Disability, Employment Transitions, and Wages: The Role of Employer and Occupational Tenure

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Abstract

Despite the growing prevalence of disability among prime age men and strong correlations between disability and negative employment outcomes, few economic analyses address the avenues through which disability may influence these observed outcomes. Particularly, the impact of disability on employment decisions of disabled workers who remain employed is unknown. In this research, I focus on the role of employer and occupational tenure as contributors to the observed difference in wages of working age males. Based on a dynamic framework of employment transitions and disability over time, the empirical model jointly estimates employer and occupational changes, disability status, and wages of men using longitudinal data on individuals from the Survey of Income and Program Participation. A nonlinear random effects joint estimation technique accounts for both permanent and time-varying unobserved heterogeneity that may influence employment transitions, wages, and disability. The results suggest that moderately disabled workers are 23 percent more likely to change occupations and/or employers compared to non-disabled men. Furthermore, the loss of tenure from these transitions reduces wages. Compared to disabled workers who do not make a transition, moderately disabled workers who change occupations and employers experience an immediate 30 cent decline in hourly wages.

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1 Introduction

> *"Disabled Americans are an economically disadvantaged group. They work less, earn less, and earn lower wages when they do work."*
> -DeLeire (2000)

The number of people in the United States with a disability has been steadily increasing over the past several decades. This upward trend has elicited much concern over the welfare of the elderly and near elderly, and has generated interest among economists in the effect of disability on medical care consumption and retirement decisions. However, comparatively little is understood about the employment patterns and wages of prime age disabled workers despite the increasing frequency of disability among this group. In 2006, the U.S. Census Bureau reported that almost 13% of men aged 21-64 were disabled.[1] Furthermore, the Social Security Administration has found that a 20 year old worker has a 30% chance of becoming disabled before reaching retirement age.[2] Supporting this notion, a 2004 study by Lakdawalla et al. using National Health Interview Study data from 1984-2000 found that disability reports among the elderly have actually fallen while reports of those under age 50 have increased. The authors note that this trend is especially prevalent among those aged 30-49.

Disability is an important concern in the realm of economics as it is negatively correlated with employment and wage outcomes. It has been well documented that persons with a disability receive lower wages, earning 16 to 18% less than non-disabled workers (Baldwin and Johnson, 2000; DeLeire, 2001). The combination of low employment and low wages may help explain why over 20% of the disabled live in poverty compared to less than 8% of those without a disability.[3] In order to assist this group, many social programs have been created and in 2006 over 91 billion dollars was spent on Social Security disability insurance payments alone.[4] These payments are only available to the disabled who do not participate

[1] US Census Bureau, 2006 ACS. Data available at: http://www.census.gov/hhes/www/disability/2006acs.html
[2] Social Security Administration Disability planner. http://www.ssa.gov/dibplan/index.htm
[3] US Census Bureau, 2006 ACS. Data available at: http://www.census.gov/hhes/www/disability/2006acs.html
[4] SSA Annuals Statistical Supplement: http://www.ssa.gov/policy/docs/statcomps/supplement/2007/highlights.html

in substantial gainful activity. Many other federal programs such as Ticket to Work, an incentive program for employers to hire disabled workers, are also only available to disabled individuals who are not gainfully employed. However, many disabled individuals are capable of working and continue to work following the onset of a disability.

While historically the majority of legislation regarding disability has focused on supporting disabled workers who are unable to work, the 1990 Americans with Disabilities Act (ADA) enacted laws to protect disabled workers. The ADA is an important civil rights act that prohibits discrimination in the hiring, firing, pay, and promotion of qualified disabled individuals.[5] Additionally, the act requires firms of 15 or more employees to provide "reasonable accommodations" to disabled workers. These accommodations may include flexible work hours, equipment, assistants, and other such work modifications that do not impose undue hardship on the employer. Thus, a goal of the ADA was to limit job turnover among disabled workers. However, not all employers are required or capable of making all accommodations requested by disabled workers and many more may not provide a welcoming atmosphere to a disabled employee. Furthermore, certain health limitations may render the individual incapable of performing required job tasks, necessitating an exit from the occupation. Therefore, even in the post-ADA era, disabled workers may still have a high rate of job turnover.

This paper adds to the current research on disability by jointly estimating a dynamic model of employer and occupational change, wages, and disability status for men ages 25 to 60. Using the 1996 panel of the Survey of Income and Program Participation (SIPP), the direct impact of disability on employment transitions and the indirect impact of disability on wages through tenure is analyzed. As tenure is valuable to employers, if disabled workers change employers or occupations frequently, it may be reflected in lower wages. Since employment transitions are endogenous, modeling employer and occupational change produces unbiased estimates of the impact of tenure on wages.

Further complicating estimation, both disability and employment outcomes may be affected by individual variables unobserved by researchers. To control for this unobserved heterogeneity, correlation across the associated error terms in all equations is allowed. The

[5]For more information on the Americans with Disabilities Act, refer to www.ada.gov.

equations are simultaneously estimated using a dynamic nonlinear random effects joint estimation technique that accounts for both permanent and time-varying unobserved heterogeneity. Estimates from this analysis suggest that in a given four-month period a moderately disabled worker is 1.4 percentage points more likely to change occupations and 0.8 percentage points more likely to change employers than a non-disabled worker. Furthermore, both of these changes are found to negatively impact the wage rate of a moderately disabled worker.

2 Background

2.1 Disability

The measure of disability available in the SIPP data is based on the response to the question of whether a person has "a physical, mental, or other health condition that limits the kind or amount of work" he can perform. This measure is often referred to as a work limiting disability and is the only disability definition provided in many data sets. The definition is very similar to the definition of disability used by the Americans with Disabilities Act which defines an individual with a disability as a person who "has a physical or mental impairment that substantially limits one or more major life activities; has a record of such an impairment; or is regarded as having such an impairment."

Several studies have found the self-reported measure of disability to be superior to other indicators of disability. It has been noted that objective measures such as specific health conditions and medical reports measure health and not the capacity to work. The use of such objective measures may lead to bias in estimating the impact of disability on employment (Bound, 1991). Furthermore, using objective measures to instrument self-reports may create more bias than when self-reports alone are used (Bound, 1991). Several researchers have concluded that self-reported disability is an accurate reflection of ability to work and empirical analyses using such a measure produce unbiased results of the impact of disability on employment (Stern, 1989; Dwyer and Mitchell, 1999; Benitez-Silva et al., 2004).

Many other researchers, however, have concluded that self-reported disability is correlated with unobservables that also impact employment decisions (Anderson and Burkhauser,

1985; Bazzoli, 1985; Kerkhofs and Lindeboom, 1995; Kreider, 1999). Specifically, several potential problems have been raised with the measure. One issue, known as the justification hypothesis, states that an individual may report that he has a disability to justify his exit from the labor force or other labor market decisions. Thus, measures of the effect of disability on employment status, for example, would be overstated. Furthermore, disability partially determines receipt of compensation from several government programs such as Social Security Disability Insurance and Worker's Compensation. The desire to receive these types of assistance may induce individuals to report that they are disabled. A competing effect is the stigma that one might feel with classifying himself as having a disability. This stigma would cause individuals to underreport disability. Finally, even if workers are not justifying non-employment or hiding their disabilities, the question itself is subjective and thus leads to measurement error. Interpretation of disability and ability to work may differ across individuals. See Bound (1991) for a comprehensive review and comparison of self-reported measures to objective measures.

In this paper I allow self-reported disability to be determined by unobservables that may be correlated with other outcomes of interest such as employment and wages. I model permanent and time-varying unobserved factors influencing disability status and employment outcomes using a flexible random effects maximum likelihood estimation known as the Discrete Factor Random Effects method. A detailed description of this approach is presented in Section 4.2.

2.2 Related Literature

The majority of empirical research on disability has focused on the decision to remain employed or exit the labor force. There is less known about the employment-related outcomes of disabled workers who remain employed. Although a disability may render an individual unable to remain in his current job, that person may adapt to his new set of abilities by changing occupations or employers as opposed to discontinuing employment.

A few studies have explored the role of health on employer or occupational transitions among older workers. Daly and Bound (1996) analyze the characteristics that contribute to employer change for disabled workers using the Health and Retirement Survey (HRS). The

authors find that age has a negative impact on the likelihood of employer change and that disabled workers who change employers have a larger decrease in physical job demands compared to those who remain with their current employer. Bound et al. (1999) and Blau and Gilleskie (2001) analyze the dynamic effects of impairment on labor market withdrawal and job change of older workers using the first three waves of the HRS. These papers are some of the only studies in this area to explicitly model disability, controlling for the endogeneity of the variable. Bound et al. (1999) find that a transition from good to poor health has a positive effect on the probability of changing jobs between nine and fourteen percentage points. Blau and Gilleskie (2001) find that a transition from excellent to poor health has a small negative impact on the probability of changing jobs. Pelkowski and Berger (2003) extend employment transition analysis to include occupational change, although only consider occupational changes in conjunction with employer change. Their model is dynamic in that they consider the timing of health onset relative to employment spells. The study finds that workers with health problems are 15 percentage points less likely to change employer, but those who do are more likely to also have large occupational changes.

Even fewer researchers have analyzed the role of health on employer and occupational transitions of younger workers. Baldwin and Schumacher (2002) use the SIPP to study voluntary and involuntary employer changes over a 20-month period of disabled persons 16 to 65 years old. Considering a survey responder who has changed employers at any point during this period a "changer", they find that disabled workers are 2.7 percent more likely to have an involuntary job change, but no more or less likely to have a voluntary job change. Differencing the wage between the start and end of the survey, the authors also find that involuntary changes have almost no impact on wages for disabled workers but voluntary changes have a negative impact. Campolieti (2009) uses the Participation and Activity Limitation Survey (PALS) from Canada to study the employer changes of disabled workers across a four-month span. His goal is to identify characteristics that influence the decision to change employers or exit employment relative to remaining with an employer. He finds that, compared to a worker with a mild disability, men with moderate and severe disabilities are respectively 9.1 and 6.9 percentage points more likely to change employers. No comparison is made to non-disabled workers as they are not included in the survey. Campolieti and

Krashinsky (2006) analyze the role of employer change on wages of permanently disabled Canadian workers over a one-year period. They find that the disabled workers who return to their pre-injury employer earn over 27 percent more than those who change employers. Each of these three studies treat disability as exogenous and thus may misestimate of the impact of disability if unobservables influence both disability and employment outcomes.

