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# Health Capital and Human Capital as Explanations for Health-Related Wage Disparities

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We use a dynamic modeling strategy to evaluate two potential avenues through which health differences generate a wage gap: directly through reductions in health capital and indirectly through employment transitions that reduce human capital (specifically, occupation and employer tenure). Our results suggest that male workers with a moderate disability are 23 percent more likely to change occupations or employers than nondisabled men. Compared to those who do not make a transition, workers with a moderate disability who change occupations and employers experience an immediate \$0.30 decline in hourly wages on top of a \$0.57 decline associated with the disability onset.

## I. Introduction

In this paper we quantify the different roles of human capital and health capital in explaining wage variation among men. Empirical economists typically measure human capital as accumulated years of education and work experience. Measures of work experience often include total years of employment and years since last unemployment spell but rarely include further decompositions such as length of time in a particular occupation or with a particular employer. Even fewer economists have investigated the wage impact of health capital, where variations in health may capture variations in employee productivity, employer preference, or job suitability and, hence, observed wages. The growing prevalence of reported disability lends itself well to analyzing the roles of both human and health capital because a disability onset is likely to reduce health capital as well as increase the probability of occupation and employer change (to a greater extent than reductions in the often available general measure of self-reported health status). Furthermore, disability status may be temporary or permanent and, therefore, provide additional variation

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to aid in identifying the health capital effects. We use observations of disability over time and associated occupation and employer changes to measure the roles that each play in explaining wage variation among otherwise similar workers.

In order to uncover causal effects of detailed measures of human capital (i.e., occupation and employer tenure), we jointly model hourly wages with occupation and employer transitions over time. As a contribution to the short literature that examines such human capital effects, we explore how health capital (i.e., disability severity and length of disability) affects these transitions, wages directly, and the returns to human capital. We do so by modeling transitions in disability jointly with employment transitions and wages over time. Because we observe individuals in our research data for 12 waves with interviews every 4 months, we are able to capture many potential employment and disability transitions that would not be observed with annual or biennial observations. To summarize, we evaluate two potential avenues through which disability may generate an observed wage gap using a dynamic modeling strategy that captures the life cycle impacts of disability on wages directly through reductions in health and indirectly through employment transitions that reduce occupation and employer tenure.

The role of disability among the elderly and near elderly has received much attention from economists interested in behaviors such as exit from the labor force and medical care consumption. However, relatively little is understood about how disability affects employment patterns and wages of prime-age workers despite the high prevalence and increasing frequency of reported work limitation among this age group.<sup>1</sup> In 2010, the US Census Bureau reported that 16.6 percent of individuals aged 21–64 had a disability (Brault 2012). Furthermore, the Social Security Administration (SSA) has found that a 20-year-old worker has a 30 percent chance of becoming disabled before reaching retirement age (SSA disability planner: <http://www.ssa.gov/dibplan/index.htm>). Supporting this notion, a study by Lakdawalla, Bhattacharya, and Goldman (2004) using National Health Interview Study data from 1984–2000 found that disability reports among the elderly have actually fallen while reports by those under age 50 have increased. The authors note that this trend is especially prevalent among those aged 30–49. More recent evidence suggests that the upward trend in long-term disability claims among younger Americans continues (Drake et al. 2010).

It is well known that disability is negatively correlated with labor force participation and that workers with a disability receive lower wages, earning up to 18 percent less than nondisabled workers on average (Baldwin and Johnson 2000; DeLeire 2001). The combination of low employment and low wages may help explain why 29 percent and 18 percent of people

<sup>1</sup> Recent work has explored the measurement of disability in this population and over time in an attempt to correctly portray the factual and often misperceived trends (Burkhauser et al. 2002; Burkhauser, Houtenville, and Tennant 2012; Martin et al. 2012).

with severe and nonsevere disabilities, respectively, live in poverty compared to less than 15 percent of those without a disability (Brault 2012). In addition to assistance from current and former employers through short- and long-term disability insurance claim payments, many social programs have been created to assist individuals with disabilities. In 2008, federal programs provided over \$350 billion of support, or 12 percent of total federal outlays, to this population (Livermore, Stapleton, and O'Toole 2011). Many of these programs, such as Social Security Disability Insurance (SSDI), are available only to people with disabilities who do not participate in substantial gainful activity. Other federal programs such as Ticket to Work, an incentive program to encourage employers to hire and retain workers with disabilities, are available to individuals with disabilities who are receiving monthly cash benefit payments from SSDI or SSI (Supplemental Security Income). Yet, many individuals with disabilities continue to work following the onset of disability and do not receive income assistance. In this paper we seek to understand how the working patterns of males with and without disabilities explain the observed wage disparity.

In an effort to protect workers with disabilities, the 1990 Americans with Disabilities Act (ADA) prohibits discrimination in the hiring, firing, pay, and promotion of qualified individuals.<sup>2</sup> Additionally, the act requires firms with 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 is to limit job turnover among workers who experience disability.<sup>3</sup> However, not all employers are required to make, or are capable of making, all accommodations requested by these workers, and many more may not provide a welcoming atmosphere. Furthermore, certain health limitations may render the worker incapable of performing required job tasks, necessitating a change in occupation. Therefore, even in the post-ADA era, workers with disabilities may still have a higher rate of job turnover than nondisabled workers.<sup>4</sup>

<sup>2</sup> For more information on the Americans with Disabilities Act, refer to [http://www.ada](http://www.ada.gov)

[.gov](http://www.ada.gov).

<sup>3</sup> The ADA defines disability status partially on the basis of an individual's ability to perform a set list of "major life activities." On January 1, 2009, the ADA list of major life activities was expanded to include the ability to eat, sleep, read, learn, concentrate, communicate, stand/bend/lift, and perform major bodily functions (Americans with Disabilities Act Amendment Act). The main implication of the recent changes is a dramatic expansion in the number of Americans who can be classified as disabled and, hence, eligible for accommodation.

<sup>4</sup> More recently, medical care benefits through Medicaid and Medicare have become available to disabled individuals who continue to work (Expanded Availability of Health Care Services enacted in 2000). Other programs, such as benefit offset programs designed to encourage employment among the disabled who may be eligible for income assistance, have been considered (Benitez-Silva, Buchinsky, and Rust 2010). An early assessment of the Benefit Offset National Demonstration is available at <http://www.ssa.gov/disabilityresearch/offsetnational.htm>.

The main goal of this paper is to determine the role that employment transitions play in the observed wage declines that moderately disabled working males experience. We expand on the current research on employed individuals with disabilities by estimating a multi-equation dynamic model of (1) employment transitions that include occupation and employer change, (2) hourly wages that account for endogenous labor force participation, and (3) disability status that may be reported with error. Using the triennial responses of men aged 25–60 from the 1996 panel of the Survey of Income and Program Participation (SIPP), we measure both the direct impact of disability on expected (hourly) wages (i.e., health capital effects) and the indirect impact of disability on wages through changes in occupation and employer tenure (i.e., human capital effects). If tenure is valuable to employers, then a worker with a disability who changes occupation or employer (thereby depleting occupation and employer human capital) may experience lower wages. Failure to model these intensive margins of employment behavior and to account for their effect on the wage distribution suggests that the observed wage gap among people with and without a disability is fully attributable to differences in health capital directly. The modeling of occupation and employer change jointly with wages and disability over time allows us to decompose, and reduce the bias in, the estimated wage impacts of health and human capital. Our econometric approach specifically allows for (and explicitly models) correlation in observed outcomes through both permanent and time-varying unobserved individual heterogeneity.

We find that job changes contribute significantly to the expected disability penalty. More specifically, estimates from this analysis suggest that in a given 4-month period, a worker with a moderate disability is 1.4 percentage points (or 21 percent) more likely to change occupations and 0.8 percentage points (or 24 percent) more likely to change employers than a nondisabled worker. Furthermore, both of these changes, reflected in reduced occupation and employer tenure, account for one-third of the reduction in wages at the onset of a moderate disability. As human capital increases following disability onset and job change, wages improve. The sizable impact of the reduction in health capital remains, however.

## II. Background

To place in perspective our attention on the wage disparity among prime-age workers with and without disabilities and the methods we use to reduce bias in measured effects of interest, we briefly discuss several issues that economists encounter when studying employment, wages, and disability. These include analysis of extensive and intensive margins of employment behavior, incorporation of human capital and health capital as determinants of wages, measurement and modeling of disability, and the effect of income assistance programs on labor force participation.

*A. Employment-Related Outcomes of Workers with Disabilities*

In this subsection we discuss the literature examining two intensive margins of employment: occupation and employer change. Such changes are particularly relevant to a study of both human and health capital in which disability serves as the reported health variation. Although a disability may render an individual unable to remain in his current job, he 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 occupation and employer transitions among older workers. Daly and Bound (1996) analyze the characteristics that contribute to employer change for workers with disabilities using the Health and Retirement Survey (HRS). The authors find that, among workers with disabilities, age has a negative impact on the likelihood of employer change and those 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 jointly with other outcomes of interest and to allow correlation through unobservables, thereby reducing endogeneity bias. But the results are mixed. Bound et al. (1999) find that a transition from good to poor health has a positive effect on the probability of changing jobs of between 9 and 14 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 the employment transition analysis to include occupation change, although they consider occupation changes only 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 employers, but those who do are more likely to also change occupation.

Even fewer researchers have analyzed the role of health on occupation and employer transitions of younger workers. Baldwin and Schumacher (2002) use the SIPP to study voluntary and involuntary employer changes over a 20-month period of individuals aged 16–65. They find that workers with a disability 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 workers with disabilities but voluntary changes have a negative impact. Campolieti (2009) uses the Participation and Activity Limitation Survey from Canada to study the employer changes of workers across a 4-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 9.1 and 6.9 percentage points more likely to change employers, respectively. No comparison is made to nondisabled 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 1-year period. They find that the workers who return to their pre-injury employer earn over 27 percent more than those who change employers. Each of these three studies treats disability as exogenous and thus may misestimate the impact of disability if unobservables influence both disability and employment outcomes.

### *B. Human and Health Capital as Determinants of Wage*

A few recent examples of how authors have measured the impact of occupation and employer transitions on wages are warranted. Expanding beyond the differential roles of experience and tenure, Kambourov and Manovskii (2009) find that the well-known drop in weekly earnings following displacement from a job (even after 5 years) is differently experienced by individuals who stay in the same occupation and those who switch occupations; the earnings hit is three times larger for those who change occupations. They also find that the impact of employer tenure is much smaller than that of occupation experience. In Sullivan's (2010) model of occupation decisions, he allows wages to depend on (three increasing levels of) occupation and employer human capital. He concludes that finding a good employer and occupation match has a larger impact on wages than the pecuniary return to occupation or employer tenure. Although not addressing disability specifically, Harris (2014) examines the role of body mass (i.e., health capital) on occupation and hours worked decisions. In addition to accounting for the effect of job tenure (i.e., occupation-specific human capital) on wages, he allows these marginal effects to vary by body mass. He finds that individuals with excess body weight earn lower returns to current job experience and face greater switching costs in white-collar occupations than their healthy-weight counterparts.

Several authors have estimated the direct impact of disability on wages. Using similar approaches, Charles (2003), Mok et al. (2008), and Meyer and Mok (2013) find that disability has a persistent negative impact on wages that is worse for chronic and severe disabilities. After controlling for industry and occupation exogenously, Charles (2003, 638) 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." However, Charles does not jointly model these intensive margins of employment decisions (i.e., changes in industry and occupation), nor does he model changes in disability status over time. He does control for permanent

unobserved heterogeneity that might be correlated with these outcomes, but the fixed-effect method does not address bias associated with time-varying unobserved heterogeneity. Additionally, the estimated empirical model does not allow us to understand the effects of disability on employment decisions over time or to measure unbiased effects of these employment and disability histories on wages. Examining the wage gap between workers with and without disabilities in the years 1972–84, Baldwin and Johnson (1994) control for total experience and tenure with a particular employer and find that both variables have a positive impact on wages. Contrary to expectations, the workers with a disability have more experience and tenure than nondisabled men, which helps decrease the wage gap between the two groups. In a more recent study, DeLeire (2001) analyzes the wage gap from 1984 to 1993. In DeLeire's sample, workers with a disability also have higher amounts of employer tenure than the nondisabled, but he does not find that tenure is a significant component of the wage gap.

### *C. Measurement of Disability*

Like many survey instruments, the SIPP asks whether or not the respondent 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 available in many data sets. The definition is similar to the definition of disability used in the ADA, which defines an individual with a disability as one 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 capture 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, conclude that self-reported disability is correlated with unobservables that also affect employment decisions (Anderson and Burkhauser 1985; Bazzoli 1985; Kerkhofs and Lindeboom 1995; Kreider 1999).<sup>5</sup> One concern, known as the justification

<sup>5</sup> An analysis of the reliability of these measures in the SIPP data and the HRS data is available in Kreider and Pepper (2007, 2008).



hypothesis, is that an individual may report having a disability to justify his exit from the labor force or other labor market decisions. Thus, measures of the effect of disability on employment exit, for example, would be overstated. In turn, attempts to recover the effect of disability on wages of those who remain employed will insufficiently account for selection if the employment model is estimated with bias. Furthermore, receipt and amount of compensation from several government programs such as SSDI and worker's compensation depend partially on one's disability. The desire to receive these types of assistance may induce individuals to report that they are disabled. A competing effect that could lead to underreporting of disability is the stigma associated with classifying oneself as disabled. Finally, even if workers are not justifying nonemployment 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 of the trade-offs of using self-reported measures or objective measures of disability.

To add to the complexity of defining a health-related work limitation, disability is potentially a dynamic, evolving process. It is easy to think of counterexamples such as a sudden, permanent injury that leads to nonemployment as an absorbing state or of a short-term, correctable illness that affects labor supply only temporarily. Yet, not all disabilities are characterized as one or the other. Tables 1 and 2 detail the longitudinal features of individual disability in the 1996 panel of the SIPP, which chronicles disability status of participants in 4-month periods up to 4 years. Note that two-thirds of those in all 12 waves of our research sample who are initially observed to have a severe disability (29 percent) are severely disabled over the entire sample period. However, as indicated by the 4-month transition probabilities in table 2, among those who experience moderate disability, less than 7 percent transition to severe disability; in fact, over one-third of those recover by the next period.<sup>6</sup> The transition probabilities indicate the persistence of severe disability and the greater likelihood of transitioning in and out of moderate disability and no disability.

