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Work-Related Injuries and Incentives, Adequacy, and Optimality in Workers' Compensation

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Erin Todd Bronchetti

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ABSTRACT

Work-Related Injuries and Incentives, Adequacy, and Optimality in Workers' Compensation

Erin Todd Bronchetti

The three empirical analyses in this dissertation study the effects of workers' compensation benefits on individual behavior and household consumption as well as the impacts of workplace injuries and illnesses on economic outcomes for affected workers.

In Chapter 2, I study incentive effects of state workers' compensation programs, exploiting substantial cross-state variation in the generosity of workers' compensation benefits to estimate the relationship between benefit levels and the frequency of claims. Using a large data set of 25 matched March Current Population Surveys (CPS), my estimates of the reduced-form relationship between claims and benefits are appreciably smaller than those obtained by existing studies using similar methods. In addition, I find that controlling carefully for the influence of wages on claim propensities causes the estimated benefit elasticity to shrink dramatically, so that a 10 percent increase in benefits is associated with less than a 1 percent increase in claims.

Chapter 3 evaluates the extent of consumption-smoothing provided by workers' compensation benefits when a worker is injured at work. I find a significant consumption-smoothing effect of workers' compensation: A 10 percent increase in benefit levels is found to offset the drop in household consumption upon injury by 2.5 to 4 percent. I also present a model that provides an explicit formula for optimal benefits. My calculations indicate that current benefit levels are higher than optimal: That is, the consumption-smoothing benefits of workers' compensation benefits are modestly outweighed by their distortionary effects on labor supply.

Finally, Chapter 4 explores the impacts of work-related injuries and illnesses on labor market outcomes for older workers nearing retirement. I find that a workplace injury is associated with significant and persistent declines in earnings and labor supply for these workers. Incurring a work-related injury is found to substantially increase the probability of labor force exit and retirement in the year of injury onset. Results from fixed-effects regressions also indicate both short- and long-term declines in annual hours worked and earnings for workers with late-career injuries. Finally, I document evidence that the negative impacts of workplace injuries are larger, the more severely the injury impairs daily functioning.

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CHAPTER 1

Introduction and Background

1.1. Introduction

The three papers in this dissertation study the economic impacts of work-related injuries and illnesses and the effects of state workers' compensation programs on individual behavior and household material well-being. Workers' compensation benefits, which are the main form of indemnity for workers injured or becoming ill on the job, are legislated at the state level and vary significantly across states and over time. In the first two chapters, I exploit this cross-state variation to study the effects of changes in workers' compensation generosity on individual labor supply behavior and on the ability of households to smooth consumption when a worker becomes injured (or ill) on the job. The empirical estimates presented in these two chapters are important policy parameters, as they represent potential costs and benefits of changes in program generosity. Chapter 4, on the other hand, seeks to understand the effects of work-related injuries and illnesses on the earnings and labor supply of older workers.

Increases in the generosity of workers' compensation benefits can have sizeable distortionary effects on individual behavior. Chapter 2 analyzes the effect of variation in benefit levels on the frequency of claims for workers' compensation, using an extremely large micro-level data set compiled from twenty-five years of matched March Current Population Survey (CPS) files. My findings are two-fold: First, under an empirical framework similar to that used in previous studies, my initial estimates of the elasticity of claims with respect to benefits are in the range of 0.2 to 0.4, suggesting that a 10 percent increase in benefits would induce an increase in claims numbers of 2 to 4 percent. These results support the conclusion that increased benefit generosity results in greater participation in the programs. However, my estimates of the benefit-claims elasticity are appreciably smaller in magnitude than widely cited estimates from similar studies using individual-level data to estimate incentive effects in workers' compensation.

Furthermore, when I extend the methodology used by previous studies to flexibly control for the influence of past earnings on the likelihood of a workers' compensation claim, I find that the elasticity of participation with respect to benefits shrinks dramatically and is no longer statistically significant. Because the workers' compensation benefit to which an individual is entitled is a direct function of his previous earnings, it is important that researchers condition carefully on previous earnings in order to accurately estimate the relationship between benefits and program participation. This problem has not been accounted for in the existing literature. My findings represent an important contribution to the literature, as they suggest that changes in legislated benefits have very little effect on claims rates once one controls for differences in workers' compensation claiming propensities across individuals with different earnings.

Chapter 3 investigates the consumption-smoothing benefits of state workers' compensation programs. The first question is positive: To what extent do the programs help households to mitigate potential consumption losses when a worker becomes injured (or ill) on the job? Using data from the Health and Retirement Study (HRS) on household consumption expenditures for a sample of workers who have experienced a work-related, work-limiting disability, my principal findings indicate a significant consumption-smoothing effect of workers' compensation benefits. Specifically, I find that a 10 percent increase in workers' compensation benefit generosity offsets the drop in consumption upon experiencing a workplace injury by 2.5 to 4 percent. Moreover, my estimates imply that if benefits were very low, the drop in household consumption upon injury would be in the range of 20 to 30 percent.

The second question is more normative in nature: Given reasonable levels of risk aversion, what benefit level balances the trade-off between the consumption-smoothing gains from increased workers' compensation generosity and the costs due to distortionary effects on individual labor supply behavior? I present a model from the public finance literature for optimal social insurance, which is adapted for an environment in which workers face risk of work-related injury. The adapted model provides an explicit formula for the optimal level of workers' compensation benefits, which depends on my empirical estimates of the consumption-smoothing parameter. My calculations indicate that current benefits for work-related injuries and illnesses are higher than optimal. The chapter concludes by considering several possible explanations for this finding as well as the policy implications of my results.

In Chapter 4 , I turn my focus to estimating the short- and long-term impacts of work-related injuries and illnesses on labor market outcomes for workers nearing retirement age, using a seven-wave panel of individuals ages 45 to 69 from the Health and Retirement Study (HRS). This study provides the first evidence on the effects of workplace injuries on earnings and labor supply for a nationally representative sample of older workers. The findings suggest that work injuries and illnesses are associated with significant losses in the earnings and employment of affected workers both immediately after an injury is incurred and for several years following.

Under two different empirical approaches, I observe a marked decline in the number of hours worked when a worker becomes injured on the job; furthermore, estimates from individual-level fixed effects models indicate that working hours never recover to their pre-injury levels in the eight years after an injury is incurred. The estimated effects of workplace injuries on earnings are somewhat less consistent: While workplace injuries in all severity groups are associated with large drops in earnings by the second year after injury onset, I find some evidence that annual earnings recover significantly for workers with mildly or moderately disabling injuries. In contrast, those with the most severe injuries experience increasingly large declines in earnings in the years after the injury occurs. Additionally, workplace injuries have immediate impacts on extensive labor supply for these workers: I find that incurring a work-related injury increases the probability of labor force exit in the year of onset by about 25 percent and the probability of complete retirement upon injury by almost 10 percent. Finally, irrespective of the outcome of interest, economic losses are found to be substantially larger for workers whose injuries are associated with greater impairments to daily functioning.

