wage maximization. This statistical evidence is based on a subset of the data used to estimate the structural search model. Specifically, it focuses on ‘voluntary switches.’ Voluntary switches are defined as job transitions in which a worker quits his current job and begins a new job without an intervening unemployment spell. Voluntary switches are especially informative because the worker’s choice reveals his preference for the new job without relying on any assumptions about search behavior, wage formation or the form of the utility function. While the purely statistical approach indicates that workers consider factors other than wages when choosing jobs, structural assumptions are necessary to estimate the economic importance of non-wage characteristics in job market decisions.
Section 4 presents a static discrete choice model of job choice in which workers get utility from both wages and other job characteristics. The static model demonstrates the intuition behind the more complete search model in a comparatively simple environment. I estimate the static model using voluntary job switches. This model uses the bare minimum of economic structure necessary to estimate the variance of utility from non-wage job characteristics across a worker’s job offers. However, the static model does not account for measurement error in wages, strategic wage offer formation or variation in on-the-job wage growth potential.

Section 5 presents the search model that addresses the major shortcomings of the static model. The wage bargaining environment in this model follows Postel-Vinay and Robin (2002) in allowing variation in on-the-job wage growth potential to affect job choice. I add a richer specification for worker productivity and a separate match quality capturing worker utility from non-wage job characteristics.

Section 6 discusses identification and computational issues related to estimation. Measurement error is a central concern because it obscures the relationship between wages and job choice. I model measurement error using an unobserved heterogeneity specification which estimates the distribution of the true wage given the observed wage.

A number of empirical issues arise from changes in the NLSY79 survey content over time. For instance, rejected wage offer data is subject to different selection rules because the survey questions differ from year to year. I explicitly model the selection rules for each set of survey questions. The survey asks about specific non-wage job characteristics from 1994-2004. I use this data with my estimates of utility from non-wage sources to determine how workers value specific observable job characteristics.

Section 7 presents the results and applies them to simulate the impact of UI on hiring wages, on-the-job wage growth and non-wage characteristics following unemployment spells. Meyer (1990) shows that, by subsidizing search, UI causes workers to remain unemployed for longer. My estimates of the impact of UI on hiring wages are similar to other estimates
in this literature, but accounting for non-wage characteristics and on-the-job wage growth more than triples the estimated value of the improved matches facilitated by UI. I also show that the implied utility from observed job characteristics such as health insurance and paid sick leave generally have the expected sign and reasonable magnitudes.

Section 8 concludes, and I suggest that the results in this paper motivate a careful accounting of non-wage characteristics in a broad range of policy analyses.

2 Literature Review

Compensating differentials were first discussed by Adam Smith, and modern empirical analysis of the subject begins with Thaler and Rosen (1975). Thaler and Rosen estimate the implied value of a life from a regression of wages on job riskiness and control variables. Other researchers use similar empirical strategies to estimate compensating differentials for heavy workload, undesirable work hours and a variety of other job characteristics.

This literature generally assumes perfect matching with no informational frictions. Hwang, Mortensen and Reed (1998) show that if informational frictions exist, these models underestimate workers’ willingness to pay for job characteristics, and Lang and Majumdar (2003) show they may even produce estimates with the wrong sign. Models without search frictions are also inappropriate to evaluate programs that affect matching such as UI.


The research differentiating part-time from full-time work suggests that preference het-
erogeneity is important. Job offers in these models include both a wage and a number of work hours per week. Blau (1991) imposes homogeneous preferences and finds no systematic preference over hours worked at any given hourly wage. Gorgens (2002) allows for heterogeneous preferences over hours worked, and he finds that a worker’s reservation wage for full time work can vary from 31% more to 16% less than his reservation wage for part time work. Bloemen (2008) also allows for heterogeneous preferences in hours workers, and he finds that Unemployment Insurance significantly improves matches for hours worked.

Keane and Wolpin estimate homogeneous non-pecuniary utility from schooling, military service, home production, blue collar work and white collar work as controls while addressing questions of human capital accumulation. This model captures human capital investment and occupation choice, though it does not distinguish between jobs within a broad occupational category. Sullivan (2008) extends this framework to allow more occupation categories, heterogeneous preferences over occupations and firm specific human capital.

The common approach throughout the existing research focuses on observable job characteristics. This approach provides concrete interpretations of how workers value specific characteristics. I sacrifice the direct identification of compensating differentials for specific characteristics by combining all non-wage characteristics in a search model. This allows a more general search model and a more complete accounting of the benefits from improved matches due to UI.

I account for wage dynamics in a similar manner to Postel-Vinay and Robin (2002). A worker in the Postel-Vinay and Robin model has different productivities at different firms. He may accept a wage below his firm-specific marginal product, but this wage at this firm increases as the firm competes with outside offers for the worker’s services. Because a worker’s wage with a firm is limited by his marginal product at the firm, he may accept a lower initial wage to work for a higher productivity firm. This endogenously explains voluntary transitions to lower paying jobs. Connelly and Gottschalk (2004) estimate that roughly a third of job changes by low-skilled workers involving immediate wage decreases are
undertaken for higher expected future wages, and they attribute the remaining job changes to “non-economic” reasons. These “non-economic” reasons correspond to the demand for various non-wage job characteristics. Lopes de Melo (2007) undertakes a similar analysis and finds that wage dynamics explain transitions to lower paying jobs well for high-wage workers, but they do not explain voluntary transitions to lower paying jobs for low-wage workers.

The American UI system has been one of the most popular research subjects among labor economists over the last 30 years. UI subsidizes periods of job search by providing payments to laid off workers until they find a new job. This job search subsidy encourages workers to be more selective in which jobs they accept, and workers receiving generous UI benefits typically remain unemployed and search for longer than those receiving less generous UI benefits (Meyer, 1990). Existing measurements of the benefits from this induced search have had mixed and sometimes puzzling results. Early research such as Ehrenberg and Oaxaca (1976) finds this extended search increases hiring wages following unemployment spells, but later research such as Addison and Blackburn (2000) concludes that program generosity has no measurable impact on post-unemployment wages. Centeno (2004) finds that UI program generosity causes longer lasting job matches following unemployment spells, and he argues that these longer job tenures are evidence that UI improves matches. Taken together, these findings suggest the American UI program improves matches in a way that is not captured by wages. However, Card, Chetty and Weber (2007) uses a discontinuity in eligibility for the Austrian UI program to show Austrian UI extends job-search without increasing post-unemployment wage or tenure.
3 Data

3.1 Description of Data

The NLSY79 is a longitudinal sample of 12,686 individuals born between 1957 and 1965. Individuals were interviewed annually from 1979 through 1994 and biennially thereafter. I construct comprehensive employment histories using the NLSY79 interviews conducted between 1982 and 2004. These employment histories include the wage path, job start and end dates, data about non-wage characteristics and the termination reason for all employment spells. Rejected wage offer data is included in some years.

My sample excludes the military oversample, individuals who leave the survey before 1984 and those who do not hold a job at any point during the survey. I further limit my sample to males to mitigate labor force exit in the data. The employment history for each worker begins when he receives his first job after discontinuing full-time education. Workers who leave the survey after 1984 are included in the sample, but their employment histories are censored at the last interview date. These exclusions leave 5315 workers in the sample.

If a worker misses interviews in a series of years, employment information from this period is recorded in the subsequent interview. This decreases the amount of missing data, but attrition is an issue as only 64% of the sample is interviewed in 2004.\footnote{Attrition will not bias the results presented in this paper if it is uncorrelated with job market choices.}

Table 1 reports descriptive statistics for workers in the sample. The mean first employment date is 22.4 years later than the mean birth date. The mean date of last interview is 16.4 years after the mean first employment date. On average, workers are employed for 168.8 months (14.1 years) and unemployed for 27.6 months (2.3 years) of their employment history. The fraction of time that I report workers are unemployed is greater than in official unemployment statistics because I count all time that a worker is not employed as unemployment.

The NLSY79 reports 4505 spells during which a worker holds multiple jobs, but the
employment histories I construct limit workers to one job at a time. A worker holding multiple jobs is listed as continuing the job he started first. If the worker starts multiple jobs in the same month, the employment history retains only the job the worker holds for the longest time. If a worker has multiple jobs with the same start and end months, the employment history records the job in which he works the most hours.

Table 2 reports the distribution of job transitions by cause of separation from the original job and the presence of an unemployment spell between the original and new job. Causes of separation are divided into quits, layoffs and firings. Over 71% of the 29896 transitions in the data occur due to quits, and most quit-induced transitions are voluntary switches where the worker chooses to leave his original job for a new job with no intervening unemployment spell. Firings are the least common cause of separation. Most firings and layoffs are followed by unemployment spells.