To address concerns about the measurement of disability and to capture the evolving nature of disability, we jointly model (with the employment transitions and wages of individuals over time) initial disability upon entry to the survey and length of disability if disabled upon entry as well as transitions in and out of disability and transitions in disability severity in all subsequent periods of observation. We allow these time-varying self-reported disability outcomes to be determined by observables and unob-

<sup>6</sup> The temporary characteristic of many disabilities in our data contrasts with the measure of disability necessary for receipt of SSDI/SSI. Those federal programs are intended for people with long-term disabilities. SSA's definition of disability requires that beneficiaries have a disability that has lasted or is expected to last for more than 12 months or result in death.

TABLE 1  
SUMMARY OF DISABILITY DYNAMICS IN THE 1996 4-YEAR SIPP PANEL

Description	Statistic
Number of individuals in our research sample	14,963
Number of individuals observed all 4 years or 12 times (59%)	8,850
Number of individuals ever disabled (20%)	3,067
Number of individuals ever severely disabled (10%)	1,508
Number of individuals observed all 4 years and ever disabled	1,751
Begin 4-year period severely disabled	29%
Severely disabled all 12 periods	68%
Experience 12 periods severely disabled	20%
Experience 0 periods severely disabled	53%
Experience fewer than 5 of the 12 periods severely disabled	66%
Experience fewer than 5 of the 12 periods moderately disabled	80%
Average number of periods with no disability	5.9
Average number of periods with moderate disability	2.3
Average number of periods with severe disability	3.8

TABLE 2  
TRANSITION PROBABILITIES

Disability Outcome in $t$	Disability Outcome in $t + 1$		
	None	Moderate	Severe
None	82.76	14.05	3.19
Moderate	36.55	56.92	6.53
Severe	4.23	3.34	92.43

Note.—Number of person-period transitions = 19,261, conditional on being observed 12 triennial periods (1996–2000) and disabled at least once during the 4 years.

servables that may be correlated with employment and wages over time. The random-effects method that we use, which captures unobservables across the multiple outcomes and over time, attenuates both measurement error bias and omitted variable bias.

#### D. *The Role of Disability Benefits*

Integral to understanding labor force participation and disability is the decision to apply for income support or other forms of assistance available through the federal government for those who are disabled and cannot work. The largest programs for income replacement and assistance for individuals with disabilities are SSDI and SSI. Both federal programs require an elaborate process to determine eligibility for and continuation in the program, as well as the amount of assistance. Criteria include current work status; amount of substantial gainful activity; ability to work; the level of, changes in, and history of disability; and one's history of earnings. Benitez-Silva et al. (2004) confirm that the nature of one's self-assessed disability is important to application, acceptance, and award decisions. Benitez-Silva, Buchinsky, and Rust (2008) also show that classification (or award and rejection) errors associated with these disability programs are

large (i.e., some individuals without substantial or work-limiting disabilities may receive benefits and some with such disabilities are denied benefits). In the remainder of this section, we discuss how these programs enter the individual's employment decision-making process, how researchers have attempted to empirically evaluate their role, and why we do not include specific values of benefit receipt and amounts in our analyses.

### 1. Disability Benefit Application, Approval, and Acceptance

Despite detailed evaluations of application and acceptance to these federal disability programs and of award determination, analysis of their roles in the decision to remain employed or exit the labor force has been undertaken by few economists. Benitez-Silva (2009) describes the intricate model and detailed data that would be necessary to fully incorporate the incentives an individual faces. Kim (2013) provides a recent attempt to structurally incorporate these benefits and the Medicare benefit available after 2 years of SSDI benefit receipt following disability determination. While he does not have data on individual SSDI/SSI application or acceptance, the model of forward-looking behavior probabilistically incorporates the award benefit that is determined by one's disability history and employment history.<sup>7</sup>

The model solved by Kim (2013) and that of Low, Meghir, and Pistaferri (2010) are exactly the type of models from which we derive our jointly estimated set of dynamic structural equations (i.e., employment transitions, disability transitions, and wages). Because we do not solve the forward-looking dynamic stochastic model explicitly and do not estimate individual preference and expectations parameters specifically, computational tractability does not restrain us from analyzing employment outcomes at a finer level of detail (occupation and employer changes) and allows us to let the wage distribution depend on more detailed measures of human and health capital (occupation and employer tenure and disability history). Just as wages are observed only for individuals who choose to be employed, disability benefit amounts are observed only for those individuals who apply for and are approved for disability income.

<sup>7</sup> SSDI and SSI in the United States are federal programs with specific benefit formulas. The evaluation process (for disability determination) depends on current employment status, earnings below a specified "substantial gains activity" amount (\$1,070 per month in 2014 with a few exceptions—most notably a relaxation of this threshold for a trial work period; <http://www.ssa.gov/oact/cola/sga.html>), severity of the condition, and ability to do work. The benefit formula applied to each individual, once eligible, also depends on his average indexed monthly earnings prior to the first year of eligibility. SSI also has income and asset restrictions. These federal programs contrast with the US welfare benefit program (i.e., Temporary Assistance to Needy Families), which is administered by each state and provides benefits, conditional on individual characteristics, that may exhibit variation across states and time. (There are a few states [five] that offer statutory disability programs for individuals who cannot work because of disability.)

While we have the necessary data to model selection into employment (and changes in occupation and employer), we cannot appropriately model receipt and amount of SSDI/SSI benefits because we do not observe SSDI/SSI application, approval, and acceptance (i.e., selection into the program) by individuals in the SIPP data.<sup>8</sup> Recognizing this, we include in our equations for employment transitions (derived from a forward-looking, dynamic model of decision-making behavior) the histories of employment and disability, which (as referenced in n. 7) determine SSDI/SSI eligibility and benefits (i.e., outcomes resulting from the jointly occurring disability application process).

To repeat, our goal in this paper is to explore the reported wage penalty associated with disability by allowing for a richer specification of the determinants of wages than exists in the literature. We do so by including detailed measures of human and health capital to capture both the marginal effects of occupation and employer tenure by disability status and the productivity (employee) or taste-based (employer) penalties associated with disabilities of different levels and durations (although we do not distinguish between the latter mechanisms). The observed employment outcomes that we model are explained by variables that theoretically influence the joint employment and disability benefit application decisions, namely, the disability and work histories up to the current period.<sup>9</sup>

## 2. Empirical Evaluation of the Effect of Disability Benefits

Up to now, our brief discussion of the economic theory that explains employment decisions and disability transitions focuses on an individual's decision to remain in the labor force in order to appropriately model the selection necessary for exploring wages. However, individuals with disabilities may exit the labor force and then return, exhibiting another avenue of selection into employment (i.e., return as opposed to remain). A fully structural dynamic model of the employment and application decision-making process would also include the reemployment decision of a disabled individual who may (or may not) have received benefits. In this case, the disability benefit awarded to an approved applicant would become a determinant of the reentry decision. In a reduced-form model of

<sup>8</sup> Data on SSDI and SSI benefit application and receipt linked to the SIPP recently became available to researchers and contractors outside of the SSA (<http://www.census.gov/programs-surveys/sipp/methodology/sipp-synthetic-beta-data-product.html>).

<sup>9</sup> We recognize that other exogenous variables that affect the probability of approval or size of the award (especially if these are treated as stochastic in the estimated decision model) are also relevant. We include in our empirical approximation to the theoretical model monthly nonearned income and unemployment rates at the metropolitan statistical area (MSA) level. The former includes property income and all other income but excludes cash transfers. The latter captures potential variation in local labor demand, which may affect disability application and expected acceptance decisions (Autor and Duggan 2003).

return to employment, an estimated marginal effect of observed benefits exhibits bias if benefit receipt and level are treated as exogenous determinants. One way to reduce this bias is to explicitly (and perhaps jointly) model the benefit level along with the application, approval, and acceptance process (i.e., to control for selection into benefit receipt). This method is compromised, however, because it requires exclusion restrictions for identification of the endogenous benefit effect. Also, because disability insurance and disability income are federal programs in the United States, there is little variation in the benefit formula conditional on individual disability and employment histories.

Because of this lack of individual variation in benefits, when a researcher uses a nonstructural, reduced-form approach to evaluate the role of benefits and when benefit receipt and the level of benefit conditional on receipt are not jointly modeled, he must look for individual differences in benefits that result from exogenous variation in the data. Gruber and Kubik (1997) claim that disability rejection rates, or, more specifically, time-varying state differences in initial disability insurance denial rates that were the result of dramatic changes in federal funding in the late 1970s, can be used to identify changes in labor force participation rates. Autor and Duggan (2003) exploit variation in disability benefit generosity created by differences in income replacement rates resulting from wage variation among low-skilled workers across states. Chen and van der Klaauw (2008) adopt an approach similar to that of Bound (1991) of comparing rejected disability applicants with beneficiaries and finding the upper bound of the benefits' effect on labor force participation. They go on to evaluate the effect of the benefit program by exploiting the fact that determination of marginal cases rests on stated vocational attributes and an age grid. Recently, Moore (2013) identifies differences in labor force participation resulting from a change in the definition of disabling conditions that exogenously forced millions off the disability rolls. French and Song (2014) use the random assignment of initially denied disability cases to judges, and Maestas, Mullen, and Strand (2013) use random assignment of disability examiners in disability determination to identify the effect of benefit receipt on labor supply.

### 3. Our Preliminary Analyses of Benefits

We have acknowledged the theoretical role of SSDI/SSI benefits in a dynamic analysis of employment, disability, and wages. We have also discussed the ways in which researchers have attempted to find and use exogenous variation in benefits to capture their importance in reentry decisions. We now address the (potentially equally) important role of other benefits in the employment transition decisions of individuals with and without disabilities. The same discussion regarding the role of SSDI/SSI benefits could be applied to other benefits such as unemployment

income, worker's compensation, welfare, and food stamps.<sup>10</sup> Despite using the SIPP data, which were administered specifically to "provide accurate and comprehensive information about the income and program participation of individuals and households in the United States, and about the principal determinants of income and program participation" (<http://www.census.gov/sipp/>), we do not include the receipt of such benefits and benefit amounts in our analysis.<sup>11</sup> As explained in this section, we wholeheartedly agree that a model of the forward-looking, dynamic employment decision-making behavior with stochastic (and potentially endogenous) disability transition should include these constructs. Our reduced-form approximation of such a model does not include those individually observed benefit values based on theoretical reasons and the lack of individual variation, which we discussed above. Rather, transitions from non-employment to employment are modeled as a theoretically derived dynamic function of the disability level and severity history, the endogenously determined length of the nonemployment spell, and local unemployment rates capturing demand.

There are two additional empirical reasons that we do not jointly model the disability benefit receipt/amounts that we observe in our research sample. First, less than 6 percent of our research sample are "at risk" for having these benefits (i.e., potentially eligible). More specifically, only about 10 percent of the person-period observations in our research sample are jobless and therefore face the decision to exit (or not) nonemployment. Among those, three-fifths are disabled and potentially eligible for financial assistance from the federal disability programs. The majority of those (92.5 percent) are severely disabled, which largely explains their nonemployment. Among those nonemployed and severely disabled, 70 percent receive SSDI/SSI benefits. (See App. table A6 for more details on benefit receipt and amounts.) The reentry rate of those with and without benefits is 1.5 and 0.5 percent, respectively, and is not statistically different across the two groups.<sup>12</sup>

Second, despite the small sample receiving benefits and the almost universal behavior of this group, we perform a rigorous analysis of the

<sup>10</sup> Kim (2013), in his life cycle model of labor supply, consumption, and SSDI application decisions, specifically examines the role of SSDI and the Medicare benefit provision that SSDI recipients are eligible for 2 years after enrollment. He finds that the prospect of Medicare coverage in the future significantly affects employment behavior (and SSDI application). His model also incorporates unemployment insurance and two means-tested programs: SSI and food stamps.

<sup>11</sup> Note that most of the literature that exploits random variation in SSDI/SSI benefits also does not consider the role of other benefits.

<sup>12</sup> Autor and Duggan (2007) explore the reentry disincentive imposed by federal benefits by differentiating between the income and substitution effect. They are able to separate the effects by studying the reemployment decisions of individuals with benefits through the Veteran Disability Compensation program—which are not contingent on current work behavior—who did and did not experience the unanticipated extension of benefits in 2001.

empirical role of all the benefits reported in the SIPP data. We estimate transitions into and out of employment (where dependent variables include occupation and employer changes) as a function of the detailed employment and disability histories (that partially define benefit eligibility and award amounts) and individual benefit receipt and award amounts for SSDI/SSI (including state benefits), unemployment insurance, worker's compensation, welfare, and food stamps. Consistent with the literature, we find that SSDI/SSI (when considered alone) significantly reduces the probability of reentering the labor force. However, this finding reflects the bias associated with selection into benefit receipt, which is not modeled explicitly. When we account for the permanent individual heterogeneity that is likely correlated with both employment transitions and benefit application, approval, and acceptance (using individual fixed effects), we find that the role of SSDI/SSI benefit amount (but not benefit receipt) becomes insignificant. When we include the other forms of assistance, state and other unemployment benefits also reduce the probability of reentry. While this analysis suggests empirically that disability benefit receipt explains one avenue of selection into employment (namely reentry), it does not answer the question of whether we should include in our jointly estimated set of equations (i.e., employment transitions, disability transitions, and wages) an equation(s) for disability benefit receipt and benefit amount (whose error term[s] would be correlated with the errors in the other equations through permanent and time-varying unobserved heterogeneity). That is, given that (1) we model the two avenues of selection into employment (i.e., remain and return) and disability transition as a function of the endogenous variables that largely define benefit receipt and amount (i.e., disability and employment histories) and (2) we are interested in the determinants of wages of working individuals with and without disability, we need also include an equation for disability benefit receipt and amounts only if the addition of this outcome alters estimation of the (permanent and time-varying) unobserved heterogeneity distributions significantly.<sup>13</sup> We found that it did not.