Several papers have estimated the direct impact of disability on wages. Using similar approaches, Charles (2003), Mok et al. (2006), Meyer and Mok (2008) find that disability has a persistent negative impact on wages that is worse for chronic and severe disabilities. After controlling for industry and occupation, Charles (2003) finds that the effect of disability on wages is reduced and notes that "almost half of the recovery men are estimated to make in the two years after onset seems to be the result of changes in industry and occupation." Examining the wage gap between disabled and non-disabled workers in the years 1972-1984, Baldwin and Johnson (1994) control for experience and tenure, and find that both variables have a positive impact on wages. Contrary to expectations, the disabled workers analyzed have more experience and tenure than non-disabled men, which helps decrease the wage gap between the two groups. In a more recent study, DeLeire (2001) analyzes the wage gap from 1984-1993. In DeLeire's sample, disabled workers also have higher amounts of employer tenure than the non-disabled, but he does not find that tenure is a significant component of the wage gap.

I contribute to the literature on disability and employment in several ways. First, this paper captures more potential employment transitions than previous research which has spanned at most three waves. The data utilized in this study follows individuals for twelve waves with interviews every four months. Second, this is the only paper (to my knowldege) to examine the role of disability on both employer and occupational change. That is, I model individuals who change only their occupation, who change only their employer, and who change both occupations and employers.[6] Third, I model disability jointly with employment outcomes and wages. I account for both length of disability and severity of disability which

[6]In any one wave of the SIPP data, 5.3 - 13.8% of workers change only occupations, 3.1 - 4.1% change only employers, and 0.3 - 0.9% change occupations and employers. These percentages also vary by disability status.

is absent from many other related papers. Fourth, the dynamic modeling strategy allows me to measure the the direct impact of disability on wages as well as the indirect effect of disability on wages through employer and occupational tenure.

3 Conceptual Framework

The theoretical model presented in this section motivates the empirical specification that follows. The purpose of the model is to illustrate how disability may affect the likelihood that a worker changes his occupation or employer and how such transitions affect wages through occupational and employer tenure. The model describes a situation where a previously employed individual may continue to work in the same occupation with the same employer, become jobless, change employers and/or change occupations.

To focus the theoretical motivation broadly on employment transitions, I do not disaggregate the occupation and employer alternatives by job or employer characteristics that individuals are transferring to and from.[7] The goal of the current paper is to establish whether or not observed occupational and employer tenure provide an indirect avenue through which disability affects earnings, while controlling for the endogeneity of these transitions.

The interplay of disability, job mobility, and wages is modeled in a dynamic framework with the following timing assumptions:

1. The individual enters the period knowing his disability status and his disability and employment histories.
2. Four job offers are received each period: an offer from his current job, one from a new occupation, one from a new employer, and one from a new occupation with a new employer.
3. Based on this information, the individual then simultaneously chooses whether or not to work, his occupation, and his employer. Wages of those who work are observed by the researcher.
4. At the end of the period the individual's disability status evolves.

[7] Whalen (2009) explores occupational choice characterized by job attributes with the recognition that disability may affect and be affected by these observed decisions.

Individuals receive utility in period t from consumption (C_t) and leisure (L_t). The marginal utility of leisure (or disutility of working) varies with disability status (D_t). All else equal, the presence of a disability will likely increase the disutility of working. The amount of disutility caused by a disability depends not only on the nature of the disability, but also on tasks required by the job, and special accommodations made by the employer. Accordingly, the same disability may bring different levels of disutility to identical workers depending on job components (J_t) which include employer and occupational characteristics. Variables that shift preferences also affect utility. These include observable individual characteristics (X_t) and unobservable permanent (μ), time varying (ν_t), and idiosyncratic (ϵ_t) characteristics. Specifically, lifetime utility is represented by:

$$E\left[\sum_{t=1}^{T}\beta^t U_t(C_t, L_t; D_t, J_t, X_t, \mu, \nu_t, \epsilon_t)\right]$$

where E is the expectations operator and β is the discount factor. The individual subscript, i, is dropped for notational ease.

Hours in a period (Ω) are divided between hours of work (H_t) and leisure (L_t):

$$\Omega = H_t + L_t.$$

Total consumption (C_t) is the sum of earned income and unearned income (Y_t).[8] Earned income is the product of hourly wages (W_t) and hours worked. The budget constraint is given by:

$$C_t = W_t * H_t + Y_t.$$

Substituting the budget and time constraints in to the per period utility function, we have:

$$U_t(W_t * H_t + Y_t, \Omega - H_t; D_t, J_t, X_t, \mu, \nu_t, \epsilon_t).$$

At the beginning of each period an employed individual receives four job offers: a job with his current occupation and employer, a new occupation with his current employer, a new employer in his current occupation, and a new occupation with a new employer.

[8] In order to focus on the employment decision, the model abstracts from specific consumption decisions that may depend on disability status, such as medical care consumption or transportation costs.

An individual who was not employed in the previous period only has two options: non-employment and employment. These offers specify wages (W_t) and job components (J_t) including hours of work, job characteristics, and employer characteristics.

The wage is determined by individual attributes, job components, and market characteristics. An individual's demographic characteristics (X_t) and disability status entering period t (D_t) affect wages. Disability directly affects wages through productivity differences and/or discriminatory practices, although these explanations are indistinguishable (and unexplored) in this model. An individual's firm specific and skill specific expertise may also affect wages. This experience is captured by the individual's employer tenure (ET_t) and occupational tenure (OT_t) up to period t.[9] Job components of the period t alternative (J_t) include hours of work, job characteristics, and employer characteristics. Wages are also affected by local labor market conditions (Z_t). Finally, unobserved permanent (μ) and time-varying characteristics (ν_t) and an idiosyncratic wage shock (ϵ_t^W) influence wages. Wages can be described as:

$$W_t(D_t, OT_t, ET_t, J_t, X_t, Z_t, \mu, \nu_t, \epsilon_t^W). \tag{1}$$

where occupational and employer tenure are determined by the history of occupation and employer transitions.

In each period a worker may remain with his current job (which carries with it job components, an hourly wage, and hours of employment), change occupations or employers (which implies different job components but erases occupational or employer tenure), or become non-employed. The observed employment outcome is a function of individual attributes, disability status, job components, market conditions, and unearned income (Y_t). Large sums of unearned income lead to a low marginal utility of consumption and thus a higher reservation wage. Individuals with high reservation wages are less likely to work, implying that unearned income should have a negative effect on the likelihood of being employed. Employment alternatives are also affected by unobserved characteristics and preferences (μ and ν_t).

Defining all state variables as S_t and allowing disability status to take on a value

[9]Note that the measure considered here is tenure, not total work experience.

$d \in [0, D]$, the value function for an individual choosing employment alternative r can be defined as:

$$V_r(S_t, \epsilon_t) = U_t(W_t^r * H_t^r + Y_t, \Omega - H_t^r; d, J_t^r, X_t, \mu, \nu_t) + \epsilon_{rt} + \beta[\sum_{d=0}^{D} P(D_{t+1} = d)V(S_{t+1})].$$

The maximal expected value of lifetime utility is:

$$V(S_t) = E_{t-1}[\max_{q=1,\ldots,R} V_q(S_t, \epsilon_t)] \; \forall \; t.$$

An n-th order Taylor series expansion provides an approximation to the alternative-specific value function. The approximation is given by:

$$V_r(S_t, \epsilon_t) \approx R_t(S_t, \epsilon_t) = R_t(D_t, OT_t, ET_t, J_t, X_t, Y_t, Z_t, \mu, \nu_t, \epsilon_t). \tag{2}$$

Disability status evolves at the end of the period. Disability depends on observable and unobservable individual characteristics and current disability status.[10] Employment status and job components also affect one's disability status, as job tasks may have a direct effect on health. The length of time a person has been performing job tasks or in a given work environment, as captured by occupational and employer tenure, also influence disability status. Unearned income may also influence one's health, as individuals with high income may be able to purchase more preventative and curative medicine than low income individuals. Specifically, disability in period $t + 1$ is given by:

$$D_{t+1}(D_t, OT_{t+1}, ET_{t+1}, J_{t+1}, X_t, Y_t, \mu, \nu_t, \epsilon_t^D). \tag{3}$$

Equations 1, 2, and 3 above provide the basis for the empirical model described in the following section.

4 Empirical Model

In this section, I describe the econometric framework motivated by the theoretical model and used to analyze the data. The goal of this analysis is to determine the effect of disability on employment, occupational change, employer change, and observed wages. The estimated equations are linear approximations to optimal decisions that are explained by both observed (endogenous and exogenous) variables and unobserved variables.

[10] Section 2.1 provides an in-depth discussion of the sources of endogeneity.

4.1 Empirical Specification

Based on the model of decision making behavior, the employment outcomes of optimizing individuals are observed every period. These employment outcomes (R_t) of those who were employed in the previous period are:

$$r = \begin{cases} 0, \text{ non-employment} \\ 1, \text{ employment with a new employer in a new occupation} \\ 2, \text{ employment with a new employer in the same occupation} \\ 3, \text{ employment with the same employer in a new occupation} \\ 4, \text{ employment with the same employer in the same occupation.} \end{cases}$$

An individual who enters the period non-employed faces alternatives $R_t = r \in \{0, 1\}$ only.

In each period an employed individual chooses whether to remain employed and, if employed, whether to choose the same or a new occupation and employer. The theoretical model implies that job components of each employment alternative influence this decision. However, because observational data generally provide job components of the chosen employment option only, measurement of the impact of employer and occupational characteristics is compromised. Additionally, employer and occupational characteristics are endogenous. Disabled workers may change employers or occupations to accommodate themselves to deteriorations in health. These changes are likely not random as workers may systematically make employment changes as a coping mechanism. Similarly, unobserved individual characteristics may influence both disability and occupational or employer choice. As the focus of this paper is on disentangling the direct impact of disability on wages from the indirect effect captured by occupational and employer tenure and in light of the endogeneity of occupational and employer choice, I do not include contemporaneous or lagged job components such as hours of work, occupational characteristics, or employer characteristics in the employment equation.[11]

I model the per period employment outcomes indicated by $R_t = r$, which allows for the endogenous determination of occupational and employer tenure. More specifically, conditional on being employed in period $t-1$, the probability of a particular employment outcome

[11] In another paper I model the endogenous occupational and employer selection and analyze the role job components play in explaining employment transitions. For more information refer to Whalen (2009).

in period t relative to non-employment (expressed in log odds) is given by:

$$ln\left[\frac{Pr(R_t = r|E_{t-1} = 1)}{Pr(R_t = 0|E_{t-1} = 1)}\right] = \alpha_{r0} + \alpha_{r1}S_t^D + \alpha_{r2}S_t^E + \alpha_{r3}X_t + \alpha_{r4}Y_t + \alpha_{r5}Z_t + \mu_1^r + \upsilon_{1t}^r, \text{ r=1,..,4.} \tag{4}$$

The vector of variables describing one's disability history entering period t, S_t^D, includes disability status, disability severity status, the number of periods since first disability onset if the individual entered the sample disabled, and disability tenure if the individual entered the sample without a disability. Employment history entering the period, S_t^E, is described by the number of consecutive periods an individual has worked for the same employer (employer tenure), the number of consecutive periods an individual has worked in the same occupation (occupational tenure), and the number of periods of recent non-employment (which will be zero for those employed in period $t-1$). The observed exogenous variables (X_t) include age, race, marital status, number of children, educational attainment, urbanicity, and region. Unearned income is measured as the amount of non-transfer income and is denoted Y_t. Z_t describes market characteristics and includes the average local unemployment rate.[12] Note that unobserved permanent and time-varying individual components affect all estimated equations.[13]

A person who was nonemployed in period $t-1$ has only two alternatives: to become employed or remain jobless. Expressed in log odds, the probability of entering employment is:

$$ln\left[\frac{Pr(E_t = 1|E_{t-1} = 0)}{Pr(E_t = 0|E_{t-1} = 0)}\right] = \beta_0 + \beta_1 S_t^D + \beta_2 S_t^E + \beta_3 X_t + \beta_4 Y_t + \beta_5 Z_t + \mu_2 + \upsilon_{2t}. \tag{5}$$

Here, the relevant variable from the employment history vector (S_t^E) is the length of time a person has been jobless, as the occupational and employer tenure variables are zero.