Table 3 reports descriptive statistics of employment transitions. The first column of data describes all transitions listed in Table 2. The second column of data describes the 11952 voluntary switches. At the time a worker makes a voluntary switch, he has options both to continue his old job and to start his new job. Thus voluntary switches are especially informative about a worker’s preferences. Workers report a lower wage in the new job than their original job in 36.3% of all transitions and 33.3% of voluntary switches.

The scatter plot in Figure 1 shows wages before and after voluntary switches. Wages are clustered near the 45-degree line and in the area where both wages are below $15/hr. Observations are clustered near the 45 degree line due to correlation between a worker’s wages at consecutive jobs. The clustering of observations at lower wages reflects the fact that job transitions are most common early in a worker’s career, and wages are lower during this period.

If workers were choosing jobs solely based on wages, all observations would lie above the

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2 The term ‘firing’ corresponds to “firing with cause.” This denotes a separation initiated by the employer due to a cited fault of the worker. Layoffs include all other employer initiated separations.

3 The correlation coefficient between new and original wages in voluntary transitions is 0.64.
45-degree line. However, as pointed out in Table 3, workers move from a higher paying job to a lower paying job in a third of voluntary switches. This pattern is common to both low-wage and high-wage workers.

Rejected job offer data is available during 1,831 unemployment spells occurring in 1981, 1982, 1986, 1987, 1994 or 1996. The available rejected job offer data varies from year to year, and no year includes the wages associated with all rejected job offers. Data in 1981, 1982, 1986 and 1987 is selected according to questions of the form “What is the first wage offer you received?” Rejected wage offers in 1994 and 1996 are censored because the survey asks “What is the highest wage offer you rejected?” Workers reject the highest wage offer in 180 of the 592 unemployment spells in for which we observe the highest rejected offer.

4 A Simple Model of Job Choice

A simple static model will illustrate the identification strategy of the full model. The simple model does not control for measurement error in wages, variation in on-the-job wage growth potential, dynamic selection or correlation between wages and non-wage characteristics. These issues are addressed in the full model.

Worker \( i \) chooses a job \( j \) to maximize

\[
 u_{ij} = w_{ij} + d_{ij}
\]

where \( w_{ij} \) is the hourly wage associated with job \( j \) and \( d_{ij} \) is utility from non-wage characteristics of job \( j \). Utility from non-wage characteristics is distributed

\[
 d_{ij} \sim N(0, \sigma^2_d).
\]

A small value of \( \sigma^2_d \) would indicate that workers choose jobs primarily based on wages, and a large value of \( \sigma^2_d \) would indicate non-wage characteristics are an important determinant
of workers’ job choices.

For each voluntary job switch, the principle of revealed preference guarantees that utility from the new job is greater than the utility from the old job. If a worker moved from an old job paying $10/hr to a new job paying $7/hr, then the non-wage characteristics associated with the new job must be worth at least $3/hr more than the non-wage characteristics of the old job. The value of $d_{ij}$ plays a similar role to the residual in standard discrete choice models, but the residual has a concrete economic interpretation and important welfare implications in this model.

The likelihood function is

$$L = \prod_{s \in S} \Phi\left(\frac{w_{sn} - w_{so}}{\sqrt{2}\sigma_d}\right)$$

where $S$ is the set of voluntary job switches, $w_{sn}$ is the wage at the new employer and $w_{so}$ is the wage at the old employer.

The simple model estimates the standard deviation of non-wage utility among a worker’s offers is $20.54/\text{hr}$, while the standard deviation of wages among a worker’s offers is $5.67/\text{hr}$. These results should be viewed with skepticism because this model ignores numerous confounding issues for expositional simplicity. These issues are addressed in the search model.

5 The Search Model

5.1 The Environment

Workers solve an infinite-horizon dynamic programming problem when deciding which job offers to accept and when to quit a job. A firm solves a dynamic programming problem in forming wage offers to its potential workers.

Each period is comprised of four stages:

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4Estimation requires an infinite horizon model for computational tractability because employment histories include 22 years of data in 1-month periods. Workers in the data are generally far from retirement, and a terminal condition would be unlikely to dramatically affect worker or firm behavior.
1. New matches form between workers and potential employers

2. Match characteristics in existing matches evolve

3. Firms form wage offers

4. Workers with job offers choose which, if any, offer to accept.

A match between worker $i$ and firm $j$ is described by four characteristics in each period $t$. The worker’s general human capital $y_{it}$ is a measure of his average productivity across jobs. The match quality reflecting production $m_{ijt}$ measures how well the worker’s skills match the demands of the job. For example, an expert cabinet maker may have a high $m_{ijt}$ at a firm that installs cabinets and a lower $m_{ijt}$ at a job doing general carpentry.

Non-wage utility $d_{ijt}$ captures the value of characteristics of a job such as geographic location, camaraderie with coworkers, health care provision, etc. A job pays an hourly wage $w_{ijt}$. The firm’s profit from a relationship with a worker is

$$\pi_{ijt} = y_{it}m_{ijt} - w_{ijt}$$

The worker’s utility from working at firm $j$ is

$$u_{ijt} = w_{ijt}^\alpha + d_{ijt}$$

and the worker’s utility from being unemployed is

$$u_{i0t} = \gamma_0 + \gamma_1l_{it} + \gamma_2b_{it} + \epsilon_{it}$$

$$\epsilon_{it} \sim N(0, \sigma^2_u)$$

where $l_{it}$ is unemployment spell length and $b_{it}$ is the unemployment insurance benefit. $\epsilon_{it}$ is person- and period-specific utility of unemployment due to unobserved factors. Intuition
suggests $\gamma_1$ is negative because per period utility decreases as a worker depletes his savings.

Firm choices affecting non-wage utility $d_{ijt}$ are implicit in this model. For example, a firm that can use air conditioning to improve $d_{ijt}$ solves an optimization problem when deciding whether to offer this better $d_{ijt}$ or to pay the worker the higher wages necessary to keep him without air conditioning. The $m_{ijt}$ and $d_{ijt}$ in the model represent match characteristics given the firm’s optimal choices. Because non-wage characteristics may be costly to provide, a worker’s marginal product $y_{it}m_{ijt}$ is interpreted as his impact on firm profit after accounting for all costs except his wage.

The first step in each period is match formation. Unemployed workers have a probability $\lambda_u$ of being matched with a new employer, and employed workers have a probability $\lambda_e$ of being matched with a new employer. Workers are matched with at most one new employer in a period.

In the second step, the variables $y_{it}$, $m_{ijt}$ and $d_{ijt}$ evolve according to the process\(^5\)

$$
\begin{pmatrix}
y_{it} \\
m_{ijt} \\
d_{ijt}
\end{pmatrix} =
\begin{pmatrix}
y_{i,t-1} \\
m_{ij,t-1} \\
d_{ij,t-1}
\end{pmatrix} +
\begin{pmatrix}
y_{it} \\
m_{ijt} \\
d_{ijt}
\end{pmatrix} +
\begin{pmatrix}
\epsilon_{it}^y \\
\epsilon_{ijt}^m \\
\epsilon_{ijt}^d
\end{pmatrix}
$$

where $\epsilon^y, \epsilon^m, \epsilon^d \sim Skellam\left(\begin{pmatrix} \mu^y \\ \mu^m \\ \mu^d \end{pmatrix},\begin{pmatrix} \sigma^2_y & 0 & 0 \\ 0 & \sigma^2_m & 0 \\ 0 & 0 & \sigma^2_d \end{pmatrix}\right)$.

Initial draws of $m_{ijt}$ and $d_{ijt}$ for new matches are drawn from

$$
\begin{pmatrix}
m_{ijt} \\
d_{ijt}
\end{pmatrix} \sim Skellam\left(\begin{pmatrix} 1 \\ 0 \end{pmatrix},\Omega\right)
$$

\(^5\)The evolution process uses a discrete distribution because all variables in this model are discrete. The skellam distribution is a discrete distribution with two parameters defining the mean and variance. The distribution arises as the difference of Poisson random variables, and its shape generally resembles that of a normal distribution.
The mean of the initial distribution is normalized for identification.