### III. Empirical Model

We estimate the full effect of disability on wages by understanding both the direct effect through variation in disability severity and length of disability (i.e., health capital) and the indirect effect through variation in occupation and employer tenure (i.e., human capital). We derive our

<sup>13</sup> A regression of benefit receipt on disability severity and history as well as length of unemployment explains over 50 percent of the variation in receipt among those who are nonemployed, with all variables being statistically significant with greater than 97 percent confidence. The percentage of variance explained increases by only 1 percent when demographic variables, urbanicity and region indicators, month and year indicators, and local unemployment rates are included.

empirical model from a dynamic model of individual decision making with regard to employment behavior in light of stochastic transitions in disability. The observed employment behavior reflects the optimal outcomes of the forward-looking decisions and depends on information available to an individual each decision-making period. This information contains the history of employment outcomes and health transitions, as well as exogenous information that is updated each period. The theoretical model we have in mind most closely resembles that of Kim (2013).

Our empirical goal is to accurately measure the marginal effects of human and health capital on wages, which involves minimizing the bias associated with selection, endogeneity, and measurement error. Because we observe wages of only those individuals who work, we must appropriately model selection into employment (i.e., either continued employment or a return to employment). Additionally, we want to account for any unobservable individual characteristics that might be correlated with specific employment transitions (i.e., changes in occupation or employer) and the observed wage outcome of those who choose to work. Finally, we recognize that self-reports of disability both are endogenous and are potentially reported with error. We also capture the dynamics of disability and employment behavior over time by following our sample of individuals for up to 12 4-month periods. Modeling of these period-by-period transitions allows us to construct endogenous histories of disability length and severity as well as occupation and employer human capital. These four dynamic outcomes—employment transitions from employment and non-employment, wages, and disability—are potentially correlated with each other and over time. Hence, we jointly estimate the equations representing the employment behaviors and health outcomes. The right-hand-side specification of each equation (described in Sec. III.A below) includes the theoretically relevant observed (endogenous and exogenous) variables and unobserved variables that explain each outcome.

#### A. *Jointly Estimated Set of Correlated Equations*

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

1. An individual enters the period knowing his disability status ( $D_t$ ) and his disability and employment histories ( $H_t^D$ ,  $H_t^E$ ). His information set includes exogenous demographic characteristics ( $X_t$ ), exogenous nontransfer income ( $Y_t$ ), exogenous local market characteristics ( $Z_t$ ), and unobservable (to the econometrician) characteristics, which we denote  $u_t$  for now but will explain more fully below. The individual also receives a wage draw (unobserved by the econometrician) from the distribution of wages for each employment alternative.



2. Among those who were employed in the previous period ( $E_{t-1} = 1$ ), the possible employment outcomes ( $R_t = r$ ) are

$$r = \begin{cases} 1, & \text{employment with the same employer in the same occupation} \\ 2, & \text{employment with the same employer in a new occupation} \\ 3, & \text{employment with a new employer in the same occupation} \\ 4, & \text{employment with a new employer in a new occupation} \\ 5, & \text{nonemployment.} \end{cases}$$

A previously nonemployed individual ( $E_{t-1} = 0$ ) may continue to be nonemployed or become employed.

3. Wages ( $W_t$ ) of those individuals who choose to work are observed by the econometrician.
4. The employment history vector and the period  $t$  employment outcome define an individual's updated endogenous employment history vector ( $H_{t+1}^E$ ).
5. At the end of the period the individual's disability status ( $D_{t+1}$ ), which may depend on current employment behavior, evolves and is reported. He may be nondisabled, moderately disabled, or severely disabled.
6. The disability history vector and the end of period  $t$  disability outcome define an individual's updated endogenous disability history vector ( $H_{t+1}^D$ ).

Table 3 describes the jointly estimated set of outcomes that we model. The four main equations (i.e., the first four rows of the table) capture the dynamic employment behavior, wages, and disability outcomes. The employment and wage outcomes are functions of the endogenous histories of employment and disability. The employment history vector entering the period ( $H_t^E$ ) is described by the number of consecutive periods an individual has worked in the same occupation ( $OT_b$ , or occupation tenure), the number of consecutive periods an individual has worked for the same employer ( $ET_b$ , or employer tenure), and the number of periods of recent nonemployment ( $NT_b$ , which will be zero for those employed in period  $t - 1$ ). The vector of variables describing one's disability history entering period  $t$  ( $H_t^D$ ) includes disability status, disability severity status, and disability tenure.<sup>14</sup> These endogenous variables capture the dynamic relationships between outcomes over time.

The vector of observed exogenous variables ( $X_t$ ) includes age, race, marital status, number of children, educational attainment, urbanicity, and region. Nonearned income ( $Y_t$ ) is measured as the amount of non-

<sup>14</sup> If the individual began the survey without a disability, disability tenure is simply the number of periods since disability onset. If, however, the individual is observed to have a disability when the panel survey begins, disability tenure is the number of periods since first disability onset.

TABLE 3  
SET OF JOINTLY ESTIMATED DYNAMIC EQUATIONS AND INITIAL CONDITIONS

Outcome	Estimator	Explanatory Variables		
		Endogenous	Exogenous	Unobserved
Employment: $R_t = r$ Conditional on $E_{t-1} = 1$ $r = 1, \dots, 5$ $t = 1, \dots, T$	mlogit	$H_t^D, H_t^E$	$X_b, Y_b, Z_t$	$\mu_r^R, \nu_{rt}^R, \epsilon_{rt}^R$
Employment: $E_t = j$ Conditional on $E_{t-1} = 0$ $j = 0, 1$ $t = 1, \dots, T$	logit	$H_t^D, H_t^E$	$X_b, Y_b, Z_t$	$\mu_j^E, \nu_{jt}^E, \epsilon_{jt}^E$
Wage: $\ln W_t$ Conditional on $E_t = 1$ $t = 1, \dots, T$	OLS	$H_t^D, H_t^E$	$X_b, Z_b, J_t$	$\mu^W, \nu_t^W, \epsilon_t^W$
Disability: Conditional on $D_{t+1} = d$ $d = 0, 1, 2$ $t = 1, \dots, T - 1$	mlogit	$H_t^D, H_{t+1}^E$	$X_b, Y_t$	$\mu_d^D, \nu_{dt}^D, \epsilon_{dt}^D$
Attrition: $A_{t+1} = 1$ Conditional on $A_t = 0$ $t = 6, \dots, T - 1$	logit	$H_{t+1}^D, H_{t+1}^E$	$X_b, Y_t$	$\mu^A, \nu_t^A, \epsilon_t^A$
Initially observed endogenous variables entering period $t = 1$ :				
Disability: $D_1 = d$ $d = 0, 1, 2$	mlogit		$X_0, Y_0, V_0$	$\mu_d^{ID}, \epsilon_{d0}^{ID}$
Occupation tenure: $OT_1 = o$ $o = 0, \dots, 6$ levels	mlogit		$X_0, Y_0, Z_0$	$\mu_o^{OT}, \epsilon_{o0}^{OT}$
Employer tenure: $ET_1 = e$ $e = 0, \dots, 6$ levels	mlogit		$X_0, Y_0, Z_0$	$\mu_e^{ET}, \epsilon_{e0}^{ET}$

Note.—mlogit = multinomial logit; OLS = ordinary least squares.

transfer income.<sup>15</sup> Market characteristics ( $Z_t$ ) include the average local unemployment rate in period  $t$ .<sup>16</sup> Additional characteristics of one's job influence wages ( $J_t$ ); these include hours worked, employer size, and indicator variables for occupation category.<sup>17</sup>

Unobserved individual characteristics also affect the observed employment outcomes, wages, and disability transitions. Failure to account for these unobservables, which may be correlated over time as well as correlated across outcomes, will result in biased measurement of marginal

<sup>15</sup> We do not include transfer income (i.e., SSDI/SSI, unemployment income, worker's compensation, welfare, food stamps, Medicare and Medicaid benefits) for the reasons explained in Sec. I.I.D.3.

<sup>16</sup> The average local unemployment rate is defined as the unemployment rate in a given area defined by the SIPP, which is roughly an MSA.

<sup>17</sup> We acknowledge that hours worked, employer size, and the specific occupation are likely endogenous. However, we take the stance that the omitted variable bias caused by excluding these variables from the wage equation may be worse than estimation including these endogenous variables but treating them as exogenous. As the effect of these variables is not the focus of the paper, we include them in the wage equation but do not discuss their marginal effects. Our subsequent work explores the effect of disability and employment histories on these additional intensive margins of employment choice.

effects of endogenous explanatory variables. The error term in each equation of table 3 is decomposed into three parts: a permanent individual heterogeneity component ( $\mu$ ), a time-varying individual heterogeneity component ( $\nu_t$ ), and an idiosyncratic component ( $\epsilon_t$ ). That is, the error terms associated with the main outcomes of the jointly estimated equations are

$$\begin{aligned} u_{rt}^R &= \mu_r^R + \nu_{rt}^R + \epsilon_{rt}^R, \quad r = 1, \dots, 5 && [\text{Outcome: } R_t = r | E_{t-1} = 1], \\ u_t^E &= \mu_j^E + \nu_{jt}^E + \epsilon_{jt}^E, \quad j = 0, 1 && [\text{Outcome: } E_t = j | E_{t-1} = 0], \\ u_t^W &= \mu^W + \nu_t^W + \epsilon_t^W && [\text{Outcome: } \ln W_t | E_t = 1], \\ u_{dt}^D &= \mu_d^D + \nu_{dt}^D + \epsilon_{dt}^D, \quad d = 0, 1, 2 && [\text{Outcome: } D_{t+1} = d]. \end{aligned}$$

We allow the heterogeneity captured by  $\mu$  and  $\nu_t$  to be correlated across equations and assume that  $\epsilon_t$  is a vector of independent and identically distributed errors (either extreme value distributed or normally distributed where appropriate). We discuss the distribution of  $\mu$  and  $\nu_t$  after introducing the additional equations in the model.

Although we observe most individuals in our data for 12 4-month periods, some drop out before the end of the panel observation period (i.e., the sample is right censored). We retain an individual in our estimation sample if we observe at least six consecutive 4-month periods. Because this attrition from the sample at the end of a period ( $A_{t+1}$ ) may be a function of the endogenous disability and employment variables and may depend on the same unobserved heterogeneity that determines these variables (i.e., nonrandom attrition), we jointly model it with the other outcomes in the model (i.e., row 5 of table 3).

The bottom rows of table 3 describe three initial condition equations that are jointly modeled with the five dynamic equations discussed above. Accompanying the many benefits of longitudinal data on individuals is the inevitable restriction that behavior is observed for only a snapshot of the individual's life. This restriction requires that we, as econometricians, address an initial conditions problem given that our main equations are dynamic (i.e., they depend on the history of behavior). Specifically, individuals enter the research sample with nonzero values of the endogenous disability and employment history variables. We cannot use the dynamic equations outlined above to describe these nonzero values because, as specified, they depend on lagged information that is not available in the first period of the survey. Additionally, the decisions that describe these "presample" outcomes are likely correlated with unobserved permanent individual characteristics that also influence "within-sample" outcomes. To account for this correlation, we jointly estimate equations for the initially observed state variables (i.e., initial disability, initial occupation tenure, and initial employer tenure entering period  $t = 1$ ) and allow them to

depend on observed contemporaneous variables, empirically tested identifying variables ( $V_0$  and  $Z_0$ ), and unobserved permanent heterogeneity.

The permanent heterogeneity that is correlated across outcomes and over time is modeled as a joint distribution of  $\mu = [\mu^R, \mu^E, \mu^W, \mu^D, \mu^A, \mu^D, \mu^{ET}, \mu^{OT}]$ . For example, if the distribution of permanent heterogeneity was normal, we could estimate the correlation coefficients of the multivariate normal joint distribution of these unobserved variables. However, we do not want to assume normality. Rather, we model the permanent heterogeneity as a random effect and approximate its unknown distribution discretely, estimating both the mass points along the supports of the permanent unobserved components and the associated probability weights (termed a discrete factor random-effects [DFRE] method or latent factor method). We calculate an individual's contribution to the likelihood function conditional on each (estimated) mass point vector and weight the likelihood contribution by the (estimated) probability of that mass point vector. Similarly, we approximate the joint distribution of the time-varying heterogeneity components  $\nu_i = [\nu_i^R, \nu_i^E, \nu_i^W, \nu_i^D, \nu_i^A]$ . This flexible estimation technique does not impose a specific distribution on the error terms as is standard in many maximum likelihood techniques (Heckman and Singer 1984). Using Monte Carlo simulation, Mroz (1999) shows that when the true distribution of the error terms is jointly normal, the DFRE method performs as well as maximum likelihood estimation assuming normality. When the simulated distribution is not normal, the DFRE method performs better in terms of precision and bias.<sup>18</sup>

This DFRE approach offers many benefits over the fixed-effects method, which is commonly used with panel data to control for permanent individual unobservables over time (e.g., Charles 2003). First, while fixed effects account for permanent individual heterogeneity only, we 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 does not allow for measurement of the effect of observable non-time-varying variables on outcomes of interest. Finally, while both methods introduce additional estimated parameters, the discrete distributions of the random effects add only a fraction of the additional parameters (and associated loss in degrees of freedom) required by the fixed-effects method.