The natural log of observed wages in period t, conditional on employment in period t is:

$$lnW_t = \delta_0 + \delta_1 S_t^D + \delta_2 S_{t+1}^E + \delta_3 X_t + \delta_4 Z_t + \mu_3 + \upsilon_{3t} + \epsilon_{3t}. \tag{6}$$

[12]The average local unemployment rate is defined as the unemployment rate in a given area defined by the SIPP, which is roughly a metropolitan statistical area.

[13]The joint distribution of the μs and the joint distribution of the υ_ts will be discussed in Section 4.2.

The updated employment history (S^E_{t+1}) accounts for current employment choices and includes hours worked, employer size, dummy variables for occupational category, employer and occupational tenure.[14] Note that observed wages are also explained by disability entering period t and an interaction between disability status and each tenure variable.

Disability status evolves at the end of the period. Disability status is defined as three different levels: non-disabled, moderately disabled, and severely disabled (d = 0, 1, 2). Exogenous individual characteristics, current disability status, the characteristics implied by current period occupational and employment choices, unearned income, and unobserved individual characteristics influence period $t+1$ disability.[15] More specifically, in log odds, the probability of a disability is given by:

$$ln\left[\frac{Pr(D_{t+1}=d)}{Pr(D_{t+1}=0)}\right] = \gamma_{d0} + \gamma_{d1}S^D_t + \gamma_{d2}S^E_{t+1} + \gamma_{d3}X_t + \gamma_{d4}Y_t + \mu^d_4 + \upsilon^d_{4t}, d = 1, 2. \quad (7)$$

4.2 Estimation Technique

Discrete Factor Random Effects

Estimation of the empirical equations for employment outcomes, wages, and disability status is performed using a nonlinear random effects estimation technique, referred to as the Discrete Factor Random Effects method (DFRE). This approach controls for variables that are unobservable to the researcher and may impact all equations, as failure to control for these unobservables may result in biased estimates. The DFRE method estimates the distribution of these unobserved variables by decomposing the error term into three parts: permanent heterogeneity (μ), time-varying heterogeneity (υ_t) and an iid error term (ϵ_t).

[14] I acknowledge that hours worked, employer size, and occupation are likely endogenous. However, I take the stance that the omitted variable bias caused by ignoring these variables may be worse than estimation including these endogenous variables. As the effect of these variables is not the focus of the paper, I include them in estimation yet do not discuss their marginal effects.

[15] Refer to footnote 14 above.

Allowing the unobserved heterogeneity to be non-linear, the error terms may be written as:

$$\begin{aligned}
\varepsilon_{1t}^{d} &= \mu_1^r + \upsilon_{1t}^r + \epsilon_{1t}^r \quad \text{r=1,2,3,4} \\
\varepsilon_{2t} &= \mu_2 + \upsilon_{2t} + \epsilon_{2t} \\
\varepsilon_{3t} &= \mu_3 + \upsilon_{3t} + \epsilon_{3t} \\
\varepsilon_{4t}^{d} &= \mu_4^d + \upsilon_{4t}^d + \epsilon_{4t}^d \quad \text{d=1,2}
\end{aligned} \tag{8}$$

where μ and υ_t are assumed to be correlated across equations while ϵ_t is random and uncorrelated.

The cumulative distribution function of the unobserved heterogeneity terms are approximated by a discrete stepwise function. The function is estimated with points of support for the distribution of unobserved factors. This flexible estimation technique does not impose joint normality on the error terms as is standard in many maximum likelihood techniques (Heckman and Singer (1984)). Using a Monte Carlo simulation, Mroz (1999) shows that when the true distribution of the error terms is jointly normal the Discrete Factor Random Effects method performs as well as maximum likelihood estimation. However, when the distribution is not normal, the DFRE method performs better in terms of precision and bias.

This approach offers many benefits over the fixed-effects method, which is commonly used with panel data to control for permanent individual unobservables over time. While fixed effects account for permanent individual heterogeneity only, I specify discrete approximations to both permanent and time-varying unobserved individual heterogeneity using the DFRE method. Additionally, the use of fixed effects to capture permanent unobservables would not allow for measurement of the effect of observable non-time varying variables on wages. Lastly, while both methods introduce additional estimated parameters, the discrete distributions of the random effects add only a fraction of the additional parameters required by the fixed effects method.

Initial Conditions and Attrition

Accompanying the many benefits of longitudinal data on individuals is the restriction that behavior is observed for a subset of the individuals' decision making periods. More

specifically, individuals enter the research sample with non-zero values of the endogenous employment and disability history variables. Accordingly, the equations outlined above that utilize lagged information cannot be estimated for the first period of the survey. These "pre-sample" decisions are likely correlated with unobserved permanent individual characteristics that also influence observed ("within sample") outcomes. To account for this correlation, I model the initial state variables as reduced form equations using only contemporaneous variables that also depend on permanent unobserved heterogeneity. I estimate equations for initial employer tenure, occupational tenure, and disability status jointly with the per-period equations for employment outcomes, wages, and disability status.

Observations on individuals in the research sample are also right censored; individuals attrit from the sample each period. In order to account for the potential of non-random attrition, I estimate the probability of attriting as a function of observed behavior as well as permanent and time-varying unobservables. This attrition equation is jointly estimated with the other equations in the model.

Identification

In a dynamic model with many outcomes, we have to be concerned about properly identifying effects of interest. In particular, we need to measure the causal effect of occupation and employer tenure on wages and the casual effect of employment outcomes on disability. Identification requires that a variable explain observed employment outcomes that has no independent effect on wages or on disability conditional on the outcome. The theoretical model implies that unearned income affects choice of employment alternative but does not impact wages. Similarly, average unemployment rates, which affect employment alternatives, are excluded from the disability equation. Both variables are significant in the equations modeled, and a likelihood ratio test of joint significance produces a p-value of 0.001. Further, the variables are jointly insignificant in the equations from which they are excluded, supporting the validity of the instruments.

The effect of disability on employment outcomes must also be properly identified. Disability status entering period t is shifted by previous per period variables, some exogenous

and some endogenous. The endogenous variables (such as employment outcomes in the previous period) are functions of exogenous variables (such as average unemployment rates). Therefore, the entire history of exogenous variables provides exogenous variation and identifies the causal effect of disability on employment outcomes (Arellano and Bond, 1991).

Initial disability status is identified by indicators for whether one served in the Vietnam War and whether one served in any other major military conflict. These variables influence initial disability status, but do not affect subsequent disability probabilities conditional on disability entering the period. Initial occupational tenure and initial employer tenure are both identified by the unemployment rate at the time an individual graduated from his highest level of education. These variables do not affect subsequent employment outcomes but are significant in the initial occupational tenure and employer tenure equations.

4.3 Likelihood Function

An individual's contribution to the likelihood function, unconditional on the unobserved heterogeneity, is:

$$
\begin{aligned}
L_i(\theta,\rho,\psi) = \quad & \sum_{k=1}^{K} \rho_k \Bigg\{ \prod_{e=0}^{6} \mathrm{P}(ET_1 = e|\mu_{6k}^{e}) 1[ET_{i1} = e] \prod_{o=0}^{6} \mathrm{P}(OT_1 = o|\mu_{7k}^{o}) 1[OT_{i1} = o] \\
& \prod_{d=0}^{2} \mathrm{P}(D_{t+1} = d|\mu_{5k}^{d}, \upsilon_{5t\ell}^{d}) 1[D_{it+1} = d] \\
& \prod_{t=1}^{T} \sum_{\ell=1}^{L} \psi_\ell \Bigg[\prod_{r=0}^{4} \mathrm{P}(R_t = r|\mu_{1k}^{r}, \upsilon_{1t\ell}^{r}) 1[R_{it} = r] 1[E_{it-1} = 1] \\
& \mathrm{P}(E_t = 1|\mu_{2k}, \upsilon_{2t\ell})^{E_{it}} [1 - \mathrm{P}(E_t = 1|\mu_{2k}, \upsilon_{2t\ell})]^{1-E_{it}} 1[E_{it-1} = 0] \\
& [\frac{1}{\sigma} \Phi(\ln W_t|\mu_{3k}, \upsilon_{3t\ell})]^{E_{it}} \\
& \prod_{d=0}^{2} \mathrm{P}(D_{t+1} = d|\mu_{4k}^{d}, \upsilon_{4t\ell}^{d}) 1[D_{it+1} = d] \Bigg] \Bigg\}
\end{aligned}
$$

where θ denotes the parameters that are estimated in the model. ρ_k is the estimated joint probability of the k^{th} permanent mass point, which is given by:

$$
\begin{aligned}
\rho_k = \mathrm{P}(\mu_1^0 = \mu_{1k}^0, ..., \mu_1^4 = \mu_{1k}^4, \mu_2 = \mu_{2k}, \mu_3 = \mu_{3k}, \mu_4^0 = \mu_{4k}^0, .., \mu_4^2 = \mu_{4k}^2, \\
\mu_5^0 = \mu_{5k}^0, ..., \mu_5^2 = \mu_{5k}^2, \mu_6^0 = \mu_{6k}^0, ..., \mu_6^6 = \mu_{6k}^6, \mu_7^0 = \mu_{7k}^0, ..., \mu_7^6 = \mu_{7k}^6).
\end{aligned}
$$

ψ_ℓ is the estimated joint probability of the ℓ^{th} time-varying mass point and is given by:

$$\psi_\ell = \mathrm{P}(\upsilon_1^0 = \upsilon_{1\ell}^0, ..., \upsilon_1^4 = \upsilon_{1\ell}^4, \upsilon_2 = \upsilon_{2\ell}, \upsilon_3 = \upsilon_{3\ell}, \upsilon_4^0 = \upsilon_{4\ell}^0, ..., \upsilon_4^2 = \upsilon_{4\ell}^2).$$

Time-varying heterogeneity is excluded from the initial period equations.