In the third step, firms observe all match characteristics and form wage offers. Wage contracts follow Postel-Vinay and Turon (2006) in applying a mutual consent renegotiation clause. Mutual consent renegotiation stipulates that a firm needs a worker’s consent to lower his wages.\(^6\) A layoff occurs if the firm refuses to pay the current wage and the worker refuses a wage cut. A worker may consent to a wage cut if he wishes to keep his job and the firm has a credible threat of a layoff at the previous wage.

If only one firm is matched to a worker, the firm makes a take-it-or-leave-it wage offer to the worker. If two firms are matched with a worker, they form wage offers to the worker in an environment where both firms see all characteristics of both matches. The subgame perfect Nash equilibrium wage offer strategy is described in the next section.

The last event in each period is the worker’s decision to accept or reject any wage offers he receives.

\subsection*{5.2 Value Functions and Equilibrium Behavior}

The last choice in each period is the worker’s job acceptance decision. The worker has the choice to be unemployed for the period and may have up to two job offers to consider. Letting \(V^n\) denote the value of having \(n\) job offers, \(j'\) be denote a new match and \(t' = t + 1\), the worker’s value functions are

\[
V^0(y_{it}, b_{it}, l_{it}, \epsilon_{it}) = \gamma_0 + \gamma_1 l_{it} + \gamma_2 b_{it} + \epsilon_{it} + \\
\beta \left[ \lambda_u E[V^1(y_{ij't'}, m_{ij't'}, d_{ij't'}, w_{ij't'}, b_{ij't'}, l_{it} + 1, \epsilon_{ij't'})] + \\
(1 - \lambda_u) E[V^0(y_{ij't'}, b_{ij't'}, l_{it} + 1, \epsilon_{ij't'})] \right]
\]

\(^6\)Malcomson (1999) argues that mutual consent renegotiation is consistent with important legal and empirical facts about the US labor market.
\[ V^1(y_{it}, m_{ijt}, d_{ijt}, w_{ijt}, b_{it}, l_{it}, \epsilon_{it}) = \max \{ V^0(y_{it}, b_{it}, l_{it}, \epsilon_{it}), w_{ijt}^\alpha + d_{ijt} + \beta \left[ (1 - \lambda_e) E[V^1(y_{i't}, m_{ij't}, d_{ij't}, w_{ij't}, b_{it}, 0, \epsilon_{i't})] + \lambda_e E[V^2(y_{i't}, m_{ij't}, d_{ij't}, w_{ij't}, m_{ij'0}, d_{ij'0}, w_{ij'0}, 0, 0, \epsilon_{i't})] \right] \} \]

\[ V^2(y_{it}, m_{ijt}, d_{ijt}, w_{ijt}, m_{ij't}, d_{ij't}, w_{ij't}, 0, 0, \epsilon_{it}) = \max \{ V^1(y_{it}, m_{ijt}, d_{ijt}, w_{ijt}, b_{it}, 0, \epsilon_{it}), V^1(y_{it}, m_{ij't}, d_{ij't}, w_{ij't}, 0, 0, \epsilon_{it}) \} \]

The first line of \( V^0 \) is utility in the current period, and the next two lines represent the expected value in the next period. With probability \( \lambda_u \) the worker receives a new job offer and his expected value in the next period is \( V^1 \). With probability \( 1 - \lambda_u \) he receives no offer, and his expected value in the next period is \( V^0 \). The value function \( V^1 \) is the maximum of the value of rejecting the offer and the value of accepting the offer. If the worker accepts the offer, he receives \( w_{ijt}^\alpha + d_{ijt} \) in the current period, and his expected value in the next period is a weighted average of \( V^1 \) and \( V^2 \) with weights coming from the probability of receiving a second match. Finally, \( V^2 \) is the maximum of the value \( V^1 \) associated with either offer.

Let \( A(y_{it}, m_{ijt}, d_{ijt}, w_{ijt}, m_{ij't}, d_{ij't}, w_{ij't}, b_{it}, l_{it}, \epsilon_{it}) \) denote the worker’s job choice strategy as a function of potential employment and unemployment spell characteristics. This function takes a value of 1 if the worker accepts an offer from firm \( j \) and 0 otherwise. The value to the firm from a job match is

\[ V^f(w_{ij,t-1}, y_{it}, m_{ijt}, d_{ijt}, m_{ij't}, d_{ij't}, w_{ij't}, b_{it}, l, \epsilon_{it}) = \max \{ 0, \max_{w_{ijt}} \left\{ A_j(\cdot) \ast [y_{it}m_{ijt} - w_{ijt} + \beta E[V^f(w_{ij,t-1}, y_{i't}, m_{ij't}, d_{ij't}, m_{ij'0}, d_{ij'0}, w_{ij'0}, b_{it}, 0)] \right\} \} \]

s.t. \( w_{ijt} \geq w_{ij,t-1} \) if \( y_{it}m_{ijt} - w_{ij,t-1} + \beta EV^f(w_{ij,t-1}, y_{i't}, m_{ij't}, d_{ij't}, m_{ij'0}, d_{ij'0}, w_{ij'0}, b_{it}, 0) > 0 \}

I define a “profitable” wage offer as an offer that yields a positive expected present value of
profits if accepted. The constraint on $w_{ijt}$ states that the firm cannot lower the worker’s wage if the previous wage is profitable. This follows from mutual consent renegotiation because the worker will not renegotiate if the previous wage is profitable.

A layoff occurs if the wage from the previous period is unprofitable and there is no $w_{ijt}$ such that both the worker and firm value functions are strictly positive. Thus $b_{it} = 1$ if $V_f(w_{ij,t-1}, :) < 0$ because the worker is eligible for UI payments if he does not accept a pay cut.

For a set of environment parameters \( \{\alpha, \Omega, \mu_y, \mu_m, \mu_d, \sigma^2_m, \sigma^2_d, \gamma_0, \gamma_1, \gamma_2, \beta, \lambda_u, \lambda_e, \sigma^2_u\} \), an equilibrium is a wage offer function $W$ for firms and a job-choice function $A$ for workers such such that $A$ maximizes each worker’s present value of expected utility and $W$ maximizes each firm’s present value of expected profits.

The equilibrium considered in this paper employs a weakly dominant wage offer strategy in the perfect information environment. A firm that is matched to a worker but does not employ him using this strategy would earn negative expected profits if it increased its wage offer enough to hire him. Each accepted wage offer is the lowest wage that is both acceptable to the worker and consistent with mutual consent renegotiation.

This strategy is defined as follows: a firm offers any worker who was unemployed in the previous period the lowest wage that the worker will accept if this wage is profitable. Otherwise the firm offers the highest profitable wage, and the worker rejects this offer. A firm in a continuing match with a worker will follow the same strategy subject to mutual consent renegotiation. Firms may decrease a worker’s wage if the wage from the previous period is no longer profitable. Specifically, the worker may consent to a wage cut to the greatest profitable wage.

To describe the strategies of two firms competing for a worker, I arbitrarily order the firms 1 and 2. Let $A_1$ and $A_2$ denote a worker’s value of accepting the respective firms’ greatest profitable wage offers. The value to the worker of rejecting both offers and becoming

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7This model does not distinguish layoffs from firings. For simplicity, all job separations are assumed to be permanent.
unemployed is $V^0$. Assuming $A_1 > A_2$, there are three possible cases. In all three cases firm 2 will offer the highest profitable wage, and it will not win the worker’s services.

**Case 1: $V^0 > A_1 > A_2$:** Both firms offer their greatest profitable wage offer, and the worker chooses unemployment.

**Case 2: $A_1 > V^0 > A_2$:** The match to firm 2 is irrelevant. Firm 1 offers the wage it would offer if it were the only employment match.

**Case 3: $A_1 > A_2 > V^0$:** Firm 1 offers the smallest available wage such that the worker will choose firm 1 over firm 2’s best offer.

Appendix 1 contains a proof that an equilibrium exists when this wage offer strategy is used in an environment where wages and match characteristics are continuous. The distribution of a worker’s wage offers at potential matches is non-degenerate because his reservation wage depends directly on non-wage utility and productive match quality.\(^8\)

6 Estimation

6.1 Identification

The number of parameters describing shocks and new draws of $y_{it}$, $m_{ijt}$ and $d_{ijt}$ is sufficiently large that I first discuss inference of these match characteristics. If the values of a match characteristic could be inferred, calculating the model parameters related to that parameter would be straightforward. For instance, if $d_{ijt}$ was known, the parameter $\mu_d$ denoting the mean change to $d_{ijt}$ could be estimated using the mean per-period change in these known variables.