### B. Likelihood Function

The latent factor approach allows individual characteristics that are unobservable to the researcher to affect all jointly estimated equations and integrates over their distribution when constructing the likelihood function. An individual's contribution to the likelihood function, unconditional on the unobserved heterogeneity, is

<sup>18</sup> Mroz (1999) and Guilkey and Lance (2014) describe the properties of the DFRE estimator based on Monte Carlo studies.

$$\begin{aligned}
 &L_i(\theta, \rho, \psi) \\
 &= \sum_{k=1}^K \rho_k \left\{ \prod_{d=0}^2 P(D_1 = d | \mu_{dk}^{ID})^{1[D_{i1}=d]} \right. \\
 &\quad \times \prod_{e=0}^6 P(ET_1 = e | \mu_{ek}^{ET})^{1[ET_{i1}=e]} \prod_{o=0}^6 P(OT_1 = o | \mu_{ok}^{OT})^{1[OT_{i1}=o]} \\
 &\quad \times \prod_{t=1}^T \sum_{\ell=1}^L \psi_\ell \left( \left\{ \prod_{r=1}^5 P(R_t = r | \mu_{rk}^R, \nu_{r\ell}^R) \right\}^{1[E_{it}=1]} \right. \\
 &\quad \times \{P(E_t = 1 | \mu_{1k}^E, \nu_{1\ell}^E)^{E_{it}} [1 - P(E_t = 1 | \mu_{1k}^E, \nu_{1\ell}^E)]^{1-E_{it}}\}^{1[E_{it}=0]} \\
 &\quad \times \left[ \frac{1}{\sigma} \Phi(\ln W_t | \mu_k^W, \nu_{\ell}^W) \right]^{1[E_{it}=1]} \\
 &\quad \times \prod_{d=0}^2 P(D_{t+1} = d | \mu_{dk}^D, \nu_{d\ell}^D)^{1[D_{it+1}=d]} \\
 &\quad \left. \times P(A_{t+1} = 1 | \mu_k^A, \nu_{\ell}^A)^{A_{it+1}} [1 - P(A_{t+1} = 1 | \mu_k^A, \nu_{\ell}^A)]^{1-A_{it+1}} \right\},
 \end{aligned}$$

where  $\theta$  denotes the vector of estimated parameters in the equations. The vectors  $\rho$  and  $\psi$  denote mass point-specific estimates of the joint probability of the permanent and time-varying heterogeneity, respectively;  $\rho_k$  is the estimated joint probability of the  $k$ th permanent mass point, which is given by

$$\begin{aligned}
 \rho_k &= P(\mu_1^R = \mu_{1k}^R, \dots, \mu_5^R = \mu_{5k}^R, \mu_0^E = \mu_{0k}^E, \mu_1^E = \mu_{1k}^E, \mu^W = \mu_k^W, \\
 &\quad \mu_0^D = \mu_{0k}^D, \dots, \mu_2^D = \mu_{2k}^D, \mu_0^A = \mu_{0k}^A, \mu_1^A = \mu_{1k}^A, \\
 &\quad \mu_0^{ID} = \mu_{0k}^{ID}, \dots, \mu_2^{ID} = \mu_{2k}^{ID}, \mu_0^{ET} = \mu_{0k}^{ET}, \dots, \mu_6^{ET} = \mu_{6k}^{ET}, \\
 &\quad \mu_0^{OT} = \mu_{0k}^{OT}, \dots, \mu_6^{OT} = \mu_{6k}^{OT}).
 \end{aligned}$$

The term  $\psi_\ell$  is the estimated joint probability of the  $\ell$ th time-varying mass point and is given by

$$\begin{aligned}
 \psi_\ell &= P(\nu_{1t}^R = \nu_{1\ell}^R, \dots, \nu_{5t}^R = \nu_{5\ell}^R, \nu_{0t}^E = \nu_{0\ell}^E, \nu_{1t}^E = \nu_{1\ell}^E, \nu_t^W = \nu_{\ell}^W, \\
 &\quad \nu_{0t}^D = \nu_{0\ell}^D, \dots, \nu_{2t}^D = \nu_{2\ell}^D, \nu_{0t}^A = \nu_{0\ell}^A, \nu_{1t}^A = \nu_{1\ell}^A).
 \end{aligned}$$

Time-varying heterogeneity does not enter equations for the initial state variables describing disability and occupation and employer tenure

entering period 1 because these variables summarize the history of behavior from all periods prior to inclusion in the survey sample.

### C. Identification

In a dynamic model with many equations, 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 causal effect of employment outcomes on disability. Identification requires that a variable explain observed employment outcomes and have no independent effect on wages or on disability conditional on the outcome. The theoretical model implies that nonearned income affects the observed employment outcome but does not affect wages conditional on observed employment. Similarly, local unemployment rates, which affect employment outcomes, are excluded from the disability transition equation conditional on one's chosen employment. Both included variables are significant in the relevant equations, and a likelihood ratio test of joint significance produces a  $p$ -value of .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-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 local 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 ( $V_0$ ). These variables influence initial disability status but do not affect subsequent disability probabilities conditional on disability entering the period. Initial occupation tenure and initial employer tenure are both identified by the unemployment rate at the time an individual graduated from his highest level of education ( $Z_0$ ). These variables do not affect subsequent employment outcomes conditional on tenure but are significant in the initial occupation tenure and employer tenure equations.

## IV. Data

We use 4 years of triennial data from the 1996 panel of the SIPP to estimate our dynamic model. Although more recent panels of SIPP data exist, we use the 1996 panel because it had the combination of the most sample members and the longest-running panel at the time we began this analysis.<sup>19</sup>

<sup>19</sup> The 2008 panel will be slightly longer at 4 years and 3 months and will go through December 2013.

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 4 months instead of every year or every 2 years, which is common in many longitudinal surveys. 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.<sup>20</sup>

The focus of our analysis is on the employment behavior of males during their prime working years as it relates to disability. Of the 56,003 men surveyed for the 1996 panel, 26,253 are in our desired age range of over 24 and under 60 years of age. Of those, we drop 11,290 individuals who did not have six or more consecutive periods (2 years) of information on disability, employment, occupation, and hours worked.<sup>21</sup> Our research sample consists of 14,963 individuals and 155,045 person-period observations.

Because individuals in the SIPP panel are followed for up to 12 4-month periods, we get a good picture of the possible dynamics associated with work-limiting disability (see table 1). In particular, we label an individual as disabled in a period if he reports having a work limitation. He is categorized as severely disabled if he reports having a work limitation that is severe enough to prevent work. Given the repeated surveys, we are able to construct the length of time the individual has been in a spell of disability that began since the initial interview as well as the total time disabled since the individual reported his first spell of disability. Disability is a heterogeneous concept, and there are likely many differences among individuals with disabilities beyond severity and chronicity. In particular, we may wish to distinguish between physical and mental disabilities. Unfortunately, the source of disability (i.e., up to 22 different physical sources and eight different mental sources) is available only in waves 2, 5, and 11.<sup>22</sup>

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 disability evolves. The horizontal axis, labeled disability tenure, represents the number of 4-month periods before or after the onset of a disability (denoted as a disability tenure of

<sup>20</sup> At every interview, respondents are asked to report current information as well as recall particular information from each of the previous three months. For example, an individual interviewed in April would be asked about information in January, February, March, and April. Unfortunately, respondents are asked to recall disability status, occupation, and employer for only the current month. Accordingly, we may lose some monthly transitions, but this loss is much smaller than it would be with annual survey data (Blau 1994).

<sup>21</sup> The estimation sample and those excluded because of missing information are not statistically different.

<sup>22</sup> When we pool across years, individuals who report a mental disability (about 16 percent of the research sample), as opposed to a physical one, are younger, nonminority, less educated, less likely to be married, and more likely to report a severe disability.

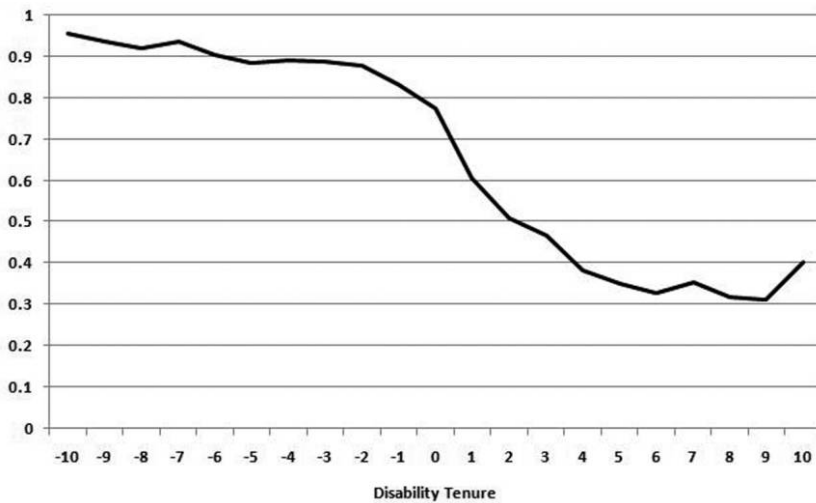


Figure 1.—Employment rate by disability tenure

0) for disability spells that begin in the survey. If we observe an individual to be disabled, to recover, and to become disabled again, we consider him to be in a new spell of disability, and his disability tenure reverts to 0 at the beginning of the second disability spell. The graph shows that the employment rate is relatively stable prior to the onset of disability but plunges and remains low once disability occurs.<sup>23</sup>

While individuals with disabilities differ by length of time disabled, the severity of their disability also differs. Figure 2 shows that employment rates at different quarters of disability tenure differ greatly by disability severity. In fact, the employment behavior of the severely disabled explains most of the drop in employment rates exhibited in figure 1. We see only a small reduction in employment among the moderately disabled. This observation is what led us to explore additional aspects of employment, namely, occupation and employer change, as explanations for the wage gap between employed males with and without a disability.

Demographic characteristics of individuals with no disability, a moderate disability, and a severe disability differ significantly. Table 4 displays summary statistics separately for each group. Of the 14,963 males in the research sample, 3,068 (20 percent) are disabled at some point during the 4-year period, with variation in the length of disability. These 3,068 individuals contribute 16,479 periods of disability to the person-period observations. Males with disabilities are older, less educated, less likely to

<sup>23</sup> 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 toward more and less healthy individuals, respectively.



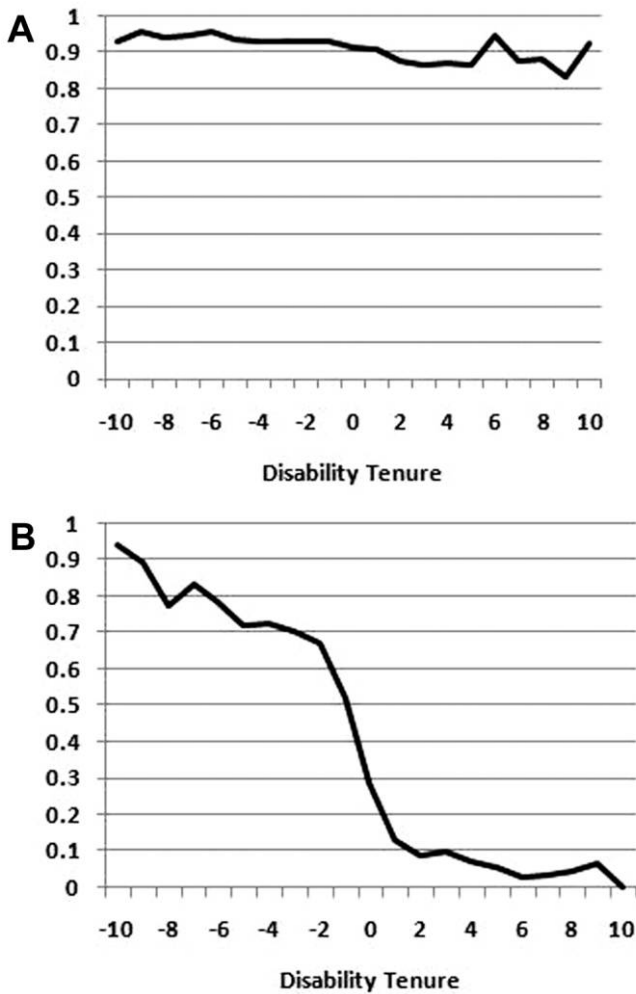


Figure 2.—Employment rate by disability tenure and severity: *A*, moderate disability; *B*, severe disability.

be married, and less likely to live in metropolitan areas. Nonearned income increases with disability severity.

Table 5 reveals the extent to which labor market behaviors vary with disability severity. While those with moderate disabilities are slightly less likely to be employed than the nondisabled, very few people with severe disabilities work. Nondisabled and moderately disabled individuals who were employed in the previous 4-month period are unlikely to be nonemployed in the current period, but over half of those with a severe disability do not work 4 months later. Over 8.3 percent of workers with any level of disability change occupations compared to 6.7 percent of nondisabled workers. Moderately disabled workers as a group are the most likely to change employers. Conversely, severely disabled workers are least

TABLE 4  
DEMOGRAPHIC CHARACTERISTICS BY CURRENT DISABILITY SEVERITY

Characteristic	No Disability	Moderate Disability	Severe Disability
Age (years)	40.99 (9.07)	43.70 (9.07)	46.24 (8.87)
Highest grade completed (years)	13.46 (2.87)	12.40 (2.97)	10.62 (3.55)
Nonwhite race	.14 (.34)	.14 (.34)	.26 (.44)
Not married	.28 (.45)	.41 (.49)	.55 (.50)
Number of children	.98 (1.19)	.71 (1.11)	.53 (1.04)
Nonearned income (1996 \$/month)	79.55 (284.55)	208.96 (481.35)	442.57 (909.94)
Nonmetropolitan residence region (relative to South):			
Northeast	.19 (.39)	.17 (.38)	.19 (.39)
Midwest	.26 (.44)	.26 (.44)	.21 (.41)
West	.22 (.41)	.22 (.41)	.18 (.39)
Unionized with previous employer	.18 (.38)	.16 (.37)	.00 (.07)
Local unemployment rate	4.51 (1.61)	4.56 (1.73)	4.78 (1.85)
Person-period observations	138,566	6,208	10,271

Note.—Standard errors are in parentheses. The number of observations (155,045) represents all (triennial) person-periods including the initial period of survey entry.