5 Data

The data used to estimate the model come from the 1996 panel of the Survey of Income and Program Participation (SIPP). Although the SIPP has been conducted as recently as 2004, I have chosen to use the 1996 panel because it runs for four years, and is the longest running of all panels. The 1996 panel also has the most sample members of all SIPP panels.

The SIPP provides detailed longitudinal information on income amounts and sources as well as the participation in and eligibility for federal, state, and local government programs. Although the SIPP does not directly focus on disability or employment, much information on these topics is provided. The SIPP interviews participants every four months instead of every year as is standard in many surveys.[16] This structure makes the SIPP particularly appealing to study disability and employment, as these outcomes may fluctuate several times within a year and may be subject to recall bias if survey intervals are long.

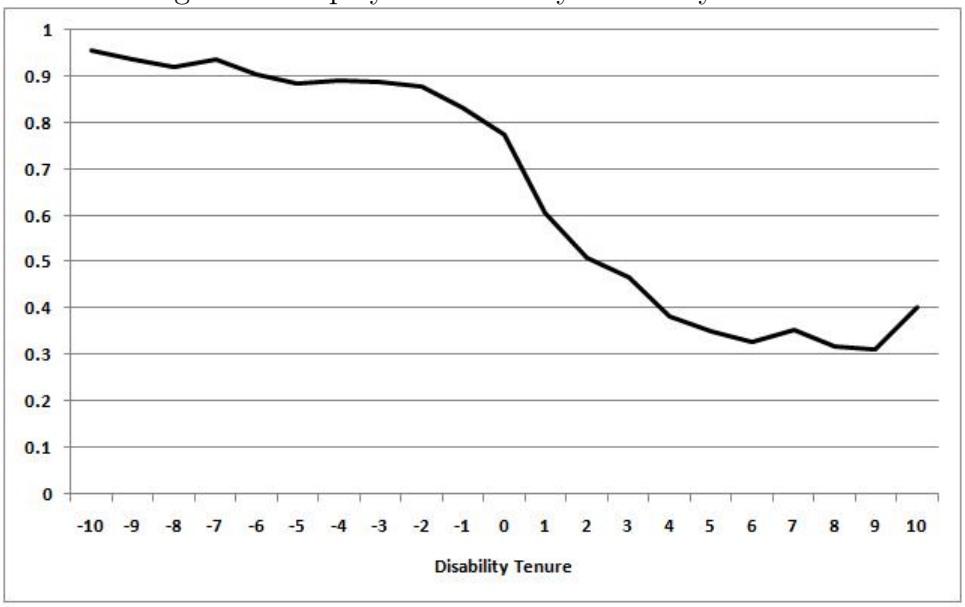
The focus of my analysis is on the employment behavior of males during their prime working years as it relates to disability. Accordingly, the research sample includes men over the age of 25 (inclusive) and less than 60 (exclusive). I retain individuals with information on disability, employment, occupation, and hours worked for at least six consecutive periods (two years). Of the 56,003 men surveyed, 26,253 were between the ages of 25 and 60. Of those, 11,290 did not have six or more consecutive periods of information and were dropped.[17] The research sample consists of 14,963 individuals and 155,045 person-wave observations.

One of the main goals of the analysis is to measure the dynamic impact of disability on employment outcomes. Figure 1 illustrates how employment rates change over time as

[16] At every interview, respondents are asked to report current information as well as recall certain information from each of the past three months. For example, a person interviewed in April, would also be asked about information in January, February, March, and April. Unfortunately, respondents are only asked to recall disability status, employer, and occupation for the current month. Accordingly, I am unable to exploit all information available in the SIPP and only analyze the data from every fourth month.

[17] The estimation sample and those excluded based on missing information are found to have similar characteristics.

Figure 1: Employment Rate by Disability Tenure



disability evolves. The horizontal axis, disability tenure, represents the number of periods before or after the onset of a disability (denoted as a disability tenure of 0) for disability spells that begin in the survey. If a person is disabled, recovers, and becomes disabled again he is considered to be in a new spell of disability and his tenure would restart at zero upon the beginning of the second disability spell. The graph shows that the employment rate is relatively stable prior to the onset of disability and plunges and remains low once disability occurs.[18]

Individuals with disabilities differ not only by length of time disabled but also by the severity of their disability. Separating the disabled into two groups, Figure 2 shows changes in employment by length of disability for the moderately disabled and the severely disabled. The progression of employment rates differs vastly across these two groups and it appears that it is the severely disabled who are driving the drop in employment rates among the disabled.

The non-disabled, the moderately disabled, and the severely disabled differ by exogenous characteristics. Table 1 displays summary statistics separately for each group. Of the

[18]Note that the sample composition is considerably smaller (and potentially different) the longer the number of quarters before or after onset. That is, the employment rates in the left and right tails of the figure are weighted towards more and less healthy individuals, respectively.

Figure 2: Employment Rate by Disability Tenure and Severity

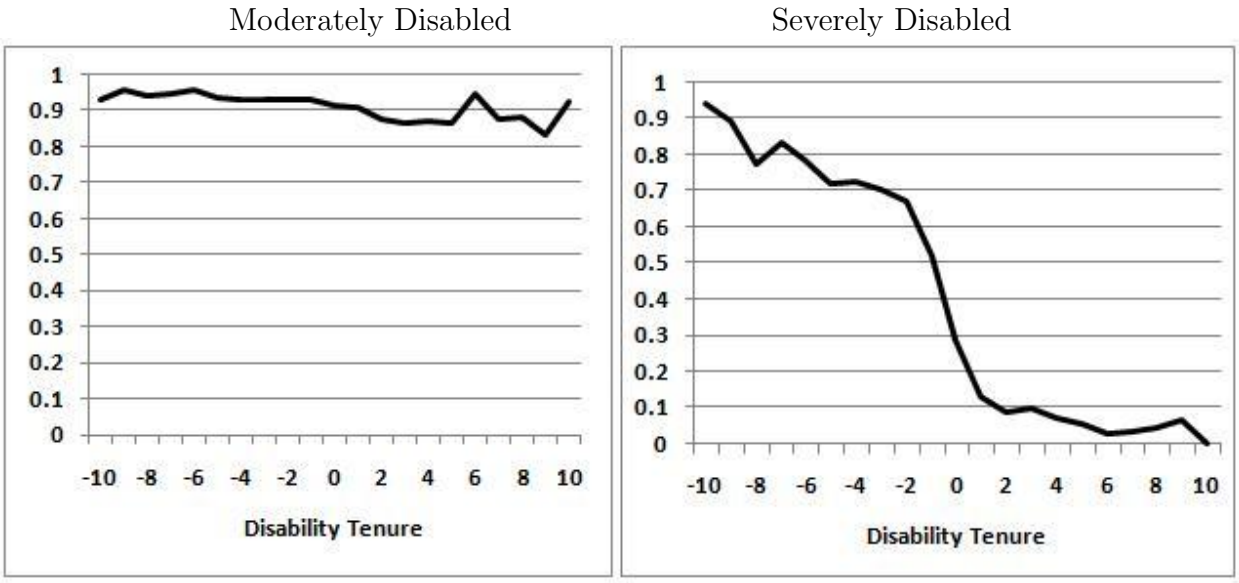


Table 1: Comparison of the Non-Disabled to the Disabled

Variable	Non-Disabled		Moderately Disabled		Severely Disabled	
Age (in years)	40.99	(9.07)	43.70	(9.07)	46.24	(8.87)
Non-White	0.14	(0.34)	0.14	(0.34)	0.26	(0.44)
Years of Education	13.46	(2.87)	12.40	(2.97)	10.62	(3.55)
Married	0.72	(0.45)	0.59	(0.49)	0.45	(0.50)
Non-Metropolitan Residence	0.20	(0.40)	0.25	(0.43)	0.28	(0.45)
Unearned Income (1996 $)	79.55	(284.55)	208.96	(481.35)	442.57	(909.94)
Employed	0.95	(0.22)	0.89	(0.31)	0.04	(0.19)
Observations (person-wave)	138,566		6,208		10,271	

Note: Standard Deviations in Parentheses.

Table 2: Comparison of the Employed Non-Disabled
to the Employed Disabled

Variable	Non-Disabled		Moderately Disabled		Severely Disabled	
Employed$_{t-1}$						
No Change (%)	87.83	(32.69)	79.06	(40.73)	29.66	(45.74)
Become Jobless (%)	1.41	(11.78)	4.97	(21.74)	58.10	(49.41)
Switch Occupation (%)	6.74	(25.08)	8.38	(27.71)	8.56	(28.02)
Switch Employer (%)	3.51	(18.39)	6.62	(24.86)	2.45	(15.47)
Switch Occupation and Employer (%)	0.51	(7.11)	1.03	(10.10)	1.22	(11.01)
Observations (person-wave)	119,026		5,049		327	
Non-Employed$_{t-1}$						
Remain Jobless (%)	74.29	(43.70)	76.74	(42.28)	96.72	(17.82)
Become Employed (%)	25.71	(43.70)	23.26	(42.28)	3.28	(17.82)
Observations (person-wave)	6,232		589		8,859	
Wage (1996 $)	10.74	(13.39)	7.42	(15.51)	5.75	(8.74)
Observations (person-wave)	118,952		4,935		428	

Note: Standard Deviations in Parentheses.

14,963 individuals in the research sample, 3,068 (20%) are disabled at some point during the four year period, with variation in the length of disability. These 3,068 individuals contribute 16,479 periods of disability to the person-wave observations. The disabled are older, less educated, less likely to be married, live outside of metropolitan areas, and have larger amounts of unearned income. While the moderately disabled are slightly less likely to be employed than the non-disabled, very few of the severely disabled work.

Table 2 reveals that labor market transitions vary across disability status. Non-disabled and moderately disabled individuals who were employed in the previous period are unlikely to become jobless in the current period, but over half of severely disabled workers become jobless. Over 8.3 percent of workers with any level of disability change occupations compared to 6.7 percent of non-disabled workers. Moderately disabled workers are group the most likely to change employers. Conversely, severely disabled workers are the group least likely to change employers. Moderate and severely disabled workers are also twice as likely to change occupations and employers than non-disabled workers. Non-disabled and moderately disabled individuals who were not employed in the previous period are over seven times more

likely to gain employment than severely disabled workers. Of individuals who are employed, wages decrease with disability severity. Non-disabled workers have an average wage of $10.74 an hour, non-severely disabled workers earn $7.42 an hour, and the severely disabled make just $5.75 an hour.[19] This paper examines the extent to which reductions in tenure associated with job transitions contribute to this wage gap.