1.2. Background on Workers' Compensation Programs in the United States

State workers' compensation, which comprise the oldest and one of the largest forms of social insurance in the United States, provide cash benefits and coverage of medical costs to American workers who are injured or become ill on the job.[1] Coverage extends to almost 94 percent of the American wage and salaried workforce, and unlike most social insurance programs in the U.S., a worker becomes eligible to receive workers' compensation as soon as he enters covered employment. Workers' compensation laws require that firms obtain insurance (or self-insure) to provide a state-mandated amount of indemnity benefits, medical care, and rehabilitation services, when necessary, to injured workers. While researchers have paid somewhat less attention to workers' compensation than other social insurance programs in recent years, the importance of workers' compensation for both workers and employers cannot be denied. In the year 2003, 59.4 billion dollars were paid in workers' compensation benefits (including medical costs), and employer costs for workers' compensation amounted to 80.8 billion dollars (Sengupta, Reno and Burton, 2005).[2] As a source of support for disabled workers, workers' compensation is surpassed only by Social Security disability insurance and Medicare. Throughout the 1990s, workers' compensation was larger than unemployment insurance, Supplemental Security Income (SSI), AFDC/TANF, or food stamps in terms of expenditures (Green Book, 2000).

Workers' compensation is a "no-fault" insurance system in which firms accept liability regardless of who is at fault in return for that liability being limited to the benefits specified by state workers' compensation laws. Thus, workers' compensation makes firm costs of

[1]See Fishback and Kantor (1998) for more on the history of states adopting workers' compensation programs in the early 1990s.

[2]The $21.4 billion difference between total employer costs and total benefits paid out is comprised of administrative costs, attorney fees, and profits of carriers.

providing support for injured workers less uncertain than if injuries were compensated on a case-by-case basis through the civil justice system. The fact that worker injuries are covered by workers' compensation without regard to fault means that in order to receive benefits for a workplace injury or illness, employees do not have to prove that their employer was negligent, only that the impairment is "work-related." In exchange for the no-fault coverage, employees forgo their rights to sue employers in order to recover full economic losses or non-pecuniary losses when such injuries occur. Provision of coverage is mandatory for firms of all sizes in nearly every state.[3]

There is no federal involvement in the financing or administering of state workers' compensation programs. Each state specifies its own workers' compensation law, and there is substantial variation across states in the legislated parameters that determine benefits. However, these state programs share some standard features. First, workers' compensation covers all medical and rehabilitation costs of a work-related injury and provides cash benefits for four classifications of disability. Over 70 percent of all claims are for 'temporary total disability' (TTD) benefits, which are paid to individuals who are unable to work for a finite period of time. If an injury persists beyond the date at which maximum medical improvement has been achieved, it is reclassified as a permanent disability.[4]

[3]Workers' compensation insurance is mandatory in all states but New Jersey and Texas: In these states, employers opting out of the system forfeit protection from lawsuits and assume full liability for workplace injuries. The vast majority of firms in these states elect coverage under the workers' compensation system.

[4]In this case, if the worker remains totally disabled and unable to work, he becomes eligible for 'permanent total disability' (PTD) benefits, which are typically the same weekly amount as TTD benefits and can continue to be paid for life. On the other hand, if the injury is only partially disabling but is expected to persist indefinitely, the worker is eligible to receive 'permanent partial disability' (PPD) benefits, which are less generous than TTD or PTD benefits. For injuries listed in the workers' compensation statute (e.g., the loss of an arm), PPD benefits are paid according to a state-specific schedule linking a benefit amount to the given impairment. Determination of PPD benefits for non-scheduled impairments like

1.2.1. Workers' Compensation Indemnity Benefits for Injured Workers

Temporary total disability (TTD) benefits, which are the focus of the following chapters, are calculated similarly across all states. Specifically, an injured worker's weekly TTD benefit will equal a fraction (the replacement rate, typically 66.7 percent) of the worker's pre-injury gross weekly wage, subject to minimum and maximum benefit amounts that vary significantly across states.[5] Maximum payment amounts are adjusted, in some states, to reflect the worker's marital status and number of dependants. Furthermore, the maximum benefit level frequently binds: Nearly half of workers earn a wage high enough that their benefit would be limited by the maximum amount (Meyer, 2002).[6] Thus, for a large fraction of injured workers, the nominal replacement rate (i.e., the ratio of weekly TTD benefits to weekly pre-injury gross wages) will be less than two-thirds. However, a key feature of workers' compensation programs is that indemnity benefits are not subject to income or payroll taxation. Because legislated replacement rates are relatively high at two-thirds of the worker's previous average weekly wage, exemption of benefits from income taxation implies a much more generous after-tax replacement rate. In fact, after-tax replacement rates near or above one are not uncommon (see Meyer (2002) for examples).

Finally, each state also determines the length of a waiting period before cash payments can begin. These waiting periods range from 3 to 7 days and act as a 'deductible' that

back injuries is less consistent across states. Lastly, survivors' benefits are paid to families of workers who are killed on the job.

[5]The pre-injury weekly wage is calculated as the individual's average gross weekly wage over the 52-week period before the injury or illness occurred.

[6]Indeed, in the sample of workers from the March Current Population Surveys (CPS) used in Chapter 2, the maximum binds for 49 percent of the sample, and in Chapter 3, the maximum binds for 46 percent of the sample of injured workers from the Health and Retirement Study (HRS).

workers must pay before receiving indemnity benefits. Workers are later compensated for this time if their injury persists beyond the length of a retroactive period, usually a few weeks.

Table 1.1 illustrates the cross-state variation in benefit replacement rates, minima and maxima, wait periods and retroactive periods in 2004. In most states, the rate of wage replacement provided by workers' compensation benefits is two-thirds; however, in several states (e.g. Connecticut, Iowa, Maine, Michigan, Rhode Island, and Washington D.C.), replacement rates are higher because benefits are calculated as a percentage of "spendable", or after-tax, earnings. The most notable differences in benefit generosity across states are in the maximum weekly benefit amounts: For instance, while Iowa has a maximum weekly benefit of $1,133, in the same year, injured workers in Mississippi receive a maximum of $341 per week. As for minimum benefit amounts, six states had no minimum benefit level, but Pennsylvania's minimum weekly benefit was higher than Mississippi's maximum.[7] Lastly, the lengths of the waiting periods range from three to seven days, and the retroactive periods last from zero days to six weeks.

1.2.2. Workers' Compensation Insurance for Firms

Workers' compensation insurance is mandatory for firms in all but two states.[8] Under workers' compensation laws, firms must obtain insurance to cover all medical and rehabilitation expenses associated with a worker's injury or illness and to provide the indemnity benefits described above. In obtaining workers' compensation insurance, firms

[7] In many states, benefits are adjusted to equal a percentage (often 100%) of the worker's average pre-injury wage if the minimum benefit exceeds that amount.

[8] Although workers' compensation insurance is not compulsory in Texas and New Jersey, almost all employers in these states elect coverage in order to limit their liability in work-related accidents.