TABLE 5  
EMPLOYMENT BEHAVIOR IN PERIOD  $t$  BY DISABILITY SEVERITY ENTERING PERIOD  $t$

Outcome	No Disability	Moderate Disability	Severe Disability
Employed <sub><math>t</math></sub>	94.97 (21.87)	87.53 (33.04)	4.66 (21.08)
Person-period observations	125,258	5,638	9,186
Employment transition if employed <sub><math>t-1</math></sub> :			
Same occupation and employer	87.83 (32.69)	79.06 (40.73)	29.66 (45.74)
Change occupation	6.74 (25.08)	8.38 (27.71)	8.56 (28.02)
Change employer	3.51 (18.39)	6.62 (24.86)	2.45 (15.47)
Change occupation and employer	.51 (7.11)	1.03 (10.10)	1.22 (11.01)
Become nonemployed	1.41 (11.78)	4.97 (21.74)	58.10 (49.41)
Person-period transitions	119,026	5,049	327
Employment transition if nonemployed <sub><math>t-1</math></sub> :			
Remain nonemployed	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)
Person-period transitions	6,232	589	8,859
Hourly wage (1996 \$) if employed <sub><math>t</math></sub>	11.21 (13.43)	8.47 (14.41)	6.59 (6.46)
Person-period observations <sup>a</sup>	113,516	4,191	340

Note.—Standard errors are in parentheses. The number of observations (140,082) represents all triennial person-period transitions. This table describes the behavior and size of the sample used in estimation of the main dependent variables.

<sup>a</sup> Wage is unobserved for some workers.

likely to change employers. Workers with a moderate or severe disability are also twice as likely to change both occupations and employers as are workers with no disability. Individuals with no disability or a moderate disability who were not employed in the previous period are over seven times more likely to gain employment than those with a severe disability.

Of individuals who are employed (and wages are observed), wages decrease with disability severity. Nondisabled workers have an average wage of \$10.84 an hour, moderately disabled workers earn \$7.51 an hour, and the severely disabled make \$5.69 an hour.<sup>24</sup> This paper examines the extent to which reductions in occupation and employer tenure associated with employment transitions contribute to this wage gap.

## V. Results

We jointly estimate a set of dynamic equations describing employment transitions of the previously employed and previously nonemployed, log wages if currently employed, disability status, and attrition from the research sample along with reduced-form equations for initial disability status and initial occupation and employer tenure. The parameters of the eight equations are estimated simultaneously with the parameters that capture unobserved permanent and time-varying correlations (and their distributions) across the equations. Coefficient estimates for the main equations are available in Appendix tables A1–A5 (with coefficient estimates on attrition and initial variable equations available from the authors). Comparisons of the observed behavior of the research sample with the behavior predicted by the model (table 6) describe how well our model explains the data. The predictions reflect the dynamic fit of the model because the estimated parameters are used to predict behavior each period sequentially (with appropriate integration over the unobserved heterogeneity distributions) while replacing endogenous state variables with the model's simulated values. Figure 3 provides additional evidence that the dynamic model fits the observed outcomes by disability severity and disability tenure.

### A. *Marginal Effects*

After obtaining coefficient estimates (which reflect a reduction in the bias associated with selection, endogeneity, and measurement error), we use our multiple-equation model to predict employment and wage outcomes when a moderate or severe disability is imposed on all sample members, and we compare that to employment and wage predictions when we impose no disability. We simulate these predictions in order to get the full marginal effect since the model contains many interactions of disability with other explanatory variables.<sup>25</sup> The marginal effects presented in table 7 represent the effect of a disability one period after its onset.<sup>26</sup> Standard errors are calculated using predictions based on 100 draws of

<sup>24</sup> The minimum wages for the years 1996–2000 (in 1996 dollars) are \$4.75, \$5.03, \$4.96, \$4.85, and \$4.69.

<sup>25</sup> Refer to tables A1–A4 to recall the specification of the disability history as nonlinear and interacted with explanatory variables.

<sup>26</sup> Disability tenure was set to 0 in all simulations. So the reported effects are for someone who has just become disabled.

TABLE 6  
SUMMARY OF DYNAMIC FIT OF MODEL

Outcome	Observed Behavior	Predicted Behavior
Employed <sub>t</sub>	88.7	88.9
Employment transition if employed <sub>t-1</sub> :		
Same occupation or employer	87.3	86.7
Change occupation	6.8	7.2
Change employer	3.6	3.7
Change occupation and employer	.5	.6
Become nonemployed	1.7	1.9
Employment transition if nonemployed <sub>t-1</sub> :		
Remain nonemployed	87.0	86.7
Become employed	13.0	13.3
Log wage if employed <sub>t</sub>	2.18	2.15
Disability status <sub>t+1</sub> :		
No disability	89.4	90.1
Moderate disability	3.9	3.8
Severe disability	6.8	6.1

the full set of coefficients from the estimated variance-covariance matrix. In order to demonstrate the magnitude of bias associated with the endogeneity of disability as well as occupation and employer tenure, we report marginal effects from a single-equation model that treats observed employment and disability histories ( $H_t^E$  and  $H_t^D$ ) as exogenous. We refer to our multiple-equation model that explicitly models permanent and time-varying unobserved heterogeneity as the *heterogeneity model* and the model that does not account for selection, endogeneity, and measurement error bias as the *no-heterogeneity model*. The estimated distributions of unobserved permanent and time-varying heterogeneity in the heterogeneity model are captured with four and two discrete mass points, respectively. The elimination of bias in estimated coefficients that is afforded by the modeling of both permanent and time-varying unobserved heterogeneity is most apparent in the wage equation, yet the estimates of the heterogeneity are statistically significant in each equation that they enter. (See App. table A5 for estimates of the unobserved heterogeneity distributions.)

Neglecting to control for unobserved differences results in overestimation of the impact of moderate disability on employment outcomes (the no-heterogeneity model compared to the heterogeneity model). This finding supports the justification hypothesis of disability reporting. Conversely, the marginal effects of a severe disability are magnified when we model this unobserved heterogeneity. This result is compatible with the stigma effect in reporting a disability. As males with moderate and severe disabilities have been shown to be distinct groups, it is highly plausible that they would face different motivations in reporting disability.

Results from the heterogeneity model in table 7 show that individuals with a moderate disability are only 2.5 percentage points less likely to be employed than nondisabled individuals while those with a severe disability are a third less likely to work. Almost 88 percent of workers with no

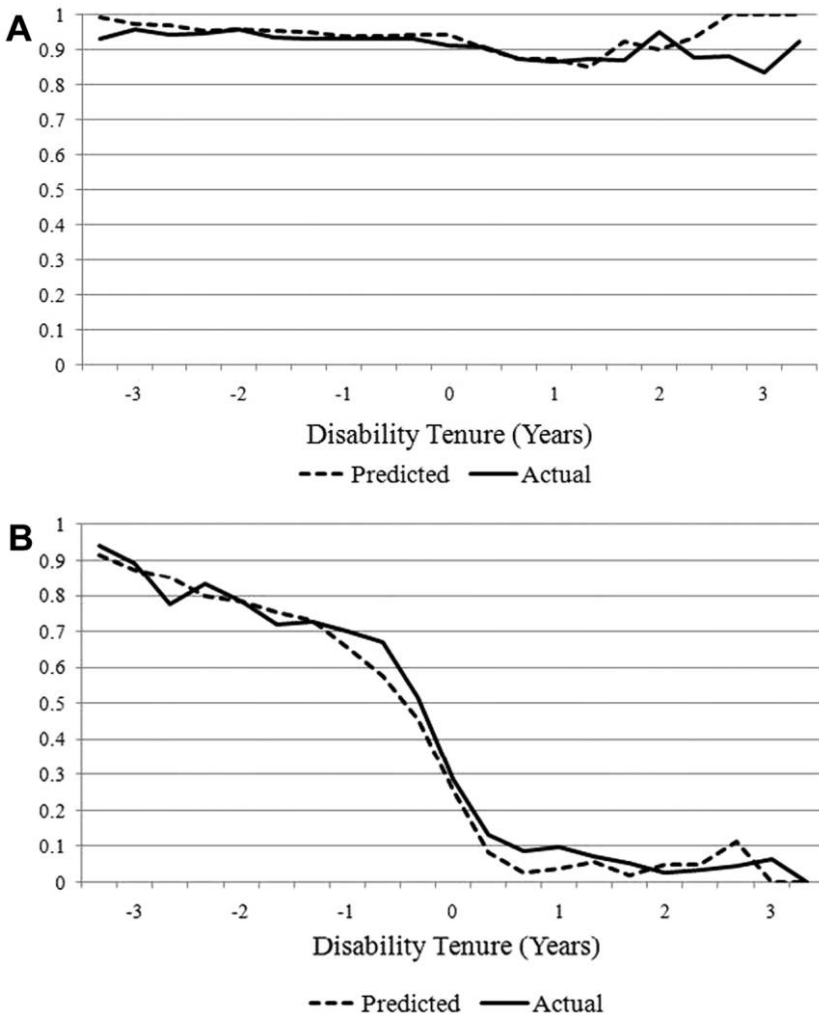


Figure 3.—Employment rate by disability tenure and severity: *A*, moderate disability; *B*, severe disability.

disability stay with their same occupation and employer during a 4-month period, but the onset of a disability leads to a 4.5 and 12.8 percentage point decrease in this rate for a moderate and severe disability, respectively. Workers with a moderate disability are about 2 percentage points more likely to become nonemployed compared to a worker without a disability. Such workers are also about 1.4 percentage points more likely to remain employed and change occupations and 0.8 percentage points more likely to change employers. In summary, workers with a moderate disability are 2.5 percentage points more likely to change occupations, employers, or both compared to nondisabled workers. As almost 11 percent of nondisabled workers make similar transitions, this marginal effect implies that moderately disabled workers are 23 percent more

TABLE 7  
MARGINAL EFFECTS OF DISABILITY ON EMPLOYMENT OUTCOMES

Outcome	No Disability: Predicted Behavior (1)	Moderate Disability		Severe Disability	
		No-Heterogeneity Model (2)	Heterogeneity Model (3)	No-Heterogeneity Model (4)	Heterogeneity Model (5)
Employed <sub>t</sub>	94.9	-2.71*** (1.10)	-2.53*** (.77)	-35.0*** (2.84)	-36.7*** (2.72)
Employment transition if employed <sub>t-1</sub> : Same occupation and employer	87.8	-5.20*** (.88)	-4.51*** (1.00)	-12.6*** (2.36)	-12.8*** (2.65)
Change occupation	6.7	1.77*** (.69)	1.39** (.68)	2.72* (1.92)	2.25 (1.86)
Change employer	3.5	1.04** (.61)	.84* (.54)	-2.10*** (.61)	-2.25*** (.72)
Change occupation and employer	.5	.45 (.27)	.27 (.30)	-.24 (.31)	-.11 (.64)
Become nonemployed	1.4	1.93*** (.33)	2.02*** (.31)	12.2*** (1.38)	12.9*** (1.29)
Log wage if employed <sub>t</sub>	2.19	-.12*** (.01)	-.02* (.01)	-.09** (.05)	-.21*** (.03)

Note.—Bootstrapped standard errors are in parentheses. Numbers in cols. 2-5 represent percentage point changes from the predicted behavior of the nondisabled in col. 1. The no-heterogeneity model is the single-equation model treating employment and disability histories as exogenous. The heterogeneity model is the multiple-equation dynamic model with permanent and time-varying unobservables.

\* Significant at the 10 percent level.

\*\* Significant at the 5 percent level.

\*\*\* Significant at the 1 percent level.

likely to make an occupation or employment transition than nondisabled workers.

Among employed individuals, a severe disability increases the probability of leaving the labor force by almost 13 percentage points over that of a worker without a disability. Workers with a severe disability are 2.3 percentage points more likely to remain employed and change occupations compared to nondisabled workers. On the other hand, these workers are also 2.3 percentage points 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 remain in the same occupation may prefer to stay with their same employer in order to maintain health and disability benefits and avoid potential hiring discrimination.

Our results confirm that disability onset reduces the wages of those who remain employed. Interestingly, the heterogeneity model that accounts for endogenous disability and employment histories suggests only a small reduction in wages of males with a moderate disability (about \$0.30 per hour) compared to their nondisabled counterparts. The biased marginal effect from the no-heterogeneity model is much larger. A severe disability, however, leads to a large and significant reduction in wages that is over twice as large as the biased estimate.

Having established that individuals with disabilities are more likely to change occupations or employers, we now examine the effects of occupation and employer tenure on wages. Table 8 reports estimated coefficients on (selected) variables in the log wage equation when we treat disability and occupation and employer tenure as exogenous by not modeling common unobserved heterogeneity (i.e., no-heterogeneity model) and when the endogeneity bias is eliminated by jointly modeling employment transitions and the permanent and time-varying unobserved heterogeneity (i.e., heterogeneity model). We focus our discussion on wages of workers with a moderate disability relative to nondisabled workers since so few males with severe disabilities work. In table 9, we report marginal effects on level wages (after retransforming predictions assuming homoskedastic normal errors).<sup>27</sup>

The biased parameter estimates from the no-heterogeneity model suggest that an additional year of occupation tenure increases hourly wages of nondisabled workers by \$0.06 while an additional year of employer tenure adds \$0.081. Males with a moderate disability gain only \$0.049 and \$0.060 for each year of occupation and employer tenure, respectively. Our heterogeneity model confirms the overprediction bias associated with unobserved heterogeneity and predicts a smaller, but still statistically sig-

<sup>27</sup> Log wages are retransformed to levels (dollars) using a smearing factor. 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 wage.

TABLE 8  
EFFECTS OF DISABILITY AND EMPLOYMENT TENURE ON WAGES:  
COEFFICIENT ESTIMATES ON LOG WAGES

Variable	No-Heterogeneity Model	Heterogeneity Model
Moderate disability	-.108*** (.017)	-.016 (.013)
Severe disability	-.022 (.039)	-.209*** (.033)
Occupation tenure	.008*** (.001)	.002*** (.001)
Occupation tenure squared/100	-.007*** (.002)	-.005*** (.002)
Occupation tenure × any disability	-.001 (.001)	-.001 (.001)
Employer tenure	.013*** (.001)	.011*** (.001)
Employer tenure squared/100	-.017*** (.002)	-.030*** (.003)
Employer tenure × any disability	-.002*** (.001)	-.003*** (.001)
Highest grade completed (relative to high school):		
Less than high school	-.127*** (.006)	-.188*** (.009)
Some college	.094*** (.005)	.101*** (.006)
College	.287*** (.004)	.315*** (.008)
More than college	.435*** (.007)	.457*** (.010)

Note.—Bootstrapped standard errors are in parentheses. The no-heterogeneity model is the single-equation model treating employment and disability histories as exogenous. The heterogeneity model is the multiple-equation dynamic model with permanent and time-varying unobservables.