6 Results

I jointly estimate Equations 4 (employment for the employed), 5 (employment for the jobless), 6 (log wages), 7 (disability status), and equations for initial tenure, initial disability status, and attrition. The equations are estimated simultaneously, allowing for unobserved permanent and time-varying heterogeneity. Coefficient estimates are available in Appendix Tables A.1, A.2, A.3, and A.4. The accuracy of a model can be determined by comparing the actual values with the predicted values determined by the model. The first column of Table 3 contains the actual sample proportions of each dependent variable. The second column contains predicted values from my model obtained by multiplying observed explanatory variables by the predicted coefficient values and integrating over the unobserved heterogeneity. These predictions, mapped to a [0,1] line, and a random uniform draw determine the simulated values of endogenous right hand side variables which are updated sequentially. The predictions are similar to the actual sample proportions, suggesting the model fits the data

Table 3: Predicted Values

Variable	Actual	Predicted
Employment Rate	0.887	0.889
No Change in Employment	0.873	0.867
Become Jobless	0.017	0.019
Change Occupation	0.068	0.072
Change Employer	0.036	0.037
Change Both	0.005	0.006
Moderately Disabled	0.039	0.038
Severely Disabled	0.067	0.061
Ln(Wage) ($E_t = 1$)	2.17	2.15

[19]The minimum wages for the years 1996-2000 (in 1996 dollars) are: $4.75, $5.03, $4.96, $4,85, $4,69.

well. Additional evidence that the dynamic model fits the observed outcomes over time is shown graphically in Appendix Tables A.1 and A.2.

Marginal Effects

In Table 4, I present the marginal effects of disability on employment outcomes from two specifications. The marginal effects presented are one period effects averaged over all individuals in the sample. Standard errors are parametrically bootstrapped by repeatedly perturbing estimated coefficients from the variance-covariance matrix 100 times. Model 1 treats the endogenous variables (S_t^E, S_t^D) as exogenous by not controlling for the unobserved heterogeneity. It produces biased effects of these variables. Model 2, the preferred model, uses the Discrete Factor Random Effects method to control for unobserved heterogeneity with four permanent and two time-varying mass points.

In comparison to the model that does not control for unobserved heterogeneity (Model 1), the majority of marginal effects of a moderate disability are dampened (Model 2). Thus, neglecting to control for unobserved differences would result in an overestimation of the impact of a moderate disability on employment outcomes. This finding supports the justification hypothesis of disability reporting. Conversely, the majority of marginal effects of a severe disability are magnified. This result is compatible with the stigma effect in reporting a disability. As the moderately and severely disabled have been shown to be distinct groups, it is highly plausible that they would face different motivations in reporting disability.

The preferred model in Table 4 shows that individuals with a moderate disability are over 2.5 percentage points less likely to be employed than non-disabled individuals and those who are employed have a slightly lower wage rate. These moderately disabled workers are over 4.5 percentage points less likely to remain employed at their current job and over two percentage points more likely to become jobless compared to a worker without a disability. Moderately disabled workers are about 1.4 percentage points more likely to remain employed and change occupations and 0.8 percentage points more likely to change employers. In all, disabled workers are 2.5 percentage points more likely to change occupations, employers, or both compared to non-disabled workers. As 10.76 percent of non-disabled workers make

Table 4: Marginal Effects of Disability on Employment Outcomes

Variable	Moderate Disability				Severe Disability			
	Model 1		Model 2		Model 1		Model 2	
Employment Rate (%)	-2.71	***	-2.53	***	-35.0	***	-36.7	***
	(1.10)		(0.77)		(2.84)		(2.72)	
Log Wage	-0.12	***	-0.03	***	-0.09	**	-0.14	***
	(0.01)		(0.01)		(0.05)		(0.03)	
No Change (%)	-5.20	***	-4.51	***	-12.6	***	-12.8	***
	(0.88)		(1.00)		(2.36)		(2.65)	
Jobless (%)	1.93	***	2.02	***	12.2	***	12.9	***
	(0.33)		(0.31)		(1.38)		(1.29)	
Change Occupation (%)	1.77	***	1.39	**	2.72	*	2.25	
	(0.69)		(0.68)		(1.92)		(1.86)	
Change Employer (%)	1.04	**	0.84	*	-2.10	***	-2.25	***
	(0.61)		(0.54)		(0.61)		(0.72)	
Change Both (%)	0.45		0.27		-0.24		-0.11	
	(0.27)		(0.30)		(0.31)		(0.64)	

Note: Bootstrapped standard errors are in parentheses.

Model 1 = Model without controlling for unobserved heterogeneity

Model 2 = Model with 4 permanent and 2 time-varying mass points to account for unobserved heterogneity

*** indicates significance at the 1% level, ** 5% level, * 10% level

these transitions, this implies that moderately disabled workers are 23 percent more likely to make an employment transition.

The last two columns of Table 4 are quite different from the first two columns, again illustrating the difference between the moderately and severely disabled. The preferred model shows that the severely disabled who are currently employed are 37 percentage points less likely to remain employed than non-disabled workers and also earn a significantly lower wage. Overall, these workers are almost 13 percentage points less likely to remain with their current job. A large portion of those who leave their current job become non-employed. Still, severely disabled workers are 2.3 percent more likely to remain employed and change occupations compared to non-disabled workers. On the other hand, severely disabled workers are also 2.3 percent less likely to change employers. Workers with a severe disability may be physically incapable of continuing in their line of work and have no choice but to change occupations if they wish to remain employed. However, those who are able to may prefer to stay with their same employer so as not to lose health benefits and avoid potential hiring discrimination.

As it has been established that disabled individuals are less likely to remain in their current job and thus have lower tenure, the effects of occupational and employer tenure on wages are now considered. Table 5 contains estimates of the marginal effects of tenure on log wages. The first column contains estimates from Model 1, which does not control for unobserved heterogeneity. The second column contains estimates from Model 2, which controls for unobserved heterogeneity. Model 1 predicts that for a disabled worker an additional year of occupational tenure will add 0.006 and an additional year of employer tenure will add 0.011 to log wages. Model 2, the preferred model, predicts that for disabled workers additional years of occupational and employer tenure will add 0.001 and 0.008 to log wages, respectively. Thus, without controls for unobserved heterogeneity, the impact of tenure on wages is over predicted.

The effects of tenure from the preferred model (Model 2) are presented in the second column of Table 5. Occupational tenure increases log wage by 0.002, which translates to about a 2 cent increase in wages for each year of tenure. Employer tenure has an even larger effect, increasing log wages by 0.011, or about 10 cents. The squared terms for

both types of tenure indicate that tenure increases wages at a decreasing rate. The effects of occupational and employer tenure on wages are smaller for disabled workers, although the effect for occupational tenure is not statistically significant. Reasons for the smaller role of tenure could include discrimination, lack of training received by disabled workers, or productivity differences compared to non-disabled workers that accumulate each year. Overall, tenure still has a positive effect on wages for disabled workers.

Table 5: Marginal Effects of Tenure on Log Wages

Variable	Model 1		Model 2	
Occupational Tenure	0.007	***	0.002	***
Occupational Tenure Squared/100	-0.004	**	-0.005	**
Occupational Tenure*Disability	-0.001	*	-0.001	
Employer Tenure	0.013	***	0.011	***
Employer Tenure Squared/100	-0.018	***	-0.030	***
Employer Tenure*Disability	-0.002	***	-0.003	***

Note: *** indicates significance at the 1% level, ** 5% level, * 10% level
Model 1 = Model without controlling for unobserved heterogeneity
Model 2 = Model with 4 permanent and 2 time-varying mass points

Dynamic Effects

While per period marginal effects are a good starting point for discerning the impact of disability on employment outcomes, they do not capture the dynamics of the model. Simulations are conducted to analyze the long term effects. In the first set of simulations, individuals are simulated to be non-disabled. Next, individuals are simulated to become moderately disabled starting in period two and remain disabled. Both groups are simulated to remain employed with their current employer in their current occupation. The simulated wages earned by each group are contained in Figure 3. Log wages are retransformed to dollars using a smearing factor.[20]

The impact of a moderate disability on wages, holding employment transitions constant, are shown in Figure 3. Between the first and second period, wages decrease from the

[20]Recall that E[y] = $e^{(X\beta)}e^{(0.5\sigma^2)}$. Thus, the homoskedastic smearing factor is calculated as $e^{(0.5\sigma^2)}$ and is multiplied by the retransformed wages.

onset of disability. The wage rate is also negatively affected by the length of time a person has been disabled, and this can be seen in the first few periods as the wage rate declines. However, after several periods, adjustments to the disability and accumulating tenure combine to increase the wage rate. By the third year of a moderate disability, wages are almost equal to that of non-disabled workers.

In the next simulations, all individuals who are employed in period one are simulated to be non-disabled, and then incur a disability starting in period two. From this point four different scenarios are considered. In the first scenario, workers are simulated to remain employed with their current employer in their current occupation for the remainder of the survey. In the second scenario, workers are simulated to change occupations in the second period and then remain in the same occupation. Next, workers are simulated to change employers in the second period, and finally workers are simulated to change both occupations and employers in the second period. The results are depicted in Figures 4 and 5.

Figure 4 shows the results when workers are simulated to have a moderate disability. Workers who remain in the same occupation with their same employer (or those who have "no change") serve as a comparison for the employment transitions.[21] The figure shows that changing occupations or employers significantly decreases the wage rate of moderately disabled workers compared to those who stay with their job. In the period in which the transition is made, workers who change occupations or employers earn wages that are 14 or 16 cents lower, respectively, compared to those who remain in their same job. Workers who change both occupations and employers experience an even larger drop in wages. However, in the nine periods (or three years) following the transition, the wage gap begins to close. These results are suggestive of a significant short run loss of wages from changing occupations and/or changing employers.

The simulated wages across time for severely disabled workers are depicted in Figure 5. As individuals with severe disabilities have low probabilities of employment, the effect of an employment transition on employment rates, contained in Figure 6, is considered in

[21] In the first period, the average person has 11.8 years of occupational tenure and 8.2 years of employer tenure.