Table 1.1: Characteristics of State Workers' Compensation Programs, 2004

State	Replacement Rate (%)	Max. weekly benefit ($)	Min. weekly benefit ($)	Waiting period	Retroactive period
Alabama	66.67	587.00	156.00	3 days	21 days
Alaska	entry	832.00	110	3 days	28 days
Arizona	66.67	374.01	———	7 days	14 days
Arkansas	66.67	453.00	20.00	7 days	14 days
California	66.67	728.00	126.00	3 days	14 days
Colorado	66.67	658.84	———	3 days	14 days
Connecticut	75	911.00	182.20	3 days	7 days
Delaware	66.67	506.81	168.94	3 days	7 days
District of Columbia	80	1022.00	255.50	3 days	14 days
Florida	66.67	626.00	20.00	7 days	21 days
Georgia	66.67	425.00	42.50	7 days	21 days
Hawaii	66.67	596.00	149.00	3 days	none
Idaho	67	480.60	80.10	5 days	14 days
Illinois	66.67	1012.01	100.90	3 days	14 days
Indiana	66.67	588.00	75.00	7 days	21 days
Iowa	80	1133.00	135.90	3 days	14 days
Kansas	66.67	440.00	25.00	7 days	21 days
Kentucky	66.67	588.43	117.69	7 days	14 days
Louisiana	66.67	429.00	114.00	7 days	42 days
Maine	80	506.42	———	7 days	14 days
Maryland	66.67	740.00	50.00	3 days	14 days
Massachusetts	60	884.46	176.89	5 days	21 days
Michigan	80	671.00	———	7 days	14 days
Minnesota	66.67	750.00	130.00	3 days	10 days
Mississippi	66.67	341.11	25.00	5 days	14 days
Missouri	66.67	662.55	40.00	3 days	14 days
Montana	66.67	487.00	———	4 days	none
Nebraska	66.67	562.00	49.00	7 days	42 days
Nevada	66.67	633.08	———	5 days	5 days
New Hampshire	60	1038.00	207.60	3 days	14 days
New Jersey	70	650.00	173.00	7 days	7 days
New Mexico	66.67	549.37	36.00	7 days	28 days
New York	66.67	400.00	40.00	7 days	14 days
North Carolina	66.67	688.00	30.00	7 days	21 days
North Dakota	66.67	555.00	303.00	4 days	5 days
Ohio	72	662.00	202.67	7 days	14 days
Oklahoma	70	528.00	30.00	3 days	none
Oregon	66.67	884.58	50.00	3 days	14 days
Pennsylvania	66.67	690.00	383.32	7 days	14 days
Rhode Island	75	726.00	———	3 days	none
South Carolina	66.67	577.73	75.00	7 days	14 days
South Dakota	66.67	498.00	249.00	7 days	7 days
Tennessee	66.67	618.00	92.70	7 days	14 days
Texas	70	537.00	81.00	7 days	28 days
Utah	66.67	579.00	45.00	3 days	14 days
Vermont	66.67	887.00	296.00	3 days	7 days
Virginia	66.67	697.11	172.75	7 days	21 days
Washington	60	885.29	43.17	3 days	14 days
West Virginia	66.67	537.00	144.20	3 days	7 days
Wisconsin	66.67	687.00	———	3 days	7 days
Wyoming	66.67	563.43	———	3 days	8 days

Note: In Ohio, the replacement rate is 72% for the first 12 weeks of injury and 66.67% thereafter.

have essentially three options. A small number of very large firms are able to self-insure to cover their potential liabilities. In all other cases, firms must purchase insurance either from a private carrier or (in some states) from a state fund that competes with private carriers. In 2001, 54.8 percent of workers' compensation benefits were paid by private insurers, 22.9 percent were from self-insured employers, and 16.1 percent came from state funds (National Academy of Social Insurance, 2003).[9]

The insurance premiums paid by firms are calculated similarly across all states: At present, premiums in 34 states are set by the National Council of Compensation Insurance, and the remaining states follow the NCCI's procedures closely.[10] A firm's insurance premium begins with a manual rate, which is determined by placing the firm into one of about 600 industry-occupation classifications.[11] These manual rates reflect the average conditions in each occupational class and are multiplied by the firm's payroll to determine the manual premium. The smallest firms (85 percent of employers, accounting for only 15 percent of covered employment) pay simply the manual premium. If the manual premium exceeds a given amount, which it will for firms with larger payrolls, the firm's premium is experience-rated. In this case, the insurance premium is modified to take into account the firm's past losses due to workplace accidents or injuries. Specifically, an experience-rated premium is calculated as a weighted average of the firm's manual rate and its incurred loss rate, which is typically based on average losses incurred over the previous three years. The weight given to a firm's past losses is based directly on the dollar amount of its

[9]The remainder of workers' compensation benefits were paid under federal programs.

[10]More detailed information on the methods used by the NCCI to assign firms to industrial-occupational classifications and calculate premiums can be found at the NCCI's website: www.ncci.com/ncciweb.

[11]A firm can actually belong to more than one of the industry-occupational classifications. In this case, the manual premium is simply computed by multiplying the manual rates by the payroll for each industrial-occupational class.

expected losses this period. In practice, this weighting factor will be positively related to the number of employees in the firm, as the number of workers exposed to job hazards is a key determinant of the magnitude of dollar losses due to workplace injuries. In the very largest firms, workers' compensation premiums are almost perfectly experience-rated, essentially reflecting only the firms' past loss experiences.

Workers' compensation insurance can be extremely costly for employers. In 2003, employers' costs for workers' compensation amounted to 80.8 billion dollars, or $1.71 per $100 in wages of covered workers (Sengupta, Reno, and Burton, 2005). For firms that self-insure against workplace injuries and illnesses, employer costs include the costs of benefits paid out plus administrative costs. For those firms that purchase insurance from private carriers or state funds, total costs in a given calendar year consist of premiums paid that year plus any costs incurred under deductible provisions.

CHAPTER 2

Revisiting the Incentive Effects of Workers' Compensation: Do Higher Benefits Really Induce More Claims?

2.1. Introduction

Economists have long been concerned with labor supply incentives associated with social insurance programs that provide income support during periods of non-work. State workers' compensation programs are one of the largest and most controversial examples of this type of government-mandated insurance. Because the costs of program changes depend on the magnitudes of workers' and firms' behavioral responses, an understanding of these incentive effects in workers' compensation is crucial for policy-making.

This paper examines the determinants of workers' compensation receipt, focusing primarily on the relationship between the generosity of workers' compensation indemnity benefits and the overall frequency of participation in the program. As described in the previous chapter, workers' compensation benefit levels are legislated at the state level and vary widely across states and over time. I exploit this variation to identify the responsiveness of workers' compensation claims rates to changes in benefit generosity, using a large, nationally representative, micro-level data set compiled from twenty-five years of matched March Current Population Surveys (CPS).