\*\*\* Significant at the 1 percent level.

TABLE 9  
EFFECTS OF DISABILITY AND EMPLOYMENT TENURE ON WAGES:  
MARGINAL EFFECTS ON LEVEL WAGES

Variable	No-Heterogeneity Model		Heterogeneity Model	
	No Disability	Moderate Disability	No Disability	Moderate Disability
1 year of occupation tenure	.060	.049***	.013	.011
If less than 5 years	.062	.052***	.021	.017***
If 5 years or more	.058	.045***	.006	.003***
1 year of employer tenure	.081	.060***	.049	-.004***
If less than 5 years	.084	.064***	.086	.031***
If 5 years or more	.078	.056***	.021	-.039***
College vs. high school	2.671	2.389***	3.190	2.874***

Note.—The no-heterogeneity model is the single-equation model treating employment and disability histories as exogenous. The heterogeneity model is the multiple-equation dynamic model with permanent and time-varying unobservables.

\*\*\* Significant at the 1 percent level.

nificant, positive effect of tenure on wages. On average, an additional year of occupation tenure increases hourly wages of nondisabled workers by \$0.013 while the similarly modest marginal gain for disabled workers is \$0.011 (which is not statistically different). Employer tenure appears more valuable than occupation tenure for workers without a disability, with hourly wages increasing by \$0.049 for each year of employer tenure, on average. The statistically significant average marginal effect of employer tenure for moderately disabled workers is negative (−\$0.004).

Exploring the nonlinearities (associated with second moments, interactions, and log retransformations) a bit further, we find that most of the



increase in hourly wages associated with additional years of occupation and employer tenure accrues in the early years of employment. That is, 1 year of occupation tenure is worth, on average, \$0.021 (\$0.17) for the nondisabled (moderately disabled) when tenure is below 5 years. This hourly gain drops to \$0.006 (\$0.003) when a nondisabled (moderately disabled) male has been in an occupation for 5 years or more. Similarly, the gain associated with employer tenure is larger during the early years with an employer. In fact, the longer a moderately disabled worker has been with his employer, the lower his real hourly wage. Reasons for the smaller role of tenure by disability status may include discrimination, lack of training received by disabled workers, or productivity differences compared to nondisabled workers that accumulate each year.

### *B. Dynamic Effects*

The marginal effects calculated above use the observed data and “turn on or off” relevant disability variables or increase occupation or employer tenure by 1 year. Our model, however, purposely captures the dynamics associated with employment and disability transitions. Thus, we want to understand the effect of employment behaviors on the evolution of wages of those with and without disabilities.<sup>28</sup> To accomplish this, we first simulate the employment responses to disability onset in order to gain an understanding of the selection into employment (through either continuation or reentry). In particular, we show in figure 4 the effect of different employment choices on subsequent employment for both those with a moderate disability and those with a severe disability. The simulations assume that everyone is employed initially, disability onset (of each type separately) occurs in period 1, and the individual may exit employment in period 2 or he may choose to change employers or occupations at that time. Individuals who reenter employment in subsequent years are not included here. The simulations suggest that people with disabilities who change employers are more likely to become jobless than their counterparts who do not make such a change, but those who remain employed have higher wages (i.e., selection), which we discuss in detail below. Those who change occupations but do not change employers have relatively stable employment but pay a small price in terms of lower wages.

To examine the dynamic wage effects, we consider three groups of simulations in which disability status is fixed: no disability in all periods, onset of a moderate disability that remains, and onset of a severe disability that remains. All three groups are then simulated to remain employed with their current employer in their current occupation each period. The impact of a disability on wages, with employment transitions held

<sup>28</sup> Note that the bias eliminated with our DFRE estimation procedure would accumulate over time if the endogenous employment and disability histories were not modeled but treated as exogenous. Our model allows us to predict wages without incorrectly assigning human and health capital effects over time.

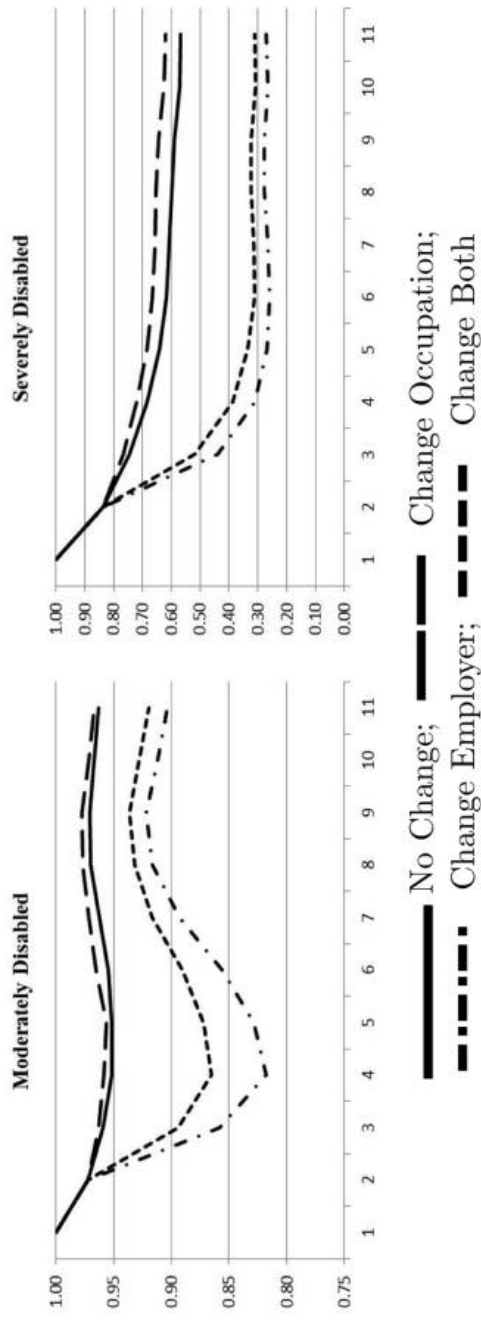


Figure 4.—Simulated employment by employment choice and disability severity

constant, is shown in figure 5. The onset of disability is indicated in the graph as time 0. Following the onset of disability, there is a sharp decline in wages. This initial drop represents a \$0.57 reduction in hourly wages for moderately disabled workers (compared to those with no disability) and a \$1.36 reduction for severely disabled workers. For a full-time worker with a moderate or severe disability, this is a loss of about \$23 or \$54, respectively, per week. Because the rate of return to tenure differs by disability status, the gap between the wages of workers with a disability and the wages of nondisabled workers grows with the length of time disabled. Thus, disability causes not only a loss in wages but also a decline in the returns to additional years of employment (which we examine further below).

For each of the three disability groups described above (nondisabled, moderately disabled, and severely disabled), we simulate four different employment scenarios. In addition to the simulation in which individuals (1) remain with the same occupation and employer over all periods, workers are simulated (2) to change occupations in the period immediately following disability onset and then remain in the same occupation, (3) to change employers in the next period and remain with that employer, and, finally, (4) to change both occupations and employers in the next period and remain. That is, we simulate the effect (on hourly wages) of a one-time change in occupation, employer, or both one period (4 months) after the onset of a disability relative to a similar employment change without disability.

Figure 6 depicts the simulated wages of moderately disabled workers. Workers who remain in the same occupation with their same employer (or those who have “no change”) serve as a comparison for the employment

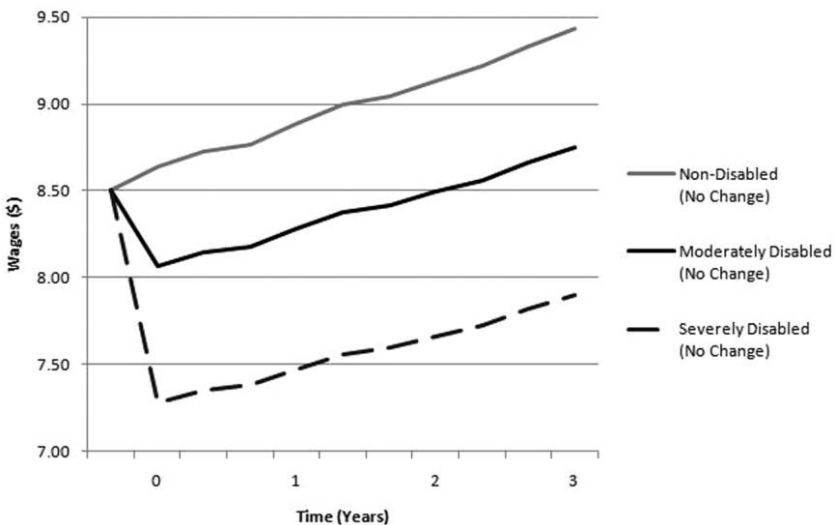


Figure 5.—Simulated wages by disability status

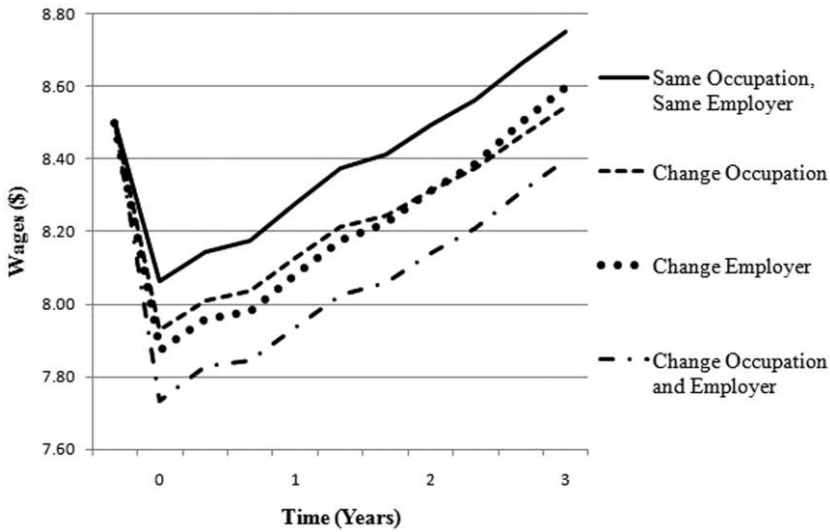


Figure 6.—Simulated wages of workers with a moderate disability

transitions.<sup>29</sup> The figure shows that changing occupations or employers significantly decreases the hourly wage rate of workers with a moderate disability compared to those who stay with their job. (Confidence intervals are available from the authors but have been omitted from the figure to avoid clutter.) In the period in which the transition is made, workers who change occupations or employers earn wages that are \$0.14 or \$0.19 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. The gap between workers who do not change jobs and workers who change occupations widens over time, while the gap closes for those who change employers. The difference for moderately disabled workers who make either transition is still statistically significant 3 years following the transition. These results are suggestive of a significant loss of wages from changing occupations or changing employers that perpetuates for at least 3 years. Furthermore, occupation changes appear to have a greater detrimental long-term effect than employer changes.

Figure 7 depicts the simulated wages of workers following onset of a severe disability. As with the wages of men with a moderate disability, workers with a severe disability who change occupations experience a significant drop in wages. The initial decline in hourly wages is about \$0.13, and the difference between occupation changers and those without a transition increases to \$0.19 after 3 years. However, the effect of changing employers is not statistically significant. Recall, though, that severely disabled workers are less likely to change employers compared to non-

<sup>29</sup> In the first wave, the average male has 11.8 years of occupation tenure and 8.2 years of employer tenure.

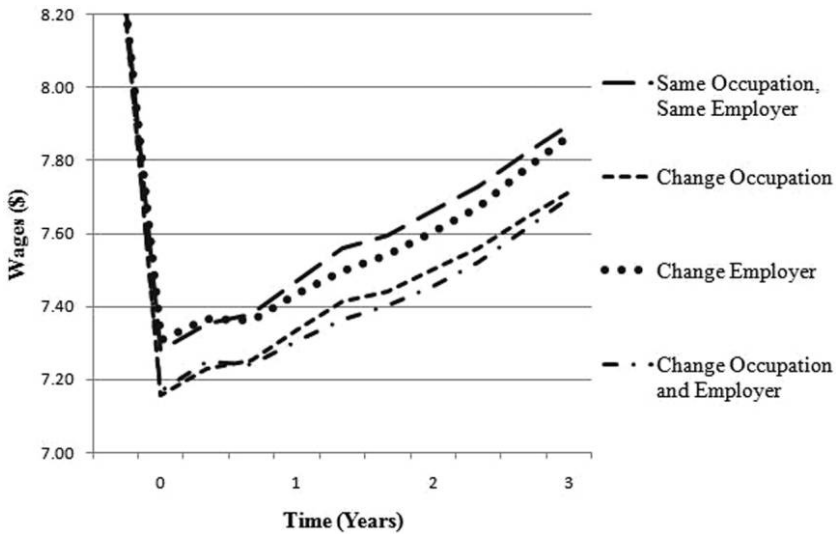


Figure 7.—Simulated wages of workers with a severe disability

disabled individuals. The finding that tenure has a smaller effect on wages for individuals who are more severely disabled is consistent with previous findings regarding returns to education and human capital. The smaller effect may be explained by either differences in real returns from tenure (i.e., training etc.) or discrimination. Overall, the results suggest that the wages of severely disabled workers are adversely affected by changing occupations.

## VI. Conclusion

In this paper we provide a detailed analysis of wage disparities among prime-age males with and without disabilities. We quantify two important measures of the impact of disability on wages: (1) the direct or contemporaneous impact of disability, which allows us to understand the possible reduction in productivity associated with a health deterioration, and (2) the indirect or life cycle impact of disability on wages that accompanies occupation and employer transitions precipitated by health decline. Using panel data from the Survey of Income and Program Participation, we jointly explain triennial employment transitions, wages, and disability over 4 years (12 waves) and account for permanent and time-varying observed and unobserved heterogeneity (with a latent factor model) that is likely correlated with each of the outcomes we observe.