Figure 3: Simulated Wages by Disability Status

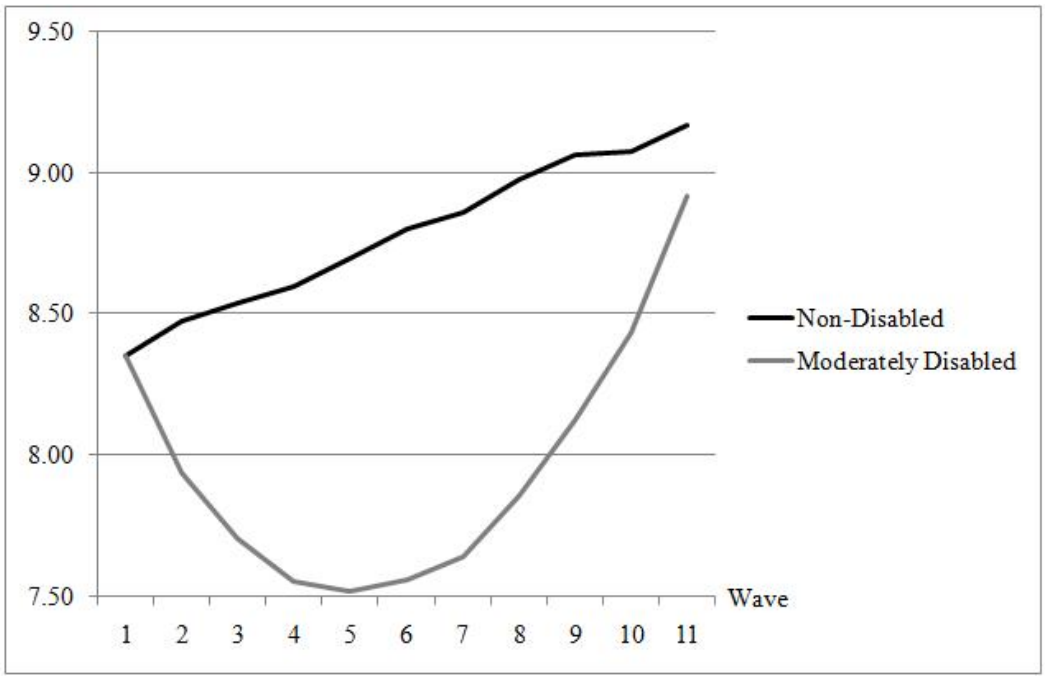


Figure 4: Simulated Wages of Moderately Disabled Workers

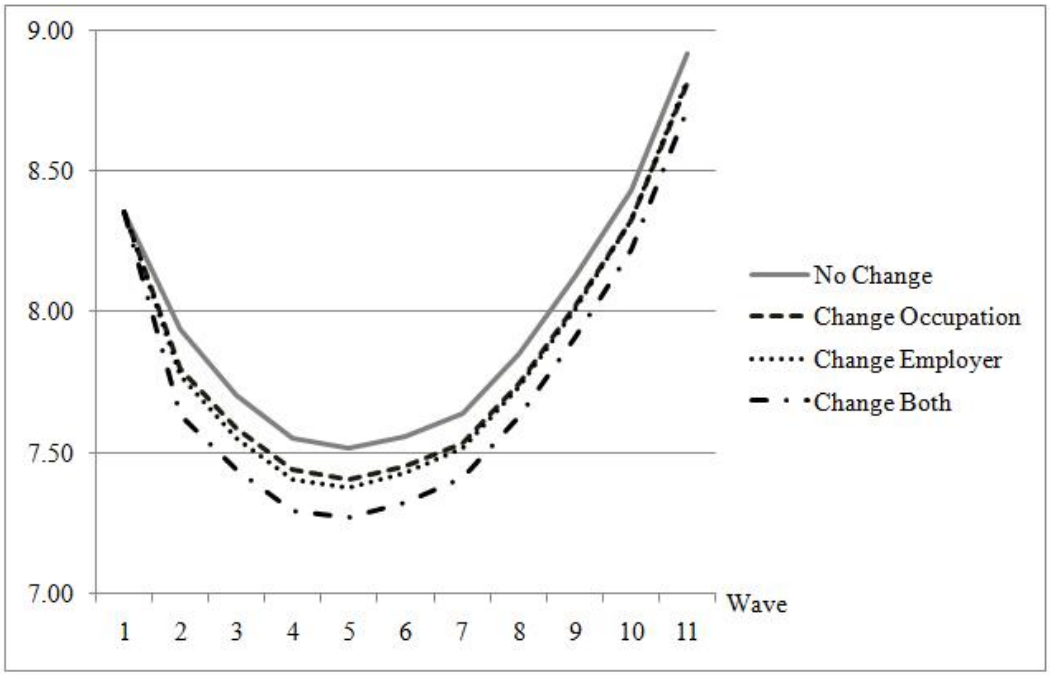


Figure 5: Simulated Wages of Severely Disabled Workers

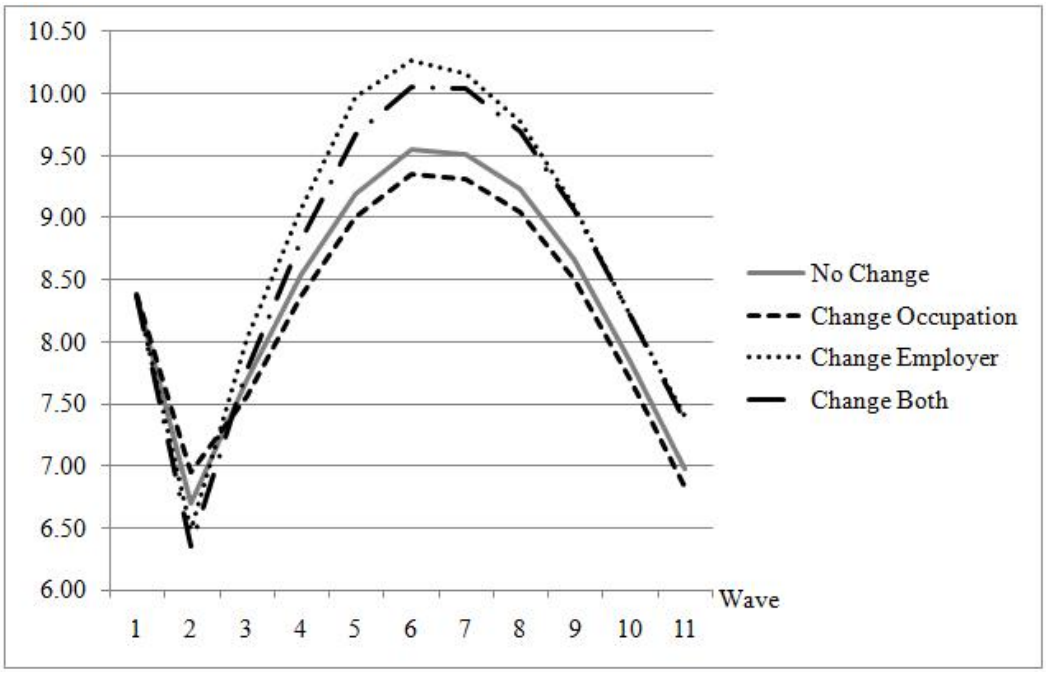
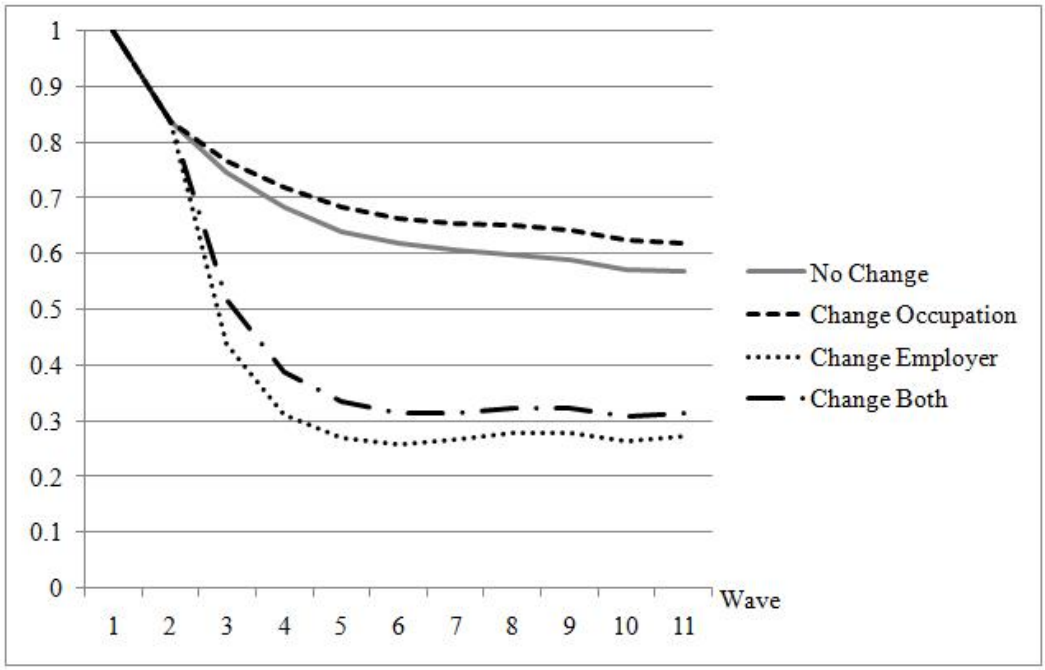


Figure 6: Simulated Employment Rate of Severely Disabled Individuals



unison with wages.[22] The onset of a severe disability (in period 2) leads to a large drop in wages as well as a 16 percent decline in employment. In subsequent periods, employment of severely disabled workers who do not change employers declines slightly, leveling out around 60 percent. Those who changed occupations have an employment rate that is about five percent higher than those who remain in their current job. Severely disabled workers who change employers (with or without an occupation change) experience even larger declines in employment, and after about three years (nine periods) have only a 30 percent employment rate.

Workers appear to have increasing wages in the first 16 months following disability onset. However, as the employment rate is declining during this period, the increase in wages is likely attributed to averaging wages over a smaller sample of workers. Specifically, workers who become nonemployed are likely those with lower wages, so the average wage of employed workers is inflated. After the employment rate stabilizes, the wage rate of severely disabled workers begins to fall. The wages of severely disabled workers who change employers appear higher than the wages of those who remain with their current job. Yet the former group has an employment rate that is almost half that of the latter group, and is likely also a result of sample selection. Severely disabled workers who change occupations earn slightly lower wages than non-changers, but again, the former group has a higher employment rate. Although wage is an important determinant of well-being, the relatively small changes in wages resulting from employer and occupational transitions may be less important than the employment rate. Overall, the results suggest that severely disabled workers may benefit from changing occupations at the time of disability onset but may be adversely affected by changing employers.

[22]Moderately disabled workers are simulated to remain employed for the entire survey. As severely disabled individuals have low employment rates, severely disabled workers are simulated to become non-employed if predicted by the model. That is, if a severely disabled worker is predicted to become non-employed, he is simulated to be non-employed. If a severely disabled worker is predicted to remain employed, he is simulated to have one of the four employment outcomes.