Changes in workers' compensation benefits can impact the number of claims filed through several channels, as they alter the incentives of both workers and employers. At the employee level, variation in benefits may affect individuals' labor supply decisions in a few key ways. First, the presence of risk-bearing moral hazard implies that an increase in benefit generosity reduces the cost of an injury and may cause workers to devote less effort to safety or illness prevention in the workplace, resulting in a larger number of work-related injuries and illnesses. It is also possible that increases in workers' compensation benefits lead to more frequent fraudulent reporting of injuries or illnesses that do not exist or occurred outside of work, often referred to as claims-reporting moral hazard. On the other hand, when a worker *is* injured on the job and considers filing a claim for indemnity, more generous benefits are more likely to outweigh the costs of taking up workers' compensation, which include forgone labor income plus any transaction costs to filing a claim and any stigma or costly reputation effect of receiving workers' compensation. That is, increased program generosity may simply induce more marginal workers to file a claim for benefits, conditional on having incurred a work-related injury. Regardless of the dimension along which benefit variation affects worker behavior, the prediction of a positive relationship between benefits and claims rates is unambiguous.[1]

Increases in benefit generosity impact firm behavior as well. Employer responses to variation in benefits will depend on the extent to which changes in workers' compensation generosity alter a firm's benefits from spending on safety measures with the goal of reducing injury frequency and the degree to which firms are able to respond to changes

[1]Increased workers' compensation benefit generosity not only impacts the frequency of employees' injury claims, but may also cause workers to remain on the benefit rolls longer, conditional on having successfully filed a claim. I do not consider the effect of benefit variation on the duration of workers' compensation claims in this paper. See Meyer, Viscusi, and Durbin (1995), Butler and Worrall (1985), and Neuhauser and Raphael (2004) for studies of the relationship between workers' compensation benefit levels and the duration of claims.

in benefits. If firms can respond to changes in benefit levels by increasing or decreasing spending on additional training, monitoring, safety equipment, or changes to plant design, a firm should set the marginal cost of spending on safety equal to its expected marginal benefits. The marginal benefits of spending on safety may include lower future workers' compensation insurance costs for firms whose premiums are experience-rated (or lower benefit payouts, in the case of self-insured firms) and lower equilibrium wages due to compensating wage differentials for improved workplace safety.[2] Because higher workers' compensation benefits translate to higher costs for a firm with a given injury experience record, the prediction is that increased benefit generosity will cause employers to spend more on safety, thus reducing the number of injuries that occur in the workplace.[3] Empirically, the existing literature generally finds a positive relationship between benefits and the frequency of claims for workers' compensation, suggesting that the incentive effects of benefit variation on worker behavior outweigh those for firms.

The primary goal of the paper is to estimate the effect of variation in workers' compensation benefit generosity on the overall frequency of participation in the program. The empirical analysis does not attempt to disentangle the effects of benefit variation on worker and firm behavior. Rather, the underlying argument of the paper is that the

[2] For the very smallest firms, workers' compensation premiums are not linked to their accident loss experiences.

[3] On the other hand, Krueger (1990) demonstrates that, if firm investments in workplace safety typically "precede employment and are relatively permanent" (e.g. plant design), the firm's decision of how much to spend on safety can be thought of as a Stackelberg game in which the firm moves first and the employee chooses his level of safety second. In this case, with imperfect experience rating and without making assumptions about the functional relationship between effort devoted to safety, firm expenditures on safety and the probability of injury, the employer's response to variation in benefit generosity is ambiguous in sign.

reduced-form estimate of the elasticity of claims with respect to benefit levels is an important policy parameter for states determining whether to raise or lower benefits, since governments can legislate benefit levels but cannot directly control decisions about safety or benefit take-up.

My approach is most closely related to that of Krueger (1990), which uses data from matched March CPS files in the mid-1980s and finds the elasticity of the workers' compensation claims rate with respect to benefits to somewhat larger than indicated elsewhere in the literature, between 0.5 and 0.7. However, Krueger (1990) uses only two years of data from the March CPS supplements, during which time only about 290 individuals actually take up workers' compensation. Thus, whether the magnitude of the benefit elasticity remains as large when substantially more data are employed remains an important question. Furthermore, some of the results in Krueger's study warrant further investigation: The estimate for the effect of the marginal tax rate on the likelihood of participation in workers' compensation takes the unexpected sign, the results differ dramatically for men and women, and the estimated elasticity of participation with respect to wages varies widely across specifications.

To extend the upon previous work, I use twenty-five years of matched March CPS data, creating a very large nationally-representative sample of individual-level data with which to examine the responsiveness of workers' compensation claims rates to variation in benefit generosity. Marginal tax rates for individuals in my sample are simulated using the NBER's TAXSIM model in order to improve the precision of the estimated relationship between marginal tax rates and workers' compensation participation relative to previous studies, which have classified individuals into discrete tax brackets. I also consider the importance of part-time work status and union membership in determining the responsiveness of claims rates to workers' compensation benefit levels. Finally, I consider an expanded specification of the empirical model that controls more flexibly for the influence of past earnings on the probability of participation in workers' compensation. The results of this extension are dramatic and indicate that researchers must carefully account for both the direct and indirect influence of past wages in order to more precisely identify the effect of variation in benefit generosity on workers' compensation claims rates.

The findings are interesting and warrant further investigation: First, when I apply the approach used in Krueger (1990) to a much larger data set, my estimates of the elasticity of workers' compensation claims with respect to benefits are notably smaller than the widely-cited estimates from his study. My initial empirical results indicate a benefit elasticity in the range of 0.2 to 0.4, which is in line with estimates presented elsewhere in the literature in studies that use aggregated state or state-by-industry level data. However, when I depart from the empirical specification employed in Krueger's study and include a flexible spline in past wages to control more carefully for the influence of past earnings on the probability of a workers' compensation claim, my estimates of the benefit elasticity shrink dramatically. Under this expanded specification, my results suggest that a 10 percent increase in benefit levels would increase the number of claims for workers' compensation by less than 1 percent.

The chapter proceeds as follows: Section 2.2 briefly describes some of the existing empirical research on the relationship between workers' compensation generosity and the number of claims for benefits. Section 2.3 discusses the CPS data used in the paper, specifically focusing on the rotational design of the CPS that permits identification of *transitions* into workers' compensation receipt, and describes the key empirical methods. Section 2.4 presents the results obtained when I apply the approach in Krueger (1990) to this paper's much larger data set. Section 2.5 departs from the specification in Krueger's study and considers several alternative models. In Section 2.6, I compare my own results to those from the existing literature and offer conclusions and directions for future research.

2.2. Related Literature

As discussed in the previous section, increases in workers' compensation benefit generosity may impact both employee and employer behavior.[4] The relationship of interest in this paper is that between benefit levels and the overall frequency of claims for workers' compensation, which will be affected by the responsiveness of both injury rates and claims reporting behavior to benefit changes.[5]

2.2.1. Workers' Compensation Benefits and Injury Rates

The effect of variation in workers' compensation benefit levels on work-related injury rates incorporates incentives for both workers and firms and has been examined in

[4]More thorough reviews of the empirical literature examining various effects of workers' compensation benefit variation on worker behavior are provided by Fortin and Lanoie (1998) and Krueger and Meyer (2002).