To infer the distribution of these match characteristics, I discuss the implications of each match characteristic on observable outcomes. In general, human capital $y_{it}$ is directly associated with wage levels across jobs, match quality affecting production $m_{ijt}$ is directly

\(^8\)Postel-Vinay and Robin (2002) show that a worker’s reservation wage is inversely related to job-specific productivity because his wage growth potential is greatest at jobs where he is most productive.
associated with job tenure and on-the-job wage growth, and non-wage utility $d_{ijt}$ is directly associated with a willingness to enter and continue a match with lower wages than outside offers. However inference about these characteristics is complicated by their overlapping effects on job choices and wage offers.

For example, a choice between simultaneous job offers cannot identify any individual match characteristic because both $m_{ijt}$ and $d_{ijt}$ affect job choice. A worker will accept a relatively low wage offer with a high draw of $m_{ijt}$ because this match offers the potential for high wage growth. He may accept the same wage with a high draw of $d_{ijt}$ because this match offers desired non-wage characteristics. Differences in the dynamic implications of $m_{ijt}$ and $d_{ijt}$ are important to distinguish their role in the original job choice. For instance, a high draw of $m_{ijt}$ increases on-the-job wage growth and reduces the likelihood of a layoff because the match will remain profitable in the face of small productivity shocks. A high draw of $d_{ijt}$ is associated with low wages throughout the match tenure. Table 5 describes the implications of different combinations of $m_{ijt}$ and $d_{ijt}$.

The match variables $y_{it}$ and $m_{ijt}$ share implications for wages and job security. For instance, controlling for the current wage and non-wage characteristics, both high values of $y_{it}$ and high values of $m_{ijt}$ decrease the likelihood of layoffs and increase on-the-job wage growth. However high $m_{ijt}$ causes longer job tenure, and $y_{it}$ does not affect tenure. Thus high wage growth in a long-lived match likely reflects a high $m_{ijt}$, and high wages offers from many employers likely reflects a high $y_{it}$.

The only pairing of match characteristics I have not discussed is between $y_{it}$ and $d_{ijt}$, and this pair has few overlapping implications. Low values of $y_{it}$ and high values of $d_{ijt}$ are both associated with low wages in a period, but high $d_{ijt}$ is associated with a long tenure while $y_{it}$ is not. The primary source of identification of $d_{ijt}$, workers’ choices between job offers, is unrelated to $y_{it}$.

Identification of parameters describing draws and shocks to $y_{it}$, $m_{ijt}$ and $d_{ijt}$ follow from the unique implications of these characteristics. For instance, variation in wage growth across
jobs and the correlation between wage growth and initial job choices identifies $\Omega_{mm}$. The sensitivity of job choice to hiring wage is a function of both $\Omega_{mm}$ and $\Omega_{dd}$, so correlation between static wage differentials and job choice identifies $\Omega_{dd}$ after controlling for the already identified $\Omega_{mm}$.

Correlation between job tenure and a firm’s ability to offer high wages identifies $\mu_m$. That is, a high $\mu_m$ decreases the likelihood that long-lasting matches will end when a poaching employer offers higher wages. Correlation between job tenure and spell termination type also identifies $\mu_m$, as growth in a worker’s marginal product over time decreases the likelihood of layoffs for the reasons mentioned above. Correlation between job tenure and the wage differential required to poach a worker away from his current job identifies $\mu_d$ after controlling for the already identified $\mu_m$. The trend over time in wages associated with rejected offers identifies $\mu_y$ because all rejected offers are the maximum profitable wage. Variation across workers in this trend identifies $\sigma_y^2$.

The frequency of wage cuts and layoffs identifies $\sigma_m^2$ after controlling for the already identified $\mu_m$ since the frequency of these events depends on the frequency and size of negative shocks to $m_{ijt}$. The amount of variation during the tenure of a match in a worker’s willingness to accept a wage lower than his outside offer identifies $\sigma_d^2$. When controlling for other parameters, variation in utility from being unemployed $\sigma_c^2$ is identified by the strength of the correlation between transitions into and out of unemployment and wage offers.

Table 4 briefly describes the patterns in the data that identify parameters of the worker’s utility function.

### 6.2 Measurement Error

Measurement error is an important concern because it obscures the relationship between wages and job choice. I account for measurement error using an unobserved heterogeneity specification. I estimate the distribution of each true wage from the observed wage and a

---

9Controlling for selection into long spells is inherent in the model’s structure.
classical measurement error assumption.

I estimate the structural model under three assumptions about the amount of measurement error. I first estimate the structural model assuming 18% of cross-sectional variation in wages is due to measurement error. This comes from Bound and Krueger (1991), which compares earnings data from the CPS and from payroll tax records. Treating tax data as true income, they find that 82% of cross-sectional variation in men’s measured earnings is due to true variation.

Because the Bound and Krueger estimate considers annual earnings, measurement error in hourly wages may be significantly more (or less) than 18%. I conduct sensitivity analysis by estimating the structural model under the assumptions that measurement error accounts for 0% and 30% of cross-sectional variation in wages.

6.3 Grouping of UI Parameters

To simplify computation, I group states with similar UI parameters together and model them with a representative UI benefit formula. This allows me to treat UI group as a discrete state variable. Workers in states that have significantly changed their benefits formulas since 1979 are assigned to the UI group that most closely matches the state’s policy during each employment or unemployment spell. Table 7 describes characteristics of each UI benefit group.

6.4 Rejected Offers

Rejected wage offer data is subject to differing selection rules in different years. In some years, the survey asks questions of the form “What is highest wage you rejected?” In other years it asks for the first rejected wage amount. I divide unemployment spells into 5 types when modeling the selection and the arrival of rejected offers, and different types of unemployment spells have different state variables.

Spells of type 1 occur in years when the survey does not ask about rejected wage offers.
The notation $R_1(l, L)$ denotes the $l^{th}$ period of an unemployment spell whose total length is $L$. Spells of types 2 and 3 occur in years when the survey contains the first rejected wage offer and the number of offers. $R_2(l, L, o)$ includes an argument $o$ denoting the number of offers the worker is yet to receive. $R_3(l, L, w, o)$ includes an argument $w$ denoting the first rejected wage offer. Spell types 4 and 5 occur in years when only the highest rejected wage is observed. $R_4(l, L, w, o)$ uses a similar notation to type 3 except that $w$ represents an upper bound on the wage offers. $R_5(l, L, w, o)$ is similar to $R_4$ except that $w$ represents the highest wage the worker is yet to receive.

Figure 3 shows the transition process for unemployment spells of all types. Transitions from unemployment spells to employment spells occur only when $l=L$ and the unemployment spell is of type 1, 2 or 4. For types 2 and 4, transitions to employment spells only occur when the state variable $o$ denoting the number of offers yet to be received is zero.

6.5 Maximum Likelihood Estimation

The empirical model progresses in discrete one-month periods. The match probabilities $\lambda_e$ and $\lambda_u$ are calculated as the mean number of offers per month that workers receive while employed and unemployed respectively during years when the survey includes this data. All other parameters are estimated using maximum likelihood estimation.

To generate the transition matrix for a given set of environmental parameters, I solve the worker’s and firm’s problems using successive iterations of a 4-step process. These four steps are

1. Calculate the firm’s value function for each set of match characteristics $\{y_{it}, m_{ijt}, d_{ijt}, w_{ijt}\}$

2. Solve for the firm’s wage offer function

3. Solve for transition probabilities between jobs

4. Calculate the worker’s value function
The first step in this process calculates the firm’s value function using the identity

$$V^f = \pi + \beta P^f V^f$$

where \( \pi \) is a vector of per-period profits for each set of match characteristics, and \( P^f \) is the current estimate of the matrix of probabilities that a worker both remains at his current job transitions between the specified match characteristics. Solving for \( V^f \) yields

$$V^f = (I - \beta P^f)^{-1} \pi.$$ 

Next I update the wage offer function using the wage offer strategy described in the previous section and the current estimates of the value functions.

In the third step, I solve for transition probabilities between jobs. New match formation and the distribution of shocks to \( y_{it}, m_{ijt} \) and \( d_{ijt} \) for existing jobs are specified by environmental parameters, and the associated wage offers \( w_{ijt} \) are specified by the current estimate of the wage offer function. Job choices for workers choosing between two matches are determined by the current estimate of the worker’s value function.

The fourth step is updating the worker’s value function given the current estimated transition probabilities. This step uses the identity

$$V^w = u + \beta P^w V^w$$

where \( u \) is the worker’s per-period utility and \( P^w \) is the worker’s transition probability matrix. Solving for \( V^w \) yields

$$V^w = (I - \beta P^w)^{-1} u.$$ 

The fixed point of this process is an equilibrium.