7 Conclusion

In this paper, I estimate the direct impact of disability on employment outcomes and the indirect impact of disability on wages via tenure implied by these occupational and employer transitions. Using the Survey of Income and Program Participation, I estimate a dynamic model of disability and employment controlling for permanent and time-varying unobserved heterogeneity. The results suggest that workers with either a moderate or severe disability are more likely to change occupations or employers, with the exception that severely disabled workers are less likely to change employers. Specifically, moderately disabled workers are 23 percent more likely to change occupations and/or employers compared to non-disabled workers. Previous literature on disability and employment outcomes generally consider "job change" as a change in employers, and this research illustrates the role of occupational change in these transitions. Further, the importance of controlling for unobserved characteristics is shown, as estimates of the impact of disability on employment outcomes differ depending on whether or not one controls for unobserved individual characteristics.

This paper also shows the effect of occupational and employer tenure on wages. Simulating potential employment paths for disabled workers, I find that for moderately disabled workers, changing occupations is associated with an immediate 14 cent wage loss and changing employers causes an immediate 16 cent wage loss for moderately disabled workers. Thus, moderately disabled workers who respond to their disability by changing employers and/or occupations help explain a significant portion of the wage gap between disabled and non-disabled workers.

Historically, disabled workers have faced many barriers to employment, promotions, and equal pay. The Americans with Disabilities Act (ADA) took great strides to change this, requiring firms to provide "reasonable accommodations" to disabled workers in an attempt to minimize the amount of job turnover experienced by disabled workers. This paper supports the goal of the ADA, as changing occupations and employers is found to negatively impact wages. Stricter requirements added to legislation like the ADA could help lower the transition rates among this group and provide a better employment outlook for disabled workers.

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A Appendix

Figure A.1: Model Fit - Employment Rate by Disability Tenure
Moderately Disabled

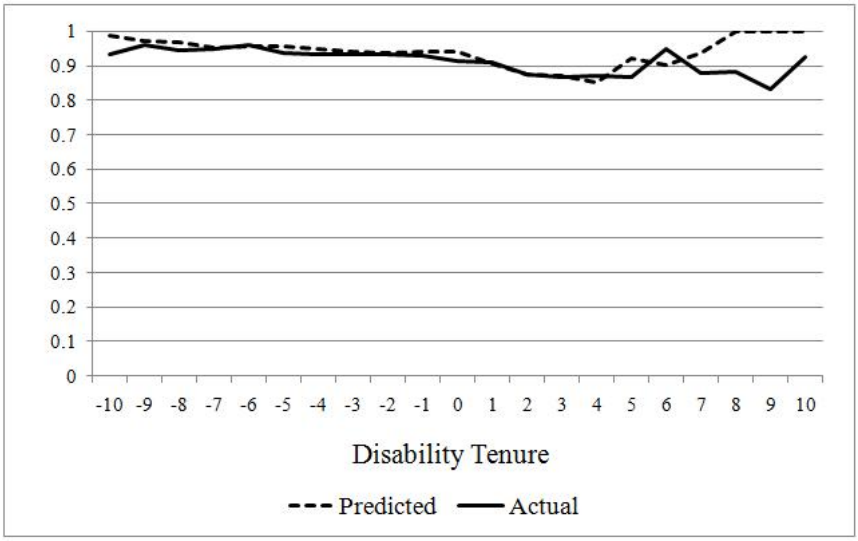

Figure A.2: Model Fit - Employment Rate by Disability Tenure
Severely Disabled

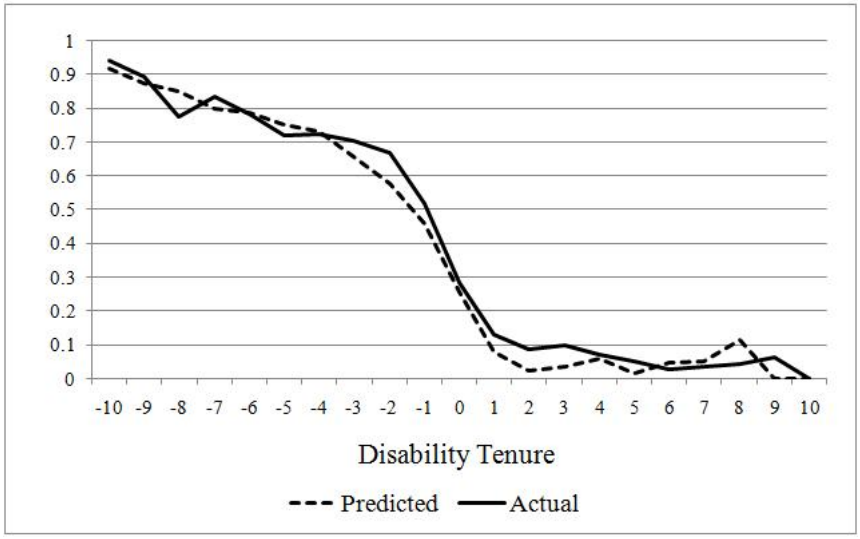

Table A.1: Coefficient Estimates from Employment Equation for the Employed
(Jointly Estimated with Disability, Wage, Attrition, and Initial Variables Equations)

Variable	Become Jobless		Change Occupation		Change Employer		Change Both	
Age	0.18	(0.17)	0.17	(0.08)	0.19	(0.09)	-0.22	(0.29)
Age Squared/100	-0.53	(0.40)	-0.48	(0.19)	-0.52	(0.22)	0.51	(0.74)
Age Cubed/1000	0.05	(0.03)	0.04	(0.02)	0.04	(0.02)	-0.04	(0.06)
Non-White	0.54	(0.06)	-0.01	(0.03)	-0.04	(0.05)	-0.19	(0.12)
Unmarried	0.56	(0.06)	0.07	(0.03)	0.17	(0.04)	0.55	(0.09)
Number of Children	0.06	(0.02)	-0.00	(0.01)	0.00	(0.02)	0.05	(0.04)
Education								
Less than High School	0.32	(0.07)	-0.13	(0.04)	0.10	(0.05)	-0.14	(0.13)
Some College	-0.17	(0.06)	0.05	(0.03)	-0.01	(0.04)	-0.02	(0.10)
College	-0.40	(0.07)	0.06	(0.03)	-0.22	(0.05)	-0.39	(0.13)
More than College	-0.72	(0.11)	-0.13	(0.05)	-0.49	(0.07)	-0.79	(0.20)
Region								
North East	-0.02	(0.07)	-0.01	(0.04)	-0.04	(0.05)	-0.49	(0.13)
Mid West	-0.06	(0.07)	0.04	(0.03)	-0.04	(0.04)	-0.15	(0.10)
West	0.09	(0.06)	0.14	(0.03)	0.11	(0.04)	-0.10	(0.11)
Non-Metropolitan	0.16	(0.06)	0.01	(0.03)	0.07	(0.04)	0.22	(0.10)

Table A.1 (Continued)

Variable	Become Jobless		Change Occupation		Change Employer		Change Both	
Disabled	0.85	(0.13)	0.18	(0.10)	0.19	(0.13)	0.50	(0.26)
Severely Disabled	2.25	(0.17)	0.46	(0.25)	-0.77	(0.41)	-0.09	(0.58)
For those who did not enter the survey disabled								
Time Disabled	0.03	(0.23)	-0.31	(0.20)	0.16	(0.22)	-2.68	(1.62)
Time Disabled Squared	-0.04	(0.09)	0.11	(0.08)	-0.01	(0.08)	2.00	(1.46)
Time Disabled Cubed/10	0.03	(0.09)	-0.10	(0.08)	-0.02	(0.08)	-3.81	(3.17)
Enter the survey disabled	0.10	(0.22)	-0.14	(0.18)	0.41	(0.21)	-0.34	(0.43)
For those who entered the survey disabled								
Total Time Disabled	-0.04	(0.07)	-0.02	(0.06)	0.03	(0.06)	-0.14	(0.17)
Total Time Disabled Squared/10	-0.02	(0.05)	0.01	(0.04)	-0.08	(0.04)	0.10	(0.13)
Total Time Disabled Cubed/100	0.01	(0.01)	-0.00	(0.01)	0.02	(0.01)	-0.02	(0.03)
Total Time Disabled*Severe	0.01	(0.00)	0.01	(0.00)	0.01	(0.01)	0.01	(0.01)
Total Time Disabled Missing	-0.27	(0.19)	-0.07	(0.16)	-0.39	(0.19)	0.42	(0.38)
Union_{t-1}	-0.14	(0.07)	-0.29	(0.04)	-0.25	(0.05)	-0.30	(0.15)
$\text{Occupational Tenure}_{t-1}$	0.06	(0.02)	-0.06	(0.01)	-0.09	(0.01)	-0.08	(0.04)
$\text{Occupational Tenure Squared}_{t-1}/100$	-0.42	(0.14)	0.21	(0.08)	0.51	(0.10)	0.38	(0.30)
$\text{Occupational Tenure Cubed }_{t-1}/1000$	0.09	(0.03)	-0.03	(0.02)	-0.07	(0.02)	-0.04	(0.06)
$\text{Disability*Occupational Tenure}_{t-1}$	-0.00	(0.01)	0.00	(0.01)	0.01	(0.01)	0.01	(0.02)
Occupational Tenure Missing $_{t-1}$	0.16	(0.09)	-0.26	(0.05)	-0.32	(0.07)	-0.64	(0.18)
$\text{Employer Tenure}_{t-1}$	-0.85	(0.03)	-0.41	(0.01)	-0.27	(0.01)	-1.03	(0.05)
$\text{Employer Tenure Squared}_{t-1}/100$	5.74	(0.23)	2.87	(0.10)	1.20	(0.11)	6.78	(0.52)
$\text{Employer Tenure Cubed}_{t-1}/1000$	-1.06	(0.06)	-0.55	(0.02)	-0.15	(0.02)	-1.23	(0.14)
$\text{Disability*Employer Tenure}_{t-1}$	0.02	(0.01)	0.02	(0.01)	0.00	(0.01)	0.00	(0.03)
Local Unemployment Rate	0.05	(0.01)	-0.03	(0.01)	0.00	(0.01)	0.02	(0.03)
Unearned Income	1.25	(0.05)	0.06	(0.05)	0.76	(0.04)	0.78	(0.12)

Notes: Standard deviations in parentheses. The omitted category is remaining with same occupation and employer. Month and Year Dummies were also regressors but are not shown in the above table.

Estimates of permanent and time-varying heterogeneity are available in Table A.5.