[5]While the extent to which benefit variation impacts the duration of workers' compensation claims is not considered explicitly in this chapter, the topic has been studied in the research on workers' compensation incentive effects. Butler and Worrall (1985) and Meyer, Viscusi, and Durbin (1995) provide empirical estimates of the elasticity of claim duration with respect to benefits that range from approximately 0.2 to 0.4. Neuhauser and Raphael (2004) point out that these estimates of the duration-benefits elasticity may understate the effect of increased benefits on claims durations by failing to control for selection effects. Using difference-in-difference methods to study a major benefit increase in California and controlling for differential selection, they find larger positive effects of benefit increases on the duration of claims, with estimated elasticities in the range of 0.7 to 0.8.

a number of important studies. For workers, an increase in the generosity of workers' compensation benefits reduces the cost of incurring a work-related injury or illness, giving workers an incentive to devote less effort to safety at work. For a given level of employer-provided safety, this should result in a positive relationship between benefit levels and the frequency of injuries and illnesses occurring on the job. Chelius (1982), Ruser (1985, 1991), and Worrall and Butler (1988) are just a few of the empirical studies that find a positive impact of variation in workers' compensation benefits on the frequency of workplace injuries.

However, while higher benefits may reduce the effort workers devote to safety, more generous benefits have incentives that work in the opposite direction for employers. Higher benefit levels increase the costs associated with a firm's accident experience if workers' compensation premiums are experience-rated. Thus, taking the safety effort of its employees as given, a firm has more incentive to increase expenditures on safety when benefits rise. Firms' incentives also differ according to the degree to which their workers' compensation insurance premiums are experience-rated. Chelius and Smith (1983), Ruser (1985, 1991) all provide empirical evidence that the relationship between benefits and nonfatal injury rates is smaller in larger, more highly experience-rated firms, supporting the hypothesis that these firms have greater incentive to respond to changes in benefit levels.

In empirical studies of the relationship between workers' compensation benefits and the overall frequency of on-the-job injuries, it is difficult to disentangle the behavioral responses of firms and workers. On average, increases in workers' compensation benefits are empirically associated with increases in nonfatal injury rates, suggesting that the incentive effects of higher benefits on worker behavior outweigh those for firms.[6] On the other hand, Moore and Viscusi (1989) examine the relationship between workers' compensation benefit generosity and the frequency of work-related fatalities. They find that the number of job fatalities decreases with increases in workers' compensation benefits, which is not surprising given that for this particular type of claim, one would expect employer responses to benefit increases to outweigh those of employees.

Lastly, another approach to assessing firm and worker behavioral responses to benefit variation is to examine the relationship between the costs of workers' compensation insurance and the level of benefits. If benefit variation has no (or perfectly offsetting) incentive effects on the behavior of workers and firms, insurance costs should rise in direct proportion to benefits. Krueger and Burton (1990) study the relationship between benefits and workers' compensation costs and find that the cost-benefit elasticity, while greater than unity, is smaller than previous empirical estimates of the claims-benefit elasticity would suggest, implying that perhaps increases in workers' compensation benefits induce claims for minor and less costly impairments.

2.2.2. Workers' Compensation Benefits and Reporting Incentives

In addition to impacting the resources that firms and workers dedicate to safety in the workplace, changes in workers' compensation benefits may also affect claiming behavior. The degree of claims-reporting moral hazard present in workers' compensation has been an important avenue for research, but the evidence on fraudulent reporting in workers'

[6] See Chelius (1982), Butler and Worrall (1983), and Ruser (1985).

compensation is somewhat mixed. A well-known paper by Smith (1990) provides evidence of a "Monday effect" in workers' compensation: Relatively more injury claims occur on Mondays than other days of the week, and more "feasible to misreport" injuries like sprains and strains are reported on Mondays or on the first workday following a holiday weekend. Smith estimates that 8.3 percent of sprains and strains reported on Mondays are actually incurred outside of work. Card and McCall (1996) hypothesize that if the "Monday effect" is due to explicit fraud, we ought to observe that uninsured workers are disproportionately filing these Monday claims. However, while they do find support for the existence of a Monday effect, Card and McCall conclude that this effect is *not* due to fraudulent claim filing by uninsured workers. Ruser (1998) studies the extent to which increases in workers' compensation benefits encourage more reports of hard-to-diagnose injuries, like sprains and strains, relative to observable injuries like broken bones and lacerations. He finds a significant effect of increases in the benefit-wage ratio on the relative frequency of hard-to-verify injuries. Butler and Worrall (1991) were the first to develop a model to separate risk-bearing and claims-reporting moral hazard in workers' compensation for the United States; their empirical estimates indicate that increased benefits lead to more claims for workers' compensation but fewer actual injuries (suggesting that firm safety incentives outweigh the effects of risk-bearing moral hazard for workers).

Finally, more generous workers' compensation payments increase the benefits of filing a claim relative to the costs, conditional upon incurring a work-related injury of a given severity. Take-up behavior in workers' compensation has been studied in a few recent papers. Biddle and Roberts (2003) analyze administrative data on a sample of injured workers in Michigan and find that only about 40 percent of these workers ever file a claim for workers' compensation. Lakdawalla, Reville, and Seabury (2005) examine whether the presence of private health insurance can explain why so many injured workers do not file claims for workers' compensation. Using data from the National Longitudinal Survey of Youth (NLSY) on workers experiencing a work-related, work-limiting disability, they find a surprising result: Uninsured workers are actually *less* likely to file a claim than those with health insurance coverage. It appears from their study that employer characteristics, namely whether an employer offers health insurance to its workers, are important determinants of workers' compensation claiming behavior.

2.2.3. Workers' Compensation Benefits and the Overall Frequency of Claims

The studies most closely related to my analysis are those that estimate the relationship between workers' compensation benefit levels and the overall frequency of claims for workers' compensation indemnity. Table 2.1 summarizes the methodologies and results of some of the key papers that estimate the responsiveness of injury and claims rates to changes in workers' compensation benefits. The general consensus provided by this research is a finding of a positive elasticity between benefit generosity and claims rates that exceeds the literature's empirical estimates of the elasticity between benefits and injury rates. Most of the papers in this strand of the literature rely on aggregated data (often at the state-by-year level or state-by-industry level).

Of the few analyses that study the relationship between claims and benefits using disaggregated micro-level data, Krueger (1990) is well-known for being the first paper to analyze a data set that is nationally representative and contains individuals from many industries, occupations, and employers. Krueger (1990) employs two years of matched March CPS files for calendar years 1982/83 and 1983/84) to study the determinants of workers' compensation recipiency, controlling for worker characteristics and exploiting individual-level variation in benefits for identification. His results suggest claims-benefit elasticities that are substantially larger than those derived by researchers using aggregated data. His estimates of participation-benefit elasticities are in the range of 0.5 to 0.7, suggesting that a 10 percent increase in benefit levels would increase the number of workers' compensation claims by 5 to 7 percent. On the other hand, Krueger's study is limited to two years of data from the mid 1980s, and these results may be sensitive to the inclusion of additional data or to the specific years used in his analysis.[7] This paper revisits the question of the magnitude of the elasticity of claims with respect to benefits, applying a similar approach to a much larger data set from matched years of the March CPS.