To simulate initial match characteristics, \( y_{i0}, m_{ij0} \) and \( d_{ij0} \), I first regress initial wage on AFQT score, age and years of schooling. Initial human capital \( y_{i0} \) is simulated from the
distribution implied by this regression. The marginal distributions for \( m_{ij0} \) and \( d_{ij0} \) are the respective distributions for new matches. I use rejection sampling to discard combinations of \( y_{i0}, m_{ij0} \) and \( d_{ij0} \) for which the observed wage is not profitable. The simulated distribution of initial states for worker \( i \) is denoted \( C_{i0} \).

Because employer identity is not an explicit state variable, I construct separate matrices corresponding to transition probabilities with and without employer changes. The transition matrix \( T_0 \) represents worker’s transition probabilities irrespective of employer identity. Each element in \( T_1 \) represents the probability that an employed worker both remains with the same employer and transitions between two specified states. Each element in \( T_2 \) represents the probability that an employed worker switches employers and transitions between two specified states. The matrix \( T_3 \) represents the probabilities for an unemployed worker of a transitioning between two given states describing the unemployment spell.\(^{10}\)

If wage data during spells were not available, the state distribution for a worker after his first employment spell would be \( C_{i0}T_1^{L_{i1}} \) where \( L_{i1} \) is the employment spell length. To calculate the probability that this spell is followed by a switch to a new employer lasting \( L_{i2} \) periods, the previous distribution is multiplied by \( T_2T_1^{L_{i2}-1} \) yielding \( C_{i0}T_1^{L_{i1}}T_2T_1^{L_{i2}-1} \). Continuing in this manner through an employment history yields an expression for a vector whose sum is the probability of the observed series of spell types and lengths.

To incorporate the observed wage, spell termination type, UI takeup and rejected wage offer data, I introduce ‘filters’. Filters impose that the state at any time \( t \) is consistent with the data observed for that time. If a worker quit his job and becomes unemployed, the appropriate filter has a value of 1 for states corresponding to unemployment following a quit and a value of 0 for all other states. I apply the filter by taking the Hadamard product of the state vector in that period with the filter.\(^{11}\)

\(^{10}\)Each transition matrix assigns probability 0 to transitions that are inconsistent with the stated usage of that matrix. For instance, the unemployment-to-unemployment matrix \( T_3 \) assigns 0 probability to transitions that either start or end in employment. Thus many columns in these matrices sum to 0, and even those rows consistent with the starting condition of a matrix condition generally sum to less than 1.

\(^{11}\)The Hadamard product of two vectors \( A \) and \( B \), denoted \( A \circ B \), is a vector such that \( (A \circ B)_j = a_j b_j \).
The most frequently used filters are associated with observed wages. The value of this filter for state $s$ is the probability of observing the wage $w_{ijt}$ when the wage associated with $s$ is the true wage. Filters associated with rejected wage offers add the requirements specified in the rejected wages section.

As an example of filter usage, the state vector in the initial period then the initial state vector is $C_{i0} \circ F_{i0}$. If wages are observed again after three months at the same job, the state vector is $(C_{i0} \circ F_{i0})T_1^3 \circ F_{i3}$. The data imply an expression consisting of transition functions and filters for each worker. Multiplying the initial state vector by this expression yields a final state vector such that the $i^{th}$ element of the final state vector is the probability of following the observed employment history and ending in state $i$. Summing over states yields the likelihood for this worker, and multiplying the likelihoods for all workers yields the likelihood function.

### 6.6 Empirical Applications

I undertake two simulation exercises to compare the relative importance of non-wage characteristics, match-specific productivity and wages. The first simulation estimates the fraction of welfare improvement during voluntary switches that is due to improvements in each of these three match characteristics. The second simulation estimates the impact of UI on employment outcomes following unemployment spells.

I simulate match characteristics at new employers following voluntary job switches as well as counterfactual match characteristics if the worker had remained at his previous job to decompose the welfare change from voluntary switches into the value of changes in each match characteristic. Letting $\bar{j}$ denote the incumbent employer and $j'$ denote the new employer, the contribution of non-wage characteristics is calculated as

$$E[V(y_{it}, m_{ijt}, d_{ij't}, w_{ij't}) - V(y_{it}, m_{ij't}, d_{ij't}, w_{ij't})].$$
The contribution of match productivity is calculated as

\[ E[V(y_{it}, m_{ij't}, d_{ij't}, w_{ij't}) - V(y_{it}, m_{ij't}, d_{ij't}, w_{ij't})]. \]

The value contribution of wages is

\[ E[V(y_{it}, m_{ij't}, d_{ij't}, w_{ij't}) - V(y_{it}, m_{ij't}, d_{ij't}, w_{ij't})]. \]

The order of decomposition affects the calculated contribution of each component because the value function is not additively separable in its arguments. I calculate the contribution of non-wage characteristics first, the contribution of productive match quality second and the contribution of wages last. This ordering attributes the least value to non-wage characteristics and the greatest value to wages of all six possible orderings.

To estimate the impact of UI on re-employment outcomes, I compare characteristics of an employment following each unemployment spell with and without UI. For spells during which the worker did not receive UI, I simulate the counterfactual employment outcome following that spell if he had received UI. For spells during which the worker received UI, I simulate the counterfactual employment outcome following the same spell had he not received UI. Welfare decomposition uses the same formula used to decompose welfare changes from voluntary switches.

Observable non-wage characteristics do not appear in the search model because explicitly modeling heterogeneous preferences over these characteristics is computationally difficult and the relevant data is not available in all survey years. Instead I use the search model’s estimates of utility from non-wage characteristics in regressions to determine the value of observed non-wage characteristics. I estimate the regression in differences

\[ d_{ijt} - d_{ij,t-1} = \beta (x_{ijt} - x_{ij,t-1}) \]
where both non-wage utilities \( d \) and non-wage characteristics \( x \) are differenced between annual measurements.

A naive approach would estimate

\[
d_{ijt} = \beta x_{ijt}
\]

where \( x_{ijt} \) is a vector of job characteristics. This is inappropriate because the structural model normalizes the mean of non-wage utilities from each worker’s potential matches in a period to 0. Therefore the estimated \( d_{ijt} \) should be interpreted as the difference between the utility to worker \( i \) at firm \( j \) and the average utility he would receive at a new match. Different workers have different distributions of non-wage characteristics from new matches, so \( d_{ijt} \) cannot be compared across workers. Similarly, it is inappropriate to compare estimated non-wage utilities across distant periods in a worker’s career because the average job characteristics associated with new matches may vary over a worker’s career. If the distribution of offers a worker receives changes gradually, then the differenced regression presented here controls for variation across workers in the characteristics of potential matches.

The data used in this regression include annual observations from 1994 to 2004 for each worker. Spells terminating before 1994 are excluded due to lack of job characteristics data.

7 Results

Table 8 presents parameter estimates from the search model. I discuss five conclusions based on these parameter estimates and related simulations:

1. Non-wage characteristics are a far more important margin of job choice than wage level.

   Productivity, the source of job security and on-the-job wage growth, is of roughly equal importance to wage level.

2. Wages have moderately declining marginal utility, and high wages workers are more
likely to sacrifice any fixed wage amount for improved non-wage characteristics than low wage workers.

3. Productive match quality $m_{ijt}$ and utility from non-wage characteristics $d_{ijt}$ are subject to significant shocks, but neither experiences a significant trend.

4. The mean impact of UI on hiring wage following an unemployment spell is $0.11/\text{hr}$ in states with the least generous UI benefits and $0.17/\text{hr}$ in states with the most generous UI benefits. This impact on wages is only a small part of the total benefit workers receive from improved post-unemployment matches.

5. The correlation between observable job characteristics and simulated utility $d_{ijt}$ generally has the expected sign and reasonable magnitudes. The most valuable characteristics are health care provision and employment with a government agency.

The estimated standard deviation of non-wage utility across new matches ($\sqrt{\Omega_{dd}}$) is 11.72 in the primary specification. For comparison, the standard deviations of simulated wage offers across new matches is $7.29/\text{hr}$.

Given that the marginal utility of wages is less than 1 unit per dollar, non-wage characteristics are a much more important determinant of job choice than wages. The estimate of $\sqrt{\Omega_{dd}}$ decreases to 11.08 in the specification that assumes high measurement error, and it increases to 14.02 in the specification that assumes wages are measured without error.