The results regarding employment transitions suggest that workers with either a moderate or a severe disability are more likely to change occupations or employers, with the exception that workers with a severe disability are less likely to change employers. Specifically, workers with a moderate disability are 23 percent more likely to change occupations

or employers compared to nondisabled workers. Previous literature on disability and employment outcomes explores the extensive margin of employment (i.e., employed or not) or, at the intensive margin, models a “job change” as a change in employers. Our research illustrates the additional role of occupation change in these transitions. Further, we demonstrate the importance of accounting for unobserved characteristics in order to obtain asymptotically unbiased estimates of the impact of disability on employment outcomes.

We also measure the unbiased effects of disability history and occupation and employer tenure on wages. At onset of a moderate (severe) disability, wages of males who remain employed decline by \$0.57 (\$1.36), which corresponds to a loss of \$23 (\$54) per week on average. Our simulations of potential employment paths for workers with a disability reveal that changing occupations is associated with another, immediate \$0.14 hourly wage loss if the disability is moderate (relative to those with moderate disabilities who stay with the same occupation and employer), changing employers results in an immediate \$0.19 wage loss for these same workers, and changing both imparts a \$0.30 wage loss. Additionally, the marginal returns to occupation and employer tenure are smaller for workers with disabilities than they are for those with no disabilities. Thus, the employment responses of changing occupations or employers among the disabled explain a significant portion of the wage gap between workers with and without disabilities.

We present these estimated effects with two important caveats in mind. First, workers with disabilities have faced many barriers to employment, promotions, and equal pay historically. The Americans with Disabilities Act, which (among other things) requires some firms to provide “reasonable accommodations” to these workers with the goal of minimizing job turnover, has been one attempt to erode these barriers. While our results suggest that reductions in occupation or employer transitions will reduce wage declines, we have not examined whether individuals experiencing disabilities are better or worse off (by welfare standards) with such employment changes despite the resulting reductions in wages. That is, an individual experiencing a disability may prefer working in a different environment with lower wages to maintaining the same job, because his new health state alters the utility of particular job demands. Second, our work provides estimates of the total impact of disability and employment histories on employment transitions and wages. It does not, however, allow us to separately identify income effects associated with income replacement programs such as SSI/SSDI from substitution effects associated with nonemployment or reduced employment, each of which may enable reemployment transitions. Data on SSDI/SSI application, approval, and acceptance have recently become available and are linked to the SIPP panel data. This addition may allow researchers to explicitly account for disability benefits as a determinant of reemployment by modeling these endogenous decisions jointly with employment outcomes.

## Appendix

TABLE A1  
COEFFICIENT ESTIMATES: EMPLOYMENT EQUATION FOR THE PREVIOUSLY EMPLOYED  
(Jointly Estimated with Disability, Wage, Attrition, and Initial Variables Equations)

Variable	Change Occupation	Change Employer	Change Both	Become Nonemployed
Any disability	.18 (.10)	.19 (.13)	.50 (.26)	.85 (.13)
Severe disability	.46 (.25)	-.77 (.41)	-.09 (.58)	2.25 (.17)
Enter the survey with any disability	-.14 (.18)	.41 (.21)	-.34 (.43)	.10 (.22)
For those who enter the survey with no disability:				
Length of current disability	-.31 (.20)	.16 (.22)	-2.68 (1.62)	.03 (.23)
Length of current disability squared	.11 (.08)	-.01 (.08)	2.00 (1.46)	-.04 (.09)
Length of current disability cubed/10	-.10 (.08)	-.02 (.08)	-3.81 (3.17)	.03 (.09)
For those who enter the survey with any disability:				
Length of disability	-.02 (.06)	.03 (.06)	-.14 (.17)	-.04 (.07)
Length of disability squared/10	.01 (.04)	-.08 (.04)	.10 (.13)	-.02 (.05)
Length of disability cubed/100	-.00 (.01)	.02 (.01)	-.02 (.03)	.01 (.01)
Severe disability × length of disability	.01 (.00)	.01 (.01)	.01 (.01)	.01 (.00)
Length of disability missing	-.07 (.16)	-.39 (.19)	.42 (.38)	-.27 (.19)
Occupation tenure	-.06 (.01)	-.09 (.01)	-.08 (.04)	.06 (.02)
Occupation tenure squared/100	.21 (.08)	.51 (.10)	.38 (.30)	-.42 (.14)
Occupation tenure cubed/1,000	-.03 (.02)	-.07 (.02)	-.04 (.06)	.09 (.03)
Occupation tenure × any disability	.00 (.01)	.01 (.01)	.01 (.02)	-.00 (.01)
Occupation tenure missing	-.26 (.05)	-.32 (.07)	-.64 (.18)	.16 (.09)
Employer tenure	-.41 (.01)	-.27 (.01)	-1.03 (.05)	-.85 (.03)
Employer tenure squared/100	2.87 (.10)	1.20 (.11)	6.78 (.52)	5.74 (.23)
Employer tenure cubed/1,000	-.55 (.02)	-.15 (.02)	-1.23 (.14)	-1.06 (.06)
Employer tenure × any disability	.02 (.01)	.00 (.01)	.00 (.03)	.02 (.01)
Age	.17 (.08)	.19 (.09)	-.22 (.29)	.18 (.17)
Age squared/100	-.48 (.19)	-.52 (.22)	.51 (.74)	-.53 (.40)
Age cubed/1,000	.04 (.02)	.04 (.02)	-.04 (.06)	.05 (.03)
Highest grade completed:				
Less than high school	-.13 (.04)	.10 (.05)	-.14 (.13)	.32 (.07)
Some college	.05 (.03)	-.01 (.04)	-.02 (.10)	-.17 (.06)
College	.06 (.03)	-.22 (.05)	-.39 (.13)	-.40 (.07)
More than college	-.13 (.05)	-.49 (.07)	-.79 (.20)	-.72 (.11)
Nonwhite race	-.01 (.03)	-.04 (.05)	-.19 (.12)	.54 (.06)
Not married	.07 (.03)	.17 (.04)	.55 (.09)	.56 (.06)
Number of children	-.00 (.01)	.00 (.02)	.05 (.04)	.06 (.02)
Nonearned income	.06 (.05)	.76 (.04)	.78 (.12)	1.25 (.05)
Nonmetropolitan residence	.01 (.03)	.07 (.04)	.22 (.10)	.16 (.06)
Region:				
Northeast	-.01 (.04)	-.04 (.05)	-.49 (.13)	-.02 (.07)
Midwest	.04 (.03)	-.04 (.04)	-.15 (.10)	-.06 (.07)
West	.14 (.03)	.11 (.04)	-.10 (.11)	.09 (.06)
Unionized with previous employer	-.29 (.04)	-.25 (.05)	-.30 (.15)	-.14 (.07)
Local unemployment rate	-.03 (.01)	.00 (.01)	.02 (.03)	.05 (.01)

Note.—Standard errors are in parentheses. The omitted category is remaining with the same occupation and employer. Month and year dummies are regressors but are not shown in the table. Table A5 displays estimates of permanent and time-varying unobserved heterogeneity.

TABLE A2  
 COEFFICIENT ESTIMATES: EMPLOYMENT EQUATION FOR THE PREVIOUSLY NONEMPLOYED  
 (Jointly Estimated with Disability, Wage, Attrition, and Initial Variables Equations)

Variable	Become Employed	
Any disability	.30	(.17)
Severe disability	-1.58	(.18)
Enter the survey with any disability	-.39	(.20)
For those who enter the survey with no disability:		
Length of current disability	-.99	(.44)
Length of current disability squared	.41	(.19)
Length of current disability cubed/10	-.38	(.20)
Severe disability $\times$ length of current disability	.03	(.05)
Severe disability $\times$ length of current disability squared	-.02	(.02)
Severe disability $\times$ length of current disability cubed/10	.02	(.02)
For those who entered the survey with any disability:		
Length of disability	-.18	(.06)
Length of disability squared/10	.12	(.04)
Length of disability cubed/100	-.02	(.01)
Severe disability $\times$ length of disability	-.00	(.00)
Length of disability missing	.16	(.17)
Length of nonemployment spell	-.32	(.02)
Age	-.29	(.19)
Age squared/100	.83	(.47)
Age cubed/1,000	-.08	(.04)
Highest grade completed:		
Less than high school	-.11	(.08)
Some college	.08	(.07)
College	.09	(.10)
More than college	.46	(.13)
Nonwhite race	-.36	(.07)
Not married	-.13	(.07)
Number of children	.02	(.03)
Nonearned income	-.58	(.08)
Nonmetropolitan residence	-.01	(.07)
Region:		
Northeast	.26	(.08)
Midwest	.28	(.08)
West	.31	(.08)
Local unemployment rate	-.02	(.02)

Note.—Standard errors in are parentheses. Month and year dummies are regressors but are not shown in the table. Table A5 displays estimates of permanent and time-varying unobserved heterogeneity.

TABLE A3  
 COEFFICIENT ESTIMATES: END-OF-PERIOD DISABILITY EQUATION  
 (Jointly Estimated with Employment, Wage, Attrition, and Initial Variables Equations)

Variable	Moderate Disability	Severe Disability
Any disability	3.36 (.07)	2.07 (.14)
Severe disability	-.69 (.12)	1.85 (.14)
Enter the survey with any disability	.36 (.11)	1.35 (.15)
For those who enter the survey with no disability:		
Length of current disability	1.04 (.12)	1.24 (.27)
Length of current disability squared	-.19 (.05)	-.20 (.11)



TABLE A3 (Continued)

Variable	Moderate Disability	Severe Disability
Length of current disability cubed/10	.12 (.05)	.12 (.10)
Severe disability $\times$ length of current disability	-.08 (.03)	-.07 (.03)
Severe disability $\times$ length of current disability squared	.02 (.01)	.02 (.01)
Severe disability $\times$ length of current disability cubed/10	-.01 (.01)	-.01 (.01)
For those who entered the survey with any disability:		
Length of disability	.36 (.04)	.33 (.04)
Length of disability/10	-.19 (.03)	-.18 (.03)
Length of disability/100	.03 (.00)	.03 (.01)
Severe disability $\times$ length of disability	-.00 (.00)	-.00 (.00)
Length of disability missing	-.53 (.09)	-.43 (.13)
Occupation tenure	-.00 (.00)	-.00 (.01)
Employer tenure	.00 (.00)	-.11 (.02)
Age	.20 (.12)	-.44 (.23)
Age squared/100	-.34 (.29)	1.38 (.54)
Age cubed/1,000	.02 (.02)	-.12 (.04)
Highest grade completed:		
Less than high school	.13 (.06)	.34 (.08)
Some college	-.08 (.04)	-.35 (.08)
College	-.47 (.07)	-1.21 (.13)
More than college	-.59 (.09)	-1.63 (.20)
Nonwhite race	-.06 (.05)	-.01 (.08)
Not married	.15 (.04)	.28 (.07)
Number of children	-.06 (.02)	-.04 (.03)
Nonearned income	.48 (.04)	.51 (.05)
Nonmetropolitan residence	.09 (.04)	-.00 (.08)
Region:		
Northeast	-.11 (.05)	-.09 (.09)
Midwest	-.09 (.05)	-.03 (.08)
West	.00 (.05)	-.10 (.08)
Health insurance	-.28 (.05)	-.41 (.07)
Nonemployed	-1.15 (.15)	4.36 (.40)
Hours worked	-.05 (.01)	.05 (.02)
Hours worked squared/100	.03 (.01)	-.08 (.02)
Small employer (<25 employees)	-.07 (.05)	-.25 (.18)
Small employer $\times$ any disability	.01 (.09)	.25 (.22)
Medium employer (25–99 employees)	-.17 (.06)	-.18 (.20)
Medium employer $\times$ any disability	.07 (.10)	-.57 (.30)
Employer size missing	-.01 (.30)	.87 (.40)
Occupation category 1	.21 (.10)	.29 (.37)
Occupation category 2	.18 (.08)	-.22 (.28)
Occupation category 3	.41 (.09)	.28 (.29)
Occupation category 4	.13 (.08)	.25 (.24)
Occupation category 5	.11 (.08)	.03 (.25)
Occupation category 6	.27 (.10)	.11 (.36)
Occupation category 7	.25 (.09)	-.45 (.31)
Occupation category 8	.41 (.07)	.19 (.23)

Note.—Standard errors are in parentheses. The omitted category is nondisabled. Month and year dummies are regressors but are not shown in the table. Table A5 displays estimates of permanent and time-varying unobserved heterogeneity.

TABLE A4  
 COEFFICIENT ESTIMATES: LOG WAGE EQUATION  
 (Jointly Estimated with Employment, Disability, Attrition,  
 and Initial Variables Equations)

Variable	Log Wage
Any disability	-.02 (.01)
Severe disability	-.21 (.03)
Enter the survey with any disability	.01 (.02)
For those who enter the survey with no disability:	
Length of current disability	-.04 (.01)
Length of current disability squared	.01 (.00)
Severe disability × length of current disability	.02 (.00)
Severe disability × length of current disability squared	-.00 (.00)
For those who enter the survey with any disability:	
Length of disability	-.02 (.01)
Length of disability squared/10	.01 (.01)
Length of disability cubed/100	-.00 (.00)
Severe disability × length of disability	.00 (.00)
Length of disability missing	.02 (.02)
Employed	.03 (.01)
Occupation tenure	.00 (.00)
Occupation tenure squared/100	-.00 (.00)
Occupation tenure × any disability	-.00 (.00)
Employer tenure	.01 (.00)
Employer tenure squared/100	-.03 (.00)
Employer tenure × any disability	-.00 (.00)
Age	.12 (.02)
Age squared/100	-.22 (.04)
Age cubed/1,000	.01 (.00)
Highest grade completed:	
Less than high school	-.19 (.01)
Some college	.10 (.01)
College	.32 (.01)
More than college	.46 (.01)
Nonwhite race	-.13 (.01)
Not married	-.09 (.01)
Number of children	.01 (.00)
Nonmetropolitan residence	-.11 (.01)
Region:	
Northeast	.11 (.01)
Midwest	.02 (.01)
West	.09 (.01)
Local unemployment rate	-.00 (.00)
Hours worked	-.02 (.00)
Hours worked squared/100	.03 (.00)
Hours worked cubed/1,000	-.00 (.00)
Small employer (<25 employees)	-.07 (.00)
Small employer × any disability	-.03 (.02)
Medium employer (25–99 employees)	-.03 (.00)
Medium employer × any disability	-.05 (.02)
Employer size missing	-.16 (.03)
Occupation category 1	-.17 (.01)
Occupation category 2	-.08 (.01)
Occupation category 3	-.20 (.01)
Occupation category 4	-.32 (.01)
Occupation category 5	-.09 (.01)
Occupation category 6	-.11 (.01)
Occupation category 7	-.21 (.01)
Occupation category 8	-.20 (.01)

Note.—Standard errors are in parentheses. Month and year dummies are regressors but are not shown in the table. Table A5 displays estimates of permanent and time-varying unobserved heterogeneity.