Moreover, other questions remain in this strand of the literature. First, in Krueger (1990), the sign of the estimate for the marginal tax rate is negative, when theory would predict it to be positive (i.e., a higher marginal tax rate, other things equal, would increase the likelihood of a claim for workers' compensation benefits, which are untaxed). Additionally, previous research has only attempted to control for the influence of past wages on the likelihood of workers' compensation recipiency linearly. However, because both potential workers' compensation benefits and the probability of filing a workers' compensation

[7]Hirsch, Macpherson, and Dumond (1997) later used Krueger's approach to study the effect of union membership on the probability of workers' compensation recipiency, employing data from several additional years of matched March CPS samples. Although not the primary focus of the study, their estimates of the claims-benefit elasticities were significantly smaller than Krueger's, in the range of 0.2 to 0.3, which is in closer agreement to estimates provided by studies of aggregated data sets.

claim are functions of an individual's past earnings, it is important to more carefully condition upon past wages in order to identify the effects of benefits on the likelihood of workers' compensation participation. Finally, the estimated elasticities in Krueger (1990) differ in somewhat unexpected ways for men and women and across specifications, which suggests a need for further investigation.

2.3. Data and Estimation Methods

The data used in this paper to examine the determinants of workers' compensation benefit receipt come from several years of the March Annual Demographic Supplement to the Current Population Survey (CPS). Each year of the March CPS contains extensive information on the sources of income, demographic characteristics, and employment patterns of respondents, including detailed information on earnings and number of weeks worked in past years. The rotational design of the CPS is such that respondents are interviewed for four consecutive months, are "off" for eight months, and are interviewed again for four more months, so information is collected for each individual in the March CPS in two consecutive years. Thus, ignoring sample attrition and migration, up to half of the observations in a given year of the March CPS should be able to be matched to their previous year's record.[8]

Since the purpose of this paper is to estimate the effect of changes in benefit generosity on the probability of receiving workers' compensation, the two-year panel nature of the March CPS data is especially useful. Specifically, I examine the determinants of *transitions* into workers' compensation receipt, where the dependent variable is the probability

[8] The CPS does not follow households that move between one survey year and the next.

Table 2.1: Estimates of the Effect of Workers' Compensation Benefits on Claims and Injury Rates

Study	Data	Dependent Variable	Key Independent Variable(s)	Key Result
Butler (1994)	Repeated cross-section of 39 states from 1954 - 1984	Claims per worker in non-agricultural sectors	Wage replacement ratio based on state wage dist.	Benefit elasticity equal to 0.4
Butler and Worrall (1983)	State-by-year data; 35 states from 1972-78	Claims by nonself-insuring firms per 1000 workers	Expected benefits based on state-year average wages	Benefit elasticity equal to 0.352 (TTD)
Chelius (1982)	State-by-industry OSHA data for manuf. industries in 36 states	Lost workday injuries and illnesses per 100 workers	Wage replacement ratio based on industry average wages	Benefit elasticity equal to 0.14
Chelius and Kavanaugh (1988)	Maintenance staff at New Jersey community colleges	WC claims rate for claims lasting > 7 days	Dummy variable equal to 1 when WC benefits lowered	Benefit elasticity equal to 0.35
Hirsch et al. (1997)	Matched March CPS files for 1976/77 to 1991/92	0-1 variable for transition into receiving WC	Union membership, potential WC benefit (TTD)	Positive effect of union on claims; Ben. elas. of 0.2
Krueger (1990)	Matched March CPS files for 1982/83 and 1983/84	0-1 variable for transition into receiving WC	Potential WC benefit (TTD) entitlement in year t	Benefit elasticity equal to 0.74.
Ruser (1985)	25 manufacturing industries across 41 states in 1972-79	Injuries per 100 full-time workers	Average weekly real benefit paid for TTD	Benefit elasticity equal to 0.062
Ruser (1991)	2,788 establishments over period from 1979-1984	Lost workday injuries and illnesses per 100 workers	Average real weekly benefit for production workers ($\div$ 100)	Benefit elasticity from 0.2 to 0.8
Worrall and Butler (1988)	15 industries from 1940-1971 in South Carolina	Annual injuries per worker resulting in TTD	Expected WC benefit for average worker	Benefit elasticity equal to 0.16

of receiving workers' compensation in year t, and inclusion in the sample is conditional on not having received benefits in year $t-1$. Moreover, having detailed information on an individual's earnings and employment in the year prior to receipt of workers' compensation permits the estimation of participation elasticities with respect to both benefits and pre-injury wages.

I take advantage of the two-year panel design of the CPS, constructing a large micro-level data set by pooling together data on individuals from twenty-five years of matched March Current Population Surveys (CPS) for the survey years 1977/78 - 1984/85, 1986/87 - 1994/95, and 1996/97 - 2003/2004.[9] To match observations across years, I adapt from the methodology in Madrian and Lefgren (1999). Specifically, because the CPS data do not provide a unique individual identifier, matching an individual across years requires merging according to a household identifier, a "line number" within a household, and the number of people in a household. "False matches" are deleted when personal characteristics like gender, age, and race differ unrealistically for what otherwise appears to be the same individual, or when a respondent reports having lived in a different residence at the time of the previous year's interview (since the CPS does not follow households that move).[10] The resulting data set provides information on each individual for two consecutive years.

[9] Income from the previous calendar year is reported in the March surveys, so these survey years correspond to calendar years 1976/77 - 1983/84, 1985/86-1993/94, and 1995/96-2002/2003. Matching observations from the 1995 survey to the 1996 supplement is not possible due to revisions in the internal census household numbering scheme in 1995. Matching individuals from 1984-85 is not possible because of changes to geographic indicators during these years. See Data Appendix for additional detail.

[10] See the Data Appendix for further information on the merge criteria used to compile the sample in this paper and for naive and refined merge rates by year.

The final sample contains individuals ages $18-65$ who report having worked at least one week in year $t-1$ but did not receive workers' compensation benefits in that year. I limit the sample to those in non-public, non-self-employed jobs, and I eliminate railroad workers, agricultural workers, longshoremen, harbor worker, seamen, and domestic employees because they are likely to be covered by federal workers' compensation acts or not covered at all. I also exclude from the sample individuals who live in states in which benefits are calculated based on "spendable earnings" instead of pretax labor earnings. During the years of interest, these states included Alaska, Connecticut, Iowa, Maine, Michigan, Rhode Island, and Washington, D.C. The pooled sample contains 352,957 individuals, with two observations for each individual in the sample.

Next, the sample is matched to a database I have constructed that contains information on all state workers' compensation laws and benefit parameters for the years from 1977 to 2004.[11] For each individual in the sample, I calculate a potential weekly temporary total workers' compensation benefit for year t, based on his or her average gross weekly wage in year $t-1$, the replacement rate and the maximum and minimum benefit amounts in his state during year t. The potential benefit is also adjusted for number of dependants and marital status for individuals in states where such allowances apply. I use temporary total benefit schedules in each state to calculate the benefit variable because all workers' compensation claims are initially filed as temporary total cases and because these temporary total cases comprise more than 70 percent of workers' compensation cases in a given year (Krueger and Meyer, 2002).

[11]This information is compiled from consecutive issues of the U.S. Chamber of Commerce's *Analysis of Workers' Compensation Laws* (1977-2004).