Table A.2: Coefficient Estimates from Employment Equation for the Non-employed (Jointly Estimated with Disability, Wage, Attrition, and Initial Variables Equations)

Variable	Become Employed	
Age	-0.29	(0.19)
Age Squared/100	0.83	(0.47)
Age Cubed/1000	-0.08	(0.04)
Non-White	-0.36	(0.07)
Unmarried	-0.13	(0.07)
Number of Children	0.02	(0.03)
Education		
Less than High School	-0.11	(0.08)
Some College	0.08	(0.07)
College	0.09	(0.10)
More than College	0.46	(0.13)
Region		
North East	0.26	(0.08)
Mid West	0.28	(0.08)
West	0.31	(0.08)
Non-Metropolitan	-0.01	(0.07)
Disabled	0.30	(0.17)
Severely Disabled	-1.58	(0.18)
For those who did not enter the survey disabled		
Time Disabled	-0.99	(0.44)
Time Disabled Squared	0.41	(0.19)
Time Disabled Cubed/10	-0.38	(0.20)
Severe Disability*Time Disabled	0.03	(0.05)
Severe Disability*Time Disabled Squared	-0.02	(0.02)
Severe Disability*Time Disabled Cubed/10	0.02	(0.02)
Enter the survey disabled	-0.39	(0.20)
For those who entered the survey disabled		
Total Time Disabled	-0.18	(0.06)
Total Time Disabled Squared/10	0.12	(0.04)
Total Time Disabled Cubed/100	-0.02	(0.01)
Total Time Disabled*Severe	-0.00	(0.00)
Total Time Disabled Missing	0.16	(0.17)
Time Non-employed$_{t-1}$	-0.32	(0.02)
Local Unemployment Rate	-0.02	(0.02)
Unearned Income	-0.58	(0.08)

Notes: Standard deviations in parentheses.
Month and Year Dummies were also regressors but are not shown in the above table.
Estimates of permanent and time-varying heterogeneity are available in Table A.5.

Table A.3: Coefficient Estimates from Disability Equation
(Jointly Estimated with Employment, Wage, Attrition, and Initial Variables Equations)

Variable	Moderately Disabled		Severely Disabled	
Age	0.20	(0.12)	-0.44	(0.23)
Age Squared/100	-0.34	(0.29)	1.38	(0.54)
Age Cubed/1000	0.02	(0.02)	-0.12	(0.04)
Non-White	-0.06	(0.05)	-0.01	(0.08)
Unmarried	0.15	(0.04)	0.28	(0.07)
Number of Children	-0.06	(0.02)	-0.04	(0.03)
Education				
Less than High School	0.13	(0.06)	0.34	(0.08)
Some College	-0.08	(0.04)	-0.35	(0.08)
College	-0.47	(0.07)	-1.21	(0.13)
More than College	-0.59	(0.09)	-1.63	(0.20)
Region				
North East	-0.11	(0.05)	-0.09	(0.09)
Mid West	-0.09	(0.05)	-0.03	(0.08)
West	0.00	(0.05)	-0.10	(0.08)
Non-metropolitan	0.09	(0.04)	-0.00	(0.08)
Disabled_{t-1}	3.36	(0.07)	2.07	(0.14)
$\text{Severely Disabled}_{t-1}$	-0.69	(0.12)	1.85	(0.14)
For those who did not enter the survey disabled				
$\text{Time Disabled}_{t-1}$	1.04	(0.12)	1.24	(0.27)
$\text{Time Disabled Squared}_{t-1}$	-0.19	(0.05)	-0.20	(0.11)
$\text{Time Disabled Cubed}_{t-1}/10$	0.12	(0.05)	0.12	(0.10)
$\text{Time Disabled}_{t-1}$*$\text{Severe}_{t-1}$	-0.08	(0.03)	-0.07	(0.03)
$\text{Time Disabled Squared}_{t-1}\text{Severe}_{t-1}$*	0.02	(0.01)	0.02	(0.01)
$\text{Time Disabled Cubed}_{t-1}\text{Severe}_{t-1}$*/10	-0.01	(0.01)	-0.01	(0.01)
Enter the survey disabled	0.36	(0.11)	1.35	(0.15)
For those who entered the survey disabled				
$\text{Total Time Disabled}_{t-1}$	0.36	(0.04)	0.33	(0.04)
$\text{Total Time Disabled Squared}_{t-1}/10$	-0.19	(0.03)	-0.18	(0.03)
$\text{Total Time Disabled Cubed}_{t-1}/100$	0.03	(0.00)	0.03	(0.01)
$\text{Total Time Disabled}_{t-1}$*$\text{Severe}_{t-1}$	-0.00	(0.00)	-0.00	(0.00)
$\text{Total Time Disabled Missing}_{t-1}$	-0.53	(0.09)	-0.43	(0.13)

Table A.3 (Continued)

Variable	Moderately Disabled		Severely Disabled	
Health Insurance$_{t-1}$	-0.28	(0.05)	-0.41	(0.07)
Non-employed	-1.15	(0.15)	4.36	(0.40)
Hours Worked	-0.05	(0.01)	0.05	(0.02)
Hours Worked Squared/100	0.03	(0.01)	-0.08	(0.02)
Small Employer (<25 Employees)	-0.07	(0.05)	-0.25	(0.18)
Small Employer*Disability$_{t-1}$	0.01	(0.09)	0.25	(0.22)
Medium Employer (25-99 Employees)	-0.17	(0.06)	-0.18	(0.20)
Medium Employer*Disability$_{t-1}$	0.07	(0.10)	-0.57	(0.30)
Employer Size Missing	-0.01	(0.30)	0.87	(0.40)
Occupational Category 1	0.21	(0.10)	0.29	(0.37)
Occupational Category 2	0.18	(0.08)	-0.22	(0.28)
Occupational Category 3	0.41	(0.09)	0.28	(0.29)
Occupational Category 4	0.13	(0.08)	0.25	(0.24)
Occupational Category 5	0.11	(0.08)	0.03	(0.25)
Occupational Category 6	0.27	(0.10)	0.11	(0.36)
Occupational Category 7	0.25	(0.09)	-0.45	(0.31)
Occupational Category 8	0.41	(0.07)	0.19	(0.23)
Occupational Tenure	-0.00	(0.00)	-0.00	(0.01)
Employer Tenure	0.00	(0.00)	-0.11	(0.02)
Unearned Income	0.48	(0.04)	0.51	(0.05)

Notes: Standard deviations in parentheses. The omitted category is non-disabled. Month and Year Dummies were also regressors but are not shown in the above table. Estimates of permanent and time-varying heterogeneity are available in Table A.5.

Table A.4: Coefficient Estimates from Wage Equation
(Jointly Estimated with Employment, Disability, Attrition, and Initial Variables Equations)

Variable	Wage	
Age	0.12	(0.02)
Age Squared/100	-0.22	(0.04)
Age Cubed/1000	0.01	(0.00)
Non-White	-0.13	(0.01)
Unmarried	-0.09	(0.01)
Number of Children	0.01	(0.00)
Education		
Less than High School	-0.19	(0.01)
Some College	0.10	(0.01)
College	0.32	(0.01)
More than College	0.46	(0.01)
Region		
North East	0.11	(0.01)
Mid West	0.02	(0.01)
West	0.09	(0.01)
Non-metropolitan	-0.11	(0.01)
Disabled	-0.02	(0.01)
Severely Disabled	-0.21	(0.03)
For those who did not enter the survey disabled		
Time Disabled	-0.04	(0.01)
Time Disabled Squared	0.01	(0.00)
Severe Disability*Time Disabled	0.02	(0.00)
Severe Disability*Time Disabled Squared	-0.00	(0.00)
Enter the survey disabled	0.01	(0.02)
For those who entered the survey disabled		
Total Time Disabled	-0.02	(0.01)
Total Time Disabled Squared/10	0.01	(0.01)
Total Time Disabled Cubed/100	-0.00	(0.00)
Total Time Disabled*Severe	0.00	(0.00)
Total Time Disabled Missing	0.02	(0.02)

Table A.4 (Continued)

Variable	Wage	
Hours Worked	-0.02	(0.00)
Hours Worked Squared/100	0.03	(0.00)
Hours Worked Cubed/1000	-0.00	(0.00)
Small Employer (<25 Employees)	-0.07	(0.00)
Small Employer*Disability$_{t-1}$	-0.03	(0.02)
Medium Employer (25-99 Employees)	-0.03	(0.00)
Medium Employer*Disability$_{t-1}$	-0.05	(0.02)
Employer Size Missing	-0.16	(0.03)
Occupational Category 1	-0.17	(0.01)
Occupational Category 2	-0.08	(0.01)
Occupational Category 3	-0.20	(0.01)
Occupational Category 4	-0.32	(0.01)
Occupational Category 5	-0.09	(0.01)
Occupational Category 6	-0.11	(0.01)
Occupational Category 7	-0.21	(0.01)
Occupational Category 8	-0.20	(0.01)
Employed$_{t-1}$	0.03	(0.01)
Occupational Tenure	0.00	(0.00)
Occupational Tenure Squared/100	-0.00	(0.00)
Occupational Tenure*Disability	-0.00	(0.00)
Employer Tenure	0.01	(0.00)
Employer Tenure Squared/100	-0.03	(0.00)
Employer Tenure*Disability	-0.00	(0.00)
Local Unemployment Rate	-0.00	(0.00)

Notes: Standard deviations in parentheses.
Month and Year Dummies were also regressors but are not shown in the above table.
Estimates of permanent and time-varying heterogeneity are available in Table A.5.

Table A.5: Unobserved Heterogeneity Parameters

Point of Support	Probability Weight	Employment ($E_{t-1}=1$) Become Jobless	Change Occupation	Change Employer	Change Both	Employment ($E_{t-1}=0$)	Disability Moderate	Severe	Wages
Permanent									
1	0.10				Normalized to 0				
2	0.18	-0.92	-0.33	-0.55	-0.88	0.74	-0.30	0.38	1.32
		(0.11)	(0.05)	(0.07)	(0.23)	(0.14)	(0.08)	(0.15)	(0.01)
3	0.44	-0.65	-0.13	-0.28	-0.21	1.08	-0.44	0.94	0.90
		(0.08)	(0.04)	(0.06)	(0.15)	(0.09)	(0.07)	(0.10)	(0.01)
4	0.28	-0.40	0.09	-0.00	0.30	1.07	0.02	0.53	0.51
		(0.08)	(0.04)	(0.06)	(0.15)	(0.11)	(0.06)	(0.11)	(0.01)
Time-Varying									
1	0.98				Normalized to 0				
2	0.02	-30.8	0.41	2.22	0.99	2.13	-0.57	3.90	1.56
		(9.23)	(0.09)	(0.09)	(0.32)	(0.23)	(0.19)	(0.18)	(0.01)

Notes: Standard deviations in parentheses.