Differences between specifications occur because a specification that assumes less measurement error will interpret choices to accept lower paying offers as evidence of non-wage characteristics instead of an artifact of measurement error. The estimated importance of non-wage characteristics is relatively stable across specifications given the large differences in assumptions about measurement error.

Figure 3 provides an accessible comparison of the three margins of job choice by decomposing the welfare increase during voluntary transitions into the benefit from improved wages,

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12Wage offers for new matches are simulated because observed wage offers are subject to selection.
improved productivity and improved non-wage characteristics. Improvements in non-wage characteristics contribute the most to worker welfare in voluntary switches, and increased productivity is the next largest important benefit. Changes in wage level account for only 18-26% of the total benefit from voluntary switches.

The exponent on wages in the utility function is approximately 0.9 in all three specifications. This implies that high wage workers are more willing to sacrifice a fixed wage amount for improved non-wage characteristics than low wage workers. However the declining marginal utility of wages is offset by larger wage differentials across jobs for high-wage workers, and human capital $y_{it}$ has no systematic effect on the likelihood of voluntary switches with wage cuts.

Productive match-quality $m_{ijt}$ and match-specific utility from non-wage characteristics $d_{ijt}$ are both subject to significant shocks each period. The variance $\sigma^2_m$ of shocks to productive match quality is 0.05, which is 5% of the mean productivity at a new potential match. The variance $\sigma^2_d$ of shocks to utility from non-wage characteristics is 3.265. The estimates of the mean shocks to these match characteristics are both small ($\mu_m = 0.002$ and $\mu_d = -0.014$), suggesting that the trend of increasing job stability over a worker’s career is due to selection into better matches rather than the accumulation of match-specific human capital or improvements in non-wage characteristics during an individual employment spell.

Simulations show that UI recipiency is associated with longer unemployment spells and improved matches following unemployment spells. Table 8 shows that, in the primary specification, UI recipiency increases hiring wages upon re-employment by $0.11/hr in states with the least generous benefits and $0.17 in states with the most generous benefits. Benefits in the most generous states can be more than twice as large as benefits in the least generous states, so UI benefit payments have a declining marginal impact on re-employment wages.

However the total benefit of better post-unemployment matches due to UI is over three times as important as the wage differential. Much of this is due to the impact on non-wage characteristics, which is roughly 1.5 times as valuable as the impact on wages. Table 9 shows
that the program’s impact on post-unemployment wages is stable across specifications, and Table 10 shows the relative importance of productivity and non-wage characteristics varies only moderately across specifications. Between 23% and 29% of the value of improved re-employment outcomes is due to improved productivity, and between 38% and 50% is due to improved non-wage characteristics.

The treatment of UI take-up as exogenous may be a concern in this UI application. If expectations about unemployment spell length affect takeup, the estimated effect of the program on post-unemployment outcomes is subject to endogeneity bias. However, most transitions in the data occur when a worker is ineligible for UI, and estimates of the relative importance of wages, productivity and non-wage characteristics are less subject to this bias. As a result, the relative importance of these three margins in the UI application is unlikely to be dramatically affected by assumptions about UI take-up.

Finally, I simulate non-wage utility $d_{ijt}$ and regress changes in $d_{ijt}$ on changes in observed non-wage characteristics. This regression is intended as a check of the model rather than an estimate of true parameters because observed non-wage characteristics are probably correlated to the unobserved characteristics constituting the residual. Nevertheless, the estimates in Table 11 are generally consistent with standard intuition.

Working for a government organization and receiving health insurance are associated with high values of $d_{ijt}$. The increase in per-period utility from receiving health care is 3.98, which is the same utility increase as a worker receives if he receives a raise from $15/hr to $20.67/hr.\footnote{Calculated as (15.91 + 3.98) = 19.89.} This is larger than estimates of the compensating differential for health insurance in Miller(2004) and Dey and Flinn(2008).

The constant term shows that $d_{ijt}$ tends to increase by 0.56 each year, though the coefficient of -0.03 on year indicates that this trend decreases slightly over time. Retirement plans, life insurance and flexible hours are associated with higher non-wage utility, though they have a much smaller impact than health insurance. Paid sick or vacation leave is rela-
tively important to workers, and an extra day per year of paid leave is half as valuable as the provision of life insurance. Working for a large firm, as proxied by the number of workers on site, negatively affects non-wage utility. The value of paternity leave is estimated to be negative, but it is neither statistically nor economically different from 0.

The relatively low $R^2$ in this regression suggests that job preferences are determined largely by unobserved characteristics.

8 Conclusion

Employed workers frequently quit higher paying jobs in favor lower paying jobs, and unemployed workers frequently reject their highest wage offer in order to accept a lower wage offer. These facts indicate that static wage maximization is a poor approximation of worker behavior. To the extent that workers value job security, potential for future wage growth, health insurance provision, camaraderie with coworkers and a multitude of other job characteristics, it is important to account for these characteristics when analyzing labor market policy such as unemployment insurance.

This paper estimates an equilibrium based job search model to determine the relative importance of these factors. I find that match-specific productivity, which determines job security and on-the-job wage growth, is as important a determinant of job choice as hiring wages, and non-wage characteristics are roughly twice as important to workers as hiring wages. These findings are relatively robust to varying assumptions about measurement error.

I apply the estimated model findings to simulate the value to workers from the improved employment outcomes that result when UI facilitates extended job search. I find that UI increases re-employment wages by 11 to 17 cents per hours, which is of similar magnitude to Addison and Blackburn. However, the total benefit to workers is more than three times the wage benefit. This result underscores the importance of accounting for wage dynamics
and non-wage characteristics when evaluating public policies.

Regressing changes in non-wage utility on changes in job characteristics, I find that health insurance, employment with a government agency and paid sick leave are among the most important observable job characteristics. However the $R^2$ of 0.08 in this regression suggests that many determinants of job choice are not observed in the NLSY79. In the seemingly likely case that determinants of job choice are not observed in any data set, treating non-wage utility as a latent variable may be broadly appropriate.

Given the demonstrated value workers place on non-wage characteristics, accounting for these characteristics may also allow a more complete analysis in other labor economics applications.

References


### Table 1: Descriptive Statistics For Workers In Sample

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth date</td>
<td>1961.3</td>
<td>2.2</td>
</tr>
<tr>
<td>First employment start date</td>
<td>1983.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Months employed</td>
<td>168.8</td>
<td>76.7</td>
</tr>
<tr>
<td>Months unemployed</td>
<td>27.6</td>
<td>35.1</td>
</tr>
<tr>
<td>First wage (per hour)</td>
<td>$6.16</td>
<td>$3.76</td>
</tr>
<tr>
<td>Last wage (per hour)</td>
<td>$15.86</td>
<td>$9.66</td>
</tr>
<tr>
<td>Employment spells</td>
<td>6.62</td>
<td>4.14</td>
</tr>
<tr>
<td>Unemployment spells</td>
<td>3.09</td>
<td>2.87</td>
</tr>
<tr>
<td>Education level at history start</td>
<td>13.1</td>
<td>1.85</td>
</tr>
<tr>
<td>Last interview date</td>
<td>2000.1</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Notes: Sample includes 5315 men. Men enter the sample in the first year in or after 1982 that they are not full time students.

### Table 2: Distribution of Job Transitions By Type

<table>
<thead>
<tr>
<th></th>
<th>With Unemployment Spell</th>
<th>Without Unemployment Spell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quits</td>
<td>9440</td>
<td>11952</td>
</tr>
<tr>
<td>Firings</td>
<td>1235</td>
<td>218</td>
</tr>
<tr>
<td>Layoffs</td>
<td>5778</td>
<td>1273</td>
</tr>
</tbody>
</table>

Notes: Quits are separations initiated by the worker. Firings in this context refer only to “firing with cause.” Firings are initiated by the firm due to a specific cited fault of the worker. Layoffs include all separations initiated by the firm that are not due to a specific cited fault of the worker. Layoffs in this context include separations sometimes described as “firing without cause.”