TABLE A5  
UNOBSERVED HETEROGENEITY PARAMETERS

Points of Support	Probability Weight	Employment (if $E_{t-1} = 1$ )				Disability			
		Change Occupation	Change Employer	Change Both	Become Nonemployed	Employment (if $E_{t-1} = 0$ )	Log Wages	Moderate	Severe
Permanent	$\rho_k$	$\mu_{ok}^E$	$\mu_{ok}^E$	$\mu_{ok}^E$	$\mu_{ok}^E$	$\mu_{ok}^E$	$\mu_{ok}^W$	$\mu_{ok}^D$	$\mu_{ok}^D$
1	.10	.00 (.07)	.00 (.23)	.00 (.05)	.00 (.11)	.00 (.14)	.00 (.01)	.00 (.08)	.00 (.15)
2	.18	-.55 (.07)	-.88 (.23)	-.33 (.05)	-.92 (.11)	.74 (.14)	1.32 (.01)	-.30 (.08)	.38 (.15)
3	.44	-.28 (.06)	-.21 (.15)	-.13 (.04)	-.65 (.08)	1.08 (.09)	.90 (.01)	-.44 (.07)	.94 (.10)
4	.28	-.00 (.06)	.30 (.15)	.09 (.04)	-.40 (.08)	1.07 (.11)	.51 (.01)	.02 (.06)	.53 (.11)
Time-varying	$\psi_\ell$	$\nu_{ok}^E$	$\nu_{ok}^E$	$\nu_{ok}^E$	$\nu_{ok}^E$	$\nu_{ok}^E$	$\nu_{ok}^W$	$\nu_{ok}^D$	$\nu_{ok}^D$
1	.98	.00	.00	.00	.00	.00	.00	.00	.00
2	.02	2.22 (.09)	.99 (.32)	.41 (.09)	-30.8 (9.23)	2.13 (.23)	1.56 (.01)	-.57 (.19)	3.90 (.18)

Note.—Standard errors are in parentheses. The first mass points are normalized to one for each type of heterogeneity. Unobserved heterogeneity also enters the attrition and initial condition equations; results are available from the authors.

TABLE A6  
 BENEFIT RECEIPT AND AMOUNTS ENTERING PERIOD  $t$  FOR THOSE NONEMPLOYED IN  $t - 1$ ,  
 BY DISABILITY SEVERITY ENTERING PERIOD  $t$

Characteristic	No Disability	Moderate Disability	Severe Disability
Person-period observations	125,258	5,638	9,186
Nonemployed at $t - 1$	6,232	589	8,859
Percentage	4.97	10.44	96.44
Percentage who remain nonemployed at $t$	74.29	76.74	96.72
Benefits if nonemployed: <sup>a</sup>			
Federal SSDI/SSI	2.65 (\$604)	19.69 (\$570)	68.61 (\$671)
State unemployment	5.74 (\$806)	6.28 (\$677)	.34 (\$644)
Worker's compensation	.22 (\$880)	6.45 (\$1,562)	6.13 (\$1,193)
Welfare (AFDC)	1.08 (\$550)	1.87 (\$310)	1.96 (\$336)
Food stamps	5.07 (\$200)	13.92 (\$140)	18.68 (\$99)

Note.—The number of observations (140,082) represents all (triennial) person-period transitions.

<sup>a</sup> Percentage who receive benefits; mean monthly amounts conditional on receipt are in parentheses.

## References

- Anderson, Kathryn, and Richard Burkhauser. 1985. "The Retirement-Health Nexus: A New Measure of an Old Puzzle." *J. Human Resources* 20 (3): 315–30.
- Arellano, Manuel, and Stephen Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Rev. Econ. Studies* 58 (2): 277–97.
- Autor, David, and Mark Duggan. 2003. "The Rise in the Disability Rolls and the Decline in Unemployment." *Q.J.E.* 118 (1): 157–206.
- . 2007. "Distinguishing Income from Substitution Effects in Disability Insurance." *A.E.R. Papers and Proc.* 97 (2): 119–24.
- Baldwin, Marjorie, and William Johnson. 1994. "Labor Market Discrimination against Men with Disabilities." *J. Human Resources* 29 (1): 1–19.
- . 2000. "Labor Market Discrimination against Men in the Year of the ADA." *Southern Econ. J.* 66 (1): 548–66.
- Baldwin, Marjorie, and Edward Schumacher. 2002. "A Note on Job Mobility among Workers with Disabilities." *Indus. Relations* 41 (3): 430–41.
- Bazzoli, Gloria. 1985. "The Early Retirement Decision: New Empirical Evidence on the Influence of Health." *J. Human Resources* 20 (2): 214–34.
- Benitez-Silva, Hugo. 2009. "Disability, Social Insurance, and Labor Force Attachment." In *Essays on Economics, Disability, and Employment* [Ensayos sobre economía, discapacidad, y empleo], edited by Pablo Alonso González. Madrid: Delta.
- Benitez-Silva, Hugo, Moshe Buchinsky, Hiu Man Chan, Sofia Cheidvasser, and John Rust. 2004. "How Large Is the Bias in Self-Reported Disability?" *J. Appl. Econometrics* 19 (6): 649–70.
- Benitez-Silva, Hugo, Moshe Buchinsky, and John Rust. 2008. "How Large Are the Classification Errors in the Social Security Disability Award Process?" Working paper, State Univ. New York, Stony Brook.
- . 2010. "Induced Entry Effects of a \$1 for \$2 Offset in SSDI Benefits." Working paper, State Univ. New York, Stony Brook.
- Blau, David. 1994. "Labor Force Dynamics of Older Men." *Econometrica* 62 (1): 117–56.

- Blau, David, and Donna Gilleskie. 2001. "The Effect of Health on Employment Transitions of Older Men." In *Worker Wellbeing in a Changing Labor Market*, Research in Labor Economics, vol. 20, edited by Solomon Polachek, 35–65. Amsterdam: Elsevier.
- Bound, John. 1991. "Self-Reported versus Objective Measures of Health in Retirement Models." *J. Human Resources* 26 (1): 106–38.
- Bound, John, Michael Schoenbaum, Todd Stinebrickner, and Timothy Waidmann. 1999. "The Dynamic Effects of Health on the Labor Force Transitions of Older Workers." *Labour Econ.* 6:179–202.
- Brault, Matthew W. 2012. "Americans with Disabilities: 2010." Current Population Reports, P70-131, US Census Bur., Washington, DC. <http://www.census.gov/prod/2012pubs/p70-131.pdf>.
- Burkhauser, Richard V., Mary C. Daly, Andrew J. Houtenville, and Nigar Nargis. 2002. "Self-Reported Work-Limitation Data: What They Can and Cannot Tell Us." *Demography* 39 (3): 541–55.
- Burkhauser, Richard V., Andrew J. Houtenville, and Jennifer Tennant. 2012. "Capturing the Elusive Working-Age Population with Disabilities: Reconciling Conflicting Social Success Estimates from the Current Population Survey and American Community Survey." *J. Disability Policy Studies* 20 (10): 1–11.
- Campolieti, Michele. 2009. "Worker Adaptation and the Desire for Accommodations after the Onset of a Disability." *Indus. Relations* 48 (2): 329–49.
- Campolieti, Michele, and Harry Krashinsky. 2006. "Disabled Workers and Wage Losses: Some Evidence from Workers with Occupational Injuries." *Indus. and Labor Relations Rev.* 60 (1): 120–38.
- Charles, Kerwin K. 2003. "The Longitudinal Structure of Earnings Losses among Work-Limited Disabled Workers." *J. Human Resources* 38 (3): 618–46.
- Chen, Susan, and Wilbert van der Klaauw. 2008. "The Work Disincentive Effects of the Disability Insurance Program in the 1990s." *J. Econometrics* 142 (2): 757–84.
- Daly, Mary, and John Bound. 1996. "Worker Adaptation and Employer Accommodation Following the Onset of a Health Impairment." *J. Gerontology* 51B (2): S53–S60.
- DeLeire, Thomas. 2001. "Changes in Wage Discrimination against People with Disabilities: 1984–1993." *J. Human Resources* 36 (1): 144–58.
- Drake, Robert, Jonathan Skinner, Gary Bond, and Howard Goldman. 2010. "Social Security and Mental Illness: Reducing Disability with Supported Employment." *Health Affairs* 28 (3): 761–70.
- Dwyer, Debra, and Olivia Mitchell. 1999. "Health Problems as Determinants of Retirement: Are Self-Rated Measures Endogenous?" *J. Health Econ.* 18 (2): 173–93.
- French, Eric, and Jae Song. 2014. "The Effect of Disability Insurance Receipt on Labor Supply." *American Econ. J.: Policy* 6 (2): 291–337.
- Gruber, Jonathan, and Jeffrey Kubik. 1997. "Disability Insurance Rejection Rates and the Labor Supply of Older Workers." *J. Public Econ.* 64 (1): 1–23.
- Guilkey, David, and Peter Lance. 2014. "Program Impact Estimation with Binary Outcome Variables: Monte Carlo Results for Alternative Estimators and Empirical Examples." In *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications*, edited by Robin C. Sickles and William C. Horrace, 5–46. New York: Springer.
- Harris, Matthew C. 2014. "What Is the Full Cost of Body Mass in the Workplace? A Dynamic Stochastic Model of Occupational Choice, Hours Worked, and Body Mass over the Life Cycle." Working paper, Univ. Tennessee.
- Heckman, James, and Burton Singer. 1984. "A Method for Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data." *Econometrica* 52 (2): 271–320.
- Kambourov, Gueorgui, and Iourii Manovskii. 2009. "Occupational Specificity of Human Capital." *Internat. Econ. Rev.* 50:63–115.

- Kerkhofs, Marcel, and Maarten Lindeboom. 1995. "Subjective Health Measures and State Dependent Reporting Errors." *Health Econ.* 4 (3): 221–35.
- Kim, Seonghoon. 2013. "The Labor Supply and Welfare Effects of Early Access to Medicare through Social Security Disability Insurance." Working paper, Singapore Management Univ.
- Kreider, Brent. 1999. "Latent Work Disability and Reporting Bias." *J. Human Resources* 34 (4): 734–69.
- Kreider, Brent, and John Pepper. 2007. "Disability and Employment: Reevaluating the Evidence in Light of Reporting Errors." *J. American Statist. Assoc.* 102 (478): 432–41.
- . 2008. "Inferring Disability Status from Corrupt Data." *J. Appl. Econometrics* 23 (3): 329–49.
- Lakdawalla, Darius, Jayanta Bhattacharya, and Dana Goldman. 2004. "Are the Young Becoming More Disabled?" *Health Affairs* 23 (1): 168–76.
- Livermore, Gina, David C. Stapleton, and Meghan O'Toole. 2011. "Health Care Costs Are a Key Driver of Growth in Federal and State Assistance to Working-Age People with Disabilities." *Health Affairs* 30 (9): 1664–72.
- Low, Hamish, Costas Meghir, and Luigi Pistaferri. 2010. "Wage Risk and Employment Risk over the Life Cycle." *A.E.R.* 100 (4): 1432–67.
- Maestas, Nicole, Kathleen Mullen, and Alexander Strand. 2013. "Does Disability Insurance Receipt Discourage Work? Using Examiner Assignment to Estimate Causal Effects of SSDI Receipt." *A.E.R.* 103 (5): 1797–1829.
- Martin, Linda G., Vicki A. Freedman, Robert F. Schoeni, and Patricia M. Andreski. 2012. "Trends in Disability and Related Chronic Conditions among People Ages Fifty to Sixty-Four." *Health Affairs* 29 (4): 725–31.
- Meyer, Bruce, and Wallace Mok. 2013. "Disability, Earnings, Income and Consumption." Working Paper no. 18869, NBER, Cambridge, MA.
- Mok, Wallace, Bruce Meyer, Kerwin Charles, and Alexandra Achen. 2008. "A Note on 'The Longitudinal Structure of Earnings Losses among Work-Limited Disabled Workers.'" *J. Human Resources* 43 (3): 721–28.
- Moore, Timothy J. 2013. "The Employment Effects of Terminating Disability Benefits: Insights from Removing Drug Addictions as Disabling Conditions." Working paper, George Washington Univ.
- Mroz, Thomas. 1999. "Discrete Factor Approximations in Simultaneous Equation Models: Estimating the Impact of a Dummy Endogenous Variable on a Continuous Outcome." *J. Econometrics* 92 (2): 233–74.
- Pelkowski, Jodi, and Mark Berger. 2003. "The Onset of Health Problems and the Propensity of Workers to Change Employers and Occupations." *Growth and Change* 34 (3): 276–98.
- Stern, Steven. 1989. "Measuring the Effect of Disability on Labor Force Participation." *J. Human Resources* 24 (3): 361–95.
- Sullivan, Paul. 2010. "A Dynamic Analysis of Educational Attainment, Occupational Choices, and Job Search." *Internat. Econ. Rev.* 51:289–317.