The previous year's weekly wage is constructed by dividing the individual's annual wage and salary income (before deductions) in year $t-1$ by the number of weeks worked in that year. Using the previous year's weekly wage to calculate the potential benefits is important: First, states generally use the average pre-tax weekly wage during the 52-week pre-injury period to calculate benefits, and further, weeks worked and earnings in year $t-1$ would not have been affected by an injury that occurred in year t. Note that it is possible that an individual's weekly wage in year $t-1$ is correlated with whether he receives workers' compensation in year t if workers in riskier jobs receive compensating differentials in their wages. To the extent that detailed occupation and industry dummies do not control for such compensating differentials, this type of correlation may remain an issue in my estimation of the probit models in Section 2.4.

A key element of workers' compensation benefits when examining their incentive effects on labor supply behavior is that these indemnity payments are not subject to income taxation. Thus, the real benefit of receiving workers' compensation is also a function of the tax rate. Since 1991, the Census Bureau has included an estimated federal marginal tax rate in the March CPS, and the Census Bureau has retrospectively added simulated marginal tax rates for respondents in the 1980 - 1990 surveys. Ideally, if self-reported tax information were thought to accurately reflect individuals' perceptions of their own tax liability, one would prefer to use self-reported tax rates over simulated rates because the decision of interest is based on an individual's own expectation of his or her tax rate. However, the estimated marginal tax rates in the CPS do not appear to represent individual tax expectations realistically: The mean estimated tax rate for the post-1979 sample in this paper is 13.7, and nearly half of the workers in this sample report their estimated marginal tax rate to be zero. Moreover, there is no information on marginal tax rates for the earlier years in my sample, nor is there an estimate of the tax rates individuals face at the state level.

Therefore, in order to base estimation on a more precise tax variable, I employ TAXSIM, the NBER's Fortran program to simulate total (state and federal) marginal tax rates for individuals. Using the TAXSIM model to derive more accurate tax rates for the individuals in my sample should improve upon the estimation done in Krueger (1990), where marginal tax rates are computed based on a classification of individuals into four tax brackets as outlined in Feenberg and Rosen (1984), and on the study of Hirsch, Macpherson, and Dumond (1997), who do not explicitly consider the effect of marginal tax rates on workers' compensation participation. TAXSIM permits the calculation of a total marginal tax rate for every individual in my sample based on information about the individual's income, number of dependants, filing status, et cetera. Importantly, that the input variables (e.g. income measures, number of dependants, filing status) used in the computation of the marginal tax rates are values for $t-1$. Thus, the simulated marginal tax rates for recipients should not be confounded by workers' compensation benefit receipt or by reduced labor income due to injury or illness. However, I calculate the tax rates according to the state and federal laws for year t so that the simulated tax rate represents the tax rate that an individual would face on his wage income in year t. By dividing my sample accordingly, I also take advantage of the model's ability to compute marginal tax rates with respect to wage income of either a primary or secondary earner. According to the TAXSIM results, the mean marginal tax rate for the sample is 27.5.

Table 2.2 presents descriptive statistics for recipients versus non-recipients in my sample, where means are calculated by pooling the years of data. Approximately 1.27 percent of individuals in the sample take up workers' compensation during the year. The table indicates that those who receive workers' compensation differ from non-recipients both demographically and according to occupational characteristics. In my sample, recipients earn somewhat less per week in the year before receiving benefits than non-recipients but have an average weekly benefit entitlement slightly higher than that of non-recipients on average.[12] Workers' compensation claimants are more likely to be male, slightly older, and less educated than those who do not claim workers' compensation. Finally, as expected, we observe that workers' compensation recipients are more likely than non-participants to work in blue-collar jobs and in industries typically perceived as having a higher risk of injury, like manufacturing, transportation, or construction.

The two-year panel structure of the matched March CPS data sets provides a unique opportunity for examining the determinants of transitions into workers' compensation receipt. That is, having information on individuals in two consecutive years permits the identification of individuals who report receiving workers' compensation income in year t, but who did not report any workers' compensation income in year $t-1$. The central empirical methods involve estimation of probit models, in which the dependent variable equals 1 if an individual receives workers' compensation in t, conditional on not having received benefits in the previous calendar year.

This paper's primary goal is to estimate the impact of variation in workers' compensation benefit *generosity* on the probability of claiming workers' compensation. The

[12]Hereafter, all dollar amounts are translated into 2003 dollars using the CPI-U.

Table 2.2: CPS Sample Characteristics by Workers' Compensation Recipiency

Variable	Recipients		Non-recipients	
Weekly WC benefit ($2003)	399.95	(174.38)	382.65	(189.88)
Weekly wage ($2003)	653.12	(392.51)	666.32	(496.07)
Marginal tax rate	26.25	(10.72)	27.61	(11.00)
Waiting period (days)	5.18	(1.92)	5.37	(1.88)
Retroactive period (days)	14.87	(7.37)	15.31	(7.67)
Male	0.64	(0.48)	0.52	(0.49)
Age	39.22	(11.97)	38.56	(12.38)
Education (years)	12.01	(2.320)	12.93	(2.49)
White	0.88	(0.32)	0.87	(0.33)
Black	0.08	(0.27)	0.08	(0.27)
Hispanic and other	0.04	(0.19)	0.05	(0.21)
Single	0.31	(0.46)	0.34	(0.47)
Occupation				
Manager	0.052	(0.221)	0.124	(0.330)
Professional	0.097	(0.295)	0.187	(0.389)
Sales	0.067	(0.251)	0.120	(0.325)
Clerical	0.112	(0.314)	0.175	(0.380)
Service	0.105	(0.306)	0.111	(0.315)
Craft	0.230	(0.421)	0.132	(0.338)
Operative	0.179	(0.384)	0.097	(0.296)
Transport Operative	0.103	(0.304)	0.045	(0.207)
Laborer	0.079	(0.269)	0.052	(0.222)
Industry				
Mining	0.025	(0.156)	0.012	(0.109)
Construction	0.098	(0.297)	0.063	(0.242)
Manufacturing	0.346	(0.475)	0.249	(0.432)
Transportation and utilities	0.098	(0.297)	0.075	(0.263)
Wholesale and retail trade	0.206	(0.405)	0.239	(0.426)
Finance, insurance, and real estate	0.038	(0.192)	0.079	(0.270)
Service Industry	0.184	(0.388)	0.279	(0.448)
Number of Observations	4,470		348,487	

Note: Figures are unweighted sample means with standard deviations in parentheses. Recipients are workers who report receiving WC income in year t, conditional on not having received WC in the previous year.

key independent variable below, therefore, is the (log) potential worker's compensation benefit for which an individual is eligible.[13] The resulting reduced-form estimate of the elasticity of claim rates with respect to benefits represents the underlying behavior of both workers and firms in response to changes in legislated workers' compensation benefit levels. Without information on the resources and effort that firms and workers allocate to safety, it is impossible to disentangle what proportion of the relationship between benefits and claims is explained by employer responses to variation in benefit generosity versus incentive effects of benefit variation on employee behavior. On the other hand, the reduced-form estimate is arguably a very important policy parameter, given that policy makers can directly affect legislated benefit levels but cannot directly influence firm and worker safety behavior.[14] Knowledge of the overall responsiveness of claims numbers to variation in legislated benefits is crucial in terms of predicting changes in total program costs that may result from a proposed increase in benefit generosity.