### Table 3: Wage Changes In Voluntary Transitions

<table>
<thead>
<tr>
<th></th>
<th>All Transitions</th>
<th>Voluntary Switches</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>29896</td>
<td>11952</td>
</tr>
<tr>
<td>Mean wage change</td>
<td>$0.66</td>
<td>$0.83</td>
</tr>
<tr>
<td>Mean wage change as %</td>
<td>21.3%</td>
<td>19.6%</td>
</tr>
<tr>
<td>Standard deviation of wage change</td>
<td>$5.67</td>
<td>$5.31</td>
</tr>
<tr>
<td>Frequency of wage increase</td>
<td>56.5%</td>
<td>59.3%</td>
</tr>
<tr>
<td>Frequency of wage decrease</td>
<td>36.3%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Frequency of no wage change</td>
<td>7.2%</td>
<td>7.4%</td>
</tr>
</tbody>
</table>

Notes: “All Transitions” includes both direct transitions from one employment spell to the next as well as those interrupted by unemployment spells. The original employment spells in this category may end by firing, layoff or quit. Voluntary switches are job transitions in which the worker quits the original job to move to a new job without an intervening unemployment spell. All wages are rounded to the nearest $0.05.
Table 4: Identification of Utility Function Parameters

<table>
<thead>
<tr>
<th>Variable</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_0$</td>
<td>Fraction of time spent unemployed</td>
</tr>
<tr>
<td>$\gamma_1$</td>
<td>Correlation between exit rate from unemployment and length of spell</td>
</tr>
<tr>
<td>$\gamma_2$</td>
<td>Correlation between exit rate from unemployment and UI benefit amount</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Correlation between current wage and willingness to accept wage change of fixed size</td>
</tr>
</tbody>
</table>

Notes: Utility while unemployed is $\gamma_0 + \gamma_1 l_t + \gamma_2 b_t + \epsilon_t$. Utility while employed is $w_{ijt} + d_{ijt}$.

Table 5: Implications of Match Characteristics on Job Spells

<table>
<thead>
<tr>
<th>$m_{ijt}$</th>
<th>High</th>
<th>Low $d_{ijt}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d_{ijt}$</td>
<td>Low initial wage</td>
<td>Average initial wage</td>
</tr>
<tr>
<td></td>
<td>Low wage growth</td>
<td>High wage growth</td>
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<tr>
<td></td>
<td>Long job tenure</td>
<td>Average tenure</td>
</tr>
<tr>
<td></td>
<td>Spell ends in quit or layoff</td>
<td>Spell ends in quit</td>
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<tr>
<td>$m_{ijt}$</td>
<td>Average initial wage</td>
<td>High initial wage</td>
</tr>
<tr>
<td></td>
<td>Low wage growth</td>
<td>Low wage growth</td>
</tr>
<tr>
<td></td>
<td>Average tenure</td>
<td>Short tenure</td>
</tr>
<tr>
<td></td>
<td>Spell ends in layoff</td>
<td>Spell ends in quit or layoff</td>
</tr>
</tbody>
</table>

Notes: Implications apply at any constant level of human capital $y_{it}$

Table 6: Unemployment Insurance Benefit Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Spells</th>
<th>Eligibility</th>
<th>Duration</th>
<th>Max</th>
<th>RR</th>
<th>Mean Length</th>
<th>Mean Pred. Length</th>
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<td>824</td>
<td>39</td>
<td>300</td>
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<td>4032</td>
<td>26</td>
<td>210</td>
<td>.50</td>
<td>8.67</td>
<td>8.71</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2886</td>
<td>26</td>
<td>200</td>
<td>.33</td>
<td>8.55</td>
<td>8.65</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3127</td>
<td>26</td>
<td>190</td>
<td>.25</td>
<td>8.48</td>
<td>8.58</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1329</td>
<td>26</td>
<td>150</td>
<td>.50</td>
<td>8.41</td>
<td>8.42</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Benefit eligibility formulas are rounded into representative groups based on maximum benefit eligibility, benefit replacement rate and number of weeks of benefit eligibility. Spells are grouped by benefit eligibility, not by takeup.
Table 7: Parameter Estimates

<table>
<thead>
<tr>
<th>Utility Parameters</th>
<th>Baseline</th>
<th>No Measurement Error</th>
<th>High Measurement Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_0$ - Constant in utility while unemployed</td>
<td>-0.735**</td>
<td>-0.131**</td>
<td>-0.918**</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.015)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>$\gamma_1$ - Spell length coefficient in utility while unemployed</td>
<td>-1.065**</td>
<td>-1.208**</td>
<td>-0.993**</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.010)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>$\gamma_2$ - UI benefit coefficient in utility while unemployed</td>
<td>.012**</td>
<td>.013**</td>
<td>.012**</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>$\alpha$ - Exponent on wages in utility while employed</td>
<td>.008**</td>
<td>.081**</td>
<td>.011**</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.010)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>$\sigma_e^2$ - Var of shock to utility while unemployed</td>
<td>47.251**</td>
<td>77.751**</td>
<td>38.456**</td>
</tr>
<tr>
<td></td>
<td>(.204)</td>
<td>(.149)</td>
<td>(.255)</td>
</tr>
</tbody>
</table>

Parameters Related To Human Capital $y_{it}$

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>No Measurement Error</th>
<th>High Measurement Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_y$ - Mean change to $y_{it}$</td>
<td>.004</td>
<td>.004</td>
<td>.003</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.012)</td>
<td>(0.024)</td>
</tr>
<tr>
<td>$\sigma_y^2$ - Var of change to $y_{it}$</td>
<td>.181</td>
<td>.237**</td>
<td>.156</td>
</tr>
<tr>
<td></td>
<td>(.125)</td>
<td>(.092)</td>
<td>(.148)</td>
</tr>
</tbody>
</table>

Parameters Related To Match Quality Affecting Production $m_{ijt}$

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>No Measurement Error</th>
<th>High Measurement Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_m$ - Mean change to $m_{ijt}$</td>
<td>.002</td>
<td>.003</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.037)</td>
<td>(0.066)</td>
</tr>
<tr>
<td>$\sigma_m^2$ - Var of change to $m_{ijt}$</td>
<td>.050</td>
<td>.061</td>
<td>.042</td>
</tr>
<tr>
<td></td>
<td>(3.02)</td>
<td>(2.63)</td>
<td>(3.29)</td>
</tr>
<tr>
<td>$\Omega_{mm}$ - Var. of $m_{ijt}$ for new matches</td>
<td>.996**</td>
<td>.998**</td>
<td>.899**</td>
</tr>
<tr>
<td></td>
<td>(.324)</td>
<td>(.265)</td>
<td>(.351)</td>
</tr>
</tbody>
</table>

Parameters Related To Non-Wage Utility $d_{ijt}$

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>No Measurement Error</th>
<th>High Measurement Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_d$ - Mean change to $d_{ijt}$</td>
<td>-0.014**</td>
<td>-0.029**</td>
<td>-0.125**</td>
</tr>
<tr>
<td></td>
<td>(.003)</td>
<td>(.002)</td>
<td>(.004)</td>
</tr>
<tr>
<td>$\sigma_d^2$ - Var of change to $d_{ijt}$</td>
<td>3.265</td>
<td>4.011</td>
<td>3.088</td>
</tr>
<tr>
<td></td>
<td>(2.711)</td>
<td>(2.110)</td>
<td>(3.035)</td>
</tr>
<tr>
<td>$\Omega_{dd}$ - Var of $d_{ijt}$ for new matches</td>
<td>137.422**</td>
<td>196.519**</td>
<td>122.855**</td>
</tr>
<tr>
<td></td>
<td>(4.128)</td>
<td>(2.943)</td>
<td>(4.960)</td>
</tr>
</tbody>
</table>

Notes: The first column shows when measurement error accounts for 18% of cross-sectional variation in wages. The second and third columns show estimates when measurement error accounts for 0% and 30% of measured variation in wages respectively. $\beta$ is fixed at .996 throughout estimation because it is not clearly identified.

* indicates statistically significant at the .05 level; ** at the .01 level
Table 8: Impact of UI on Post-Unemployment Outcome: Baseline Specification

<table>
<thead>
<tr>
<th>UI Benefit Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hourly Wage ($/hr)</td>
<td>.11</td>
<td>.11</td>
<td>.12</td>
<td>.14</td>
<td>.14</td>
<td>.15</td>
<td>.16</td>
<td>.16</td>
<td>.17</td>
</tr>
<tr>
<td>Value of Better Wage $w_{ijt}$</td>
<td>3.1</td>
<td>3.1</td>
<td>3.3</td>
<td>3.9</td>
<td>4.0</td>
<td>4.2</td>
<td>4.4</td>
<td>4.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Value of More Productive Match $m_{ijt}$</td>
<td>2.5</td>
<td>2.6</td>
<td>2.7</td>
<td>3.0</td>
<td>3.1</td>
<td>3.3</td>
<td>3.4</td>
<td>3.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Value of Improved Non-Wage Chars $d_{ijt}$</td>
<td>5.1</td>
<td>5.2</td>
<td>5.4</td>
<td>6.2</td>
<td>6.3</td>
<td>6.4</td>
<td>6.7</td>
<td>6.7</td>
<td>6.9</td>
</tr>
<tr>
<td>Fraction of Value From Wage Increase</td>
<td>.29</td>
<td>.29</td>
<td>.29</td>
<td>.29</td>
<td>.30</td>
<td>.30</td>
<td>.30</td>
<td>.30</td>
<td>.30</td>
</tr>
</tbody>
</table>

Notes: UI impact is based on simulated re-employment characteristics with and without UI takeu. The decomposition of value from each attribute is based on changes in the value function caused by changes in that job attribute while holding the other attributes constant.

Table 9: Impact of UI On Wages

<table>
<thead>
<tr>
<th>UI Benefit Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification 1 (Baseline)</td>
<td>.11</td>
<td>.11</td>
<td>.12</td>
<td>.14</td>
<td>.14</td>
<td>.15</td>
<td>.16</td>
<td>.16</td>
<td>.17</td>
</tr>
</tbody>
</table>

Notes: Listed wage impact is difference in hourly wage upon rehiring with and without UI recipiency. For a worker receiving UI benefits, the counterfactual wage he would receive without UI is simulated. For a worker not receiving UI benefits, the counterfactual wage he would receive with UI is simulated.

Table 10: Per Cent of Total Value From UI’s Impact on Matches Due To Each Margin

<table>
<thead>
<tr>
<th>UI Benefit Group</th>
<th>Wage</th>
<th>Productivity</th>
<th>Non-Wage Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Specification</td>
<td>30</td>
<td>23</td>
<td>47</td>
</tr>
<tr>
<td>Spec. 2 (No Measurement Error)</td>
<td>21</td>
<td>29</td>
<td>50</td>
</tr>
<tr>
<td>Spec. 3 (High Measurement Error)</td>
<td>36</td>
<td>26</td>
<td>38</td>
</tr>
</tbody>
</table>

Notes: Fraction of total benefits due to each margin is aggregated across different UI benefit groups, though the relative importance of each margin varies little across groups.
Table 11: Estimated Utility from Specific Job Characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Impact on Simulated Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>(0.56^{**}) (.02)</td>
</tr>
<tr>
<td>Year</td>
<td>-0.03 (.02)</td>
</tr>
<tr>
<td>Government Worker</td>
<td>4.31^{**} (.44)</td>
</tr>
<tr>
<td>Health Insurance</td>
<td>3.98^{**} (.27)</td>
</tr>
<tr>
<td>Life Insurance</td>
<td>0.61 (.36)</td>
</tr>
<tr>
<td>Retirement Plan</td>
<td>0.55 (.39)</td>
</tr>
<tr>
<td>Flexible Hours</td>
<td>0.86^{**} (.21)</td>
</tr>
<tr>
<td>Paternity Leave</td>
<td>-0.27 (.57)</td>
</tr>
<tr>
<td>Days Paid Sick Leave/Vacation</td>
<td>0.31^{**} (.03)</td>
</tr>
<tr>
<td>Workers at location</td>
<td>-0.03^{**} (0.004)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>23968</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Notes: Estimates are based on a regression in first differences. Non-wage utility \(d_{ijt}\) is the dependent variable, and the listed characteristics are independent variables. The regression is limited to job spells occurring between 1994-2004 due to data restrictions. The year variable is defined as the number of years after 1994.

* indicates statistically significant at the .05 level; ** at the .01 level
Figure 1: Wages Before And After Voluntary Job Switches

Notes: Scatter plot of hourly wage immediately before and after each voluntary job transition without an intervening unemployment spell. Transitions where either wage is greater than $50/hr are not shown.
Figure 2: Unemployment Spell Type Transitions

<table>
<thead>
<tr>
<th>Rejected offer data not collected</th>
<th>( R_1(l,L) ) → No offer or rejected offer → ( R_1(l+1,L) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of rejected offers and amount of first rejected offer collected</td>
<td>( R_2(l,L,o) ) → Rejected offer → ( R_2(l+1,L,o) )</td>
</tr>
<tr>
<td></td>
<td>( R_3(l,L,o,w) ) → Rejected offer → ( R_3(l+1,L,o-1) )</td>
</tr>
<tr>
<td></td>
<td>( R_5(l,L,o,w) ) → Rejected offer → ( R_5(l+1,L,o,w) )</td>
</tr>
<tr>
<td>Number of rejected offers and amount of highest rejected offer collected</td>
<td>( R_4(l,L,o,w) ) → No offer → ( R_4(l+1,L,o,w) )</td>
</tr>
<tr>
<td></td>
<td>( R_6(l,L,o,w) ) → Rejected offer ≤ w → ( R_6(l+1,L,o-1,w) )</td>
</tr>
</tbody>
</table>

\( l \) = Current unemployment spell length
\( L \) = Total unemployment spell length
\( o \) = Number of offers yet to be received during this spell
\( w \) = Upper bound of offers yet to be received as argument to \( R_4 \)
\( w \) = Highest offer yet to be received as argument to \( R_5 \)
Appendix 1

I prove the existence of an equilibrium in an environment where firms choose wages from a continuous set of potential wage offers, and match characteristics \( \{y_{it}, m_{ijt}, d_{ijt}\} \) lie in the continuous space \( \{[y, \bar{y}], [m, \bar{m}], [d, \bar{d}]\} \).

Let \( V \) be a function specifying the value to both workers and firms of entering a period with a match described by \( \{y_{it}, m_{ijt}, d_{ijt}, w_{ij,t-1}\} \). The wage offer and job acceptance strategies described in this paper define worker and firm behavior as a function of \( V \). These behaviors in turn imply specific values to the worker and firm from every set of match char-
acteristics. Let \( f(V) \) be the set of values of each match to workers and firms when all parties use the strategies implied by \( V \). The bidding strategies associated with any \( V^* \) such that \( f(V^*) = V^* \) constitute an equilibrium.

Let \( X \) denote the set \( \{[y, \bar{y}], [m, \bar{m}], [d, \bar{d}], \mathbb{R}, \mathbb{R}\} \). This set corresponds to all possible value functions \( V \). Schauder’s fixed point theorem states that if there is a non-empty, compact and convex \( K \subset X \) such that \( f \) continuously maps \( K \) into \( K \), then there is a fixed point \( V^* \in K \) such that \( f(V^*) = V^* \).

To construct \( K \), I first describe bounds on the values of a match to both workers and firms in equilibrium. The value of a match to a firm is bounded above by \( V_f \equiv \frac{1}{1-\beta} \bar{y} \bar{m} \) because per-period productivity is at most \( \bar{y} \bar{m} \). The value of a match to a firm is bounded below by 0 because the firm can costlessly fire a worker. The worker’s value function is bounded above by \( V_w \equiv \frac{1}{1-\beta}[(\bar{y} \bar{m})^\alpha + \bar{d}] \) because his wage is at most \( \bar{y} \bar{m} \) and non-wage utility is at most \( \bar{d} \). The worker’s value function is bounded below by \( V_w \equiv \min\{\frac{1}{1-\beta} \bar{d}, u\} \) if wages are non-negative and \( u \) is defined as the value of an infinitely long unemployment spell. The value of infinitely long unemployment spell is a convergent sequence, so \( u \) is a real number. I define \( K \) as \( \{[y, \bar{y}], [m, \bar{m}], [d, \bar{d}], [0, V_f], [V_w, V_w]\} \). \( K \) is a convex and compact subset of \( X \). By the construction of \( K \), \( f \) maps \( K \) into \( K \).

This mapping \( f \) is continuous because the effect of the value functions on bidding strategies is continuous, and the effect of bidding strategies on the resulting values is continuous. The continuity of bidding strategies as a function of value functions results directly from the nature of the bidding strategy.

To show that changes in bidding have a continuous effect on value functions, I describe the two effects of changes in bidding strategy. A change in bidding strategy causes continuous changes in equilibrium wages as well and discrete changes in a worker’s choice between matches. Continuous changes in wages cause continuous changes in the value of a match to both workers and firms. Changes in choices between matches occur only where both the worker and firm are indifferent between whether or not a worker accepts the offer from that
match. Thus neither wage changes nor choices between matches cause discontinuous changes in value functions, and $f$ is continuous.

Because $X$ is a non-empty convex set in a Banach space, $K$ is a convex and compact subset of $X$ and $f(V)$ maps $K$ continuously into $K$, there is a fixed point $V^*$ such that $V^* = f(V^*)$ by the Schauder fixed point theorem.