Throughout, the probit model takes the following form:

$$(2.1) \quad P(wc_{ist} = 1) = \Phi(\beta_1 \ln(BEN_{ist}) + \beta_2 \ln(wage_{i,t-1}) + \beta_3 \ln(1 - tax_{ist}) + \beta_4 wait_{ist} + \beta_5 retro_{ist} + \delta X_{i,t,t-1} + \gamma_s + \tau_t)$$

where $P(wc_{ist} = 1)$ is the probability that individual i receives workers' compensation in year t (conditional on not having received workers' compensation in year $t-1$), Φ is the normal cumulative distribution function, BEN_{ist} is the (log) potential weekly workers'

[13]Recall that the benefit variable is calculated based on temporary total disability (TTD) benefit schedules in an individual's state and year.

[14]For more information on interpreting the "reduced-form" parameter, see, for example, Manski (1996) or Angrist, Imbens, and Rubin (1996)).

compensation benefit for which individual i is eligible, $wage_{i,t-1}$ is the worker's (log) average gross weekly wage in year $t-1$, and tax_{ist} is the total (state + federal) marginal tax rate an individual would pay in year t based on his $t-1$ income and filing characteristics. This flexible specification allows workers to respond differently to the components of the after-tax replacement rate (i.e., the weekly benefit entitlement, the marginal tax rate and the gross weekly wage).[15] The variables $wait_{ist}$ and $retro_{ist}$ are the lengths (in days) of the waiting and retroactive periods, respectively, in individual i's state and year. The vector $X_{i,t,t-1}$ contains characteristics of the worker in year t, including his age, educational attainment, race, and marital status, as well as dummy variables for his occupation and industry in $t-1$. Finally, γ_s is a set of state fixed effects, and τ_t is a set of year effects.[16]

2.4. Revisiting the Approach in Krueger (1990)

I begin with three specifications that mimic the approach in Krueger (1990), so that my initial results for the calendar years from 1976/77-2002/2003 can be directly compared to his for 1982/83-1983/84. The parsimonious model controls only for workers' compensation parameters and the individual's weekly wage, marginal tax rate and gender. The next model adds the set of demographic controls and detailed occupation and industry dummies described above. Identification in this model comes from variations in benefits across individuals in different states, from changes in state laws over the period from 1977 to 2004, from nonlinearities in the benefit formulas, and from individual benefit variation due to the number of dependants. The third model adds a set of 43 state dummies to control

[15] See Anderson and Meyer (1997) for further discussion of using this type of specification versus focusing on the replacement rate as the key benefit variable.
[16] All models include a full set of year dummies.

for unobserved state characteristics that are fixed over time and may be correlated with workers' compensation benefits, such as how the law is administered and how aggressively claims are monitored or investigated within a state. In this specification, identification of the relationship between benefits and claims depends only on changes in state laws over the years of interest, nonlinearities in the benefit formulas, and individual benefit variation within states.

Table 2.3 displays the results of probit estimation of the three models described above, for the sample of all workers as well as for the subsamples of male and female workers, separately. Qualitatively, my results are similar to those in Krueger (1990). The key coefficients indicate a statistically significant, positive relationship between the level of workers' compensation benefit generosity and the number of workers' compensation recipients. However, my estimates of the elasticity of workers' compensation participation with respect to benefits (shown in the bottom panel of the table) are appreciably smaller than those found by Krueger for the years 1982/83 and 1983/84. Specifically, my results for the sample of all workers indicate that a 10 percent increase in benefit levels is associated with about a 3 to 4 percent increase in the number of claims for benefits. The corresponding benefit elasticities estimated by Krueger (1990), which fall around 0.7, are nearly double mine in magnitude.[17]

[17] I am not able to replicate Krueger's results by restricting my sample to the two years used in that study. Doing so, I still find substantially smaller elasticities of claims with respect to benefits than he does, although they are slightly larger than those in Table 2.2. These results are available upon request. My conversations with Dr. Krueger have led us to believe that the difference in our results may come from the fact that we use somewhat different approaches to matching observations across years or from small differences in the way we calculate the potential benefit variable. However, since Krueger's paper was written nearly twenty years ago, we are unable to directly compare the statistical code used to calculate our empirical results.

Table 2.3: Determinants of Workers' Compensation Benefit Recipiency

Sample:	All workers			Male workers			Female workers		
Independent Variable	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Log weekly WC benefit	0.156	0.097	0.147	0.183	0.104	0.129	0.042	0.020	0.108
	(0.019)	(0.020)	(0.025)	(0.024)	(0.025)	(0.033)	(0.034)	(0.035)	(0.045)
Log weekly wage	-0.059	0.037	-0.004	-0.103	-0.011	-0.029	0.069	0.126	0.041
	(0.017)	(0.018)	(0.021)	(0.020)	(0.023)	(0.027)	(0.031)	(0.033)	(0.041)
Log (1-tax)	0.561	0.325	0.376	0.629	0.316	0.336	0.456	0.249	0.358
	(0.044)	(0.046)	(0.047)	(0.057)	(0.062)	(0.065)	(0.068)	(0.070)	(0.072)
Waiting period	-0.020	-0.021	0.007	-0.019	-0.020	-0.023	-0.022	-0.023	0.073
	(0.003)	(0.003)	(0.020)	(0.004)	(0.004)	(0.026)	(0.005)	(0.005)	(0.035)
Retroactive period	-0.0012	-0.0015	0.003	-0.0023	-0.0029	0.0010	-0.0004	0.0006	0.0083
	(-0.0008)	(0.0008)	(0.002)	(0.0011)	(0.0011)	(0.0029)	(.0013)	(0.0013)	(0.0037)
Male		0.016	0.021						
		(0.015)	(0.015)						
Age		0.0003	0.0003		-0.0003	-0.0003		0.0015	0.0016
		(0.0005)	(0.0005)		(0.0007)	(0.0007)		(0.0008)	(0.0008)
Years of Schooling		-0.025	-0.023		-0.020	-0.020		-0.028	-0.025
		(0.003)	(0.003)		(0.004)	(0.004)		(0.005)	(0.005)
Black		-0.067	-0.044		-0.053	-0.029		-0.085	-0.067
		(0.022)	(0.023)		(0.030)	(0.031)		(0.034)	(0.035)
Hispanic or other race		-0.018	-0.129		-0.031	-0.105		0.002	-0.164
		(0.031)	(0.034)		(0.041)	(0.046)		(0.046)	(0.052)
Single		-0.004	-0.014		-0.058	-0.063		0.038	0.019
		(0.014)	(0.013)		(0.020)	(0.020)		(0.020)	(0.020)
Occupation dummies (19)	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
2-digit industry dummies (46)	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
State dummies (44)	No	No	Yes	No	No	Yes	No	No	Yes
- Log likelihood	23825.2	22792.2	22644.7	14395.5	13858.68	13810.2	9001.4	8800.2	8649.6
Benefit elasticity	0.404	0.250	0.378	0.473	0.269	0.335	0.108	0.053	0.281
Wage elasticity	-0.151	0.094	-0.011	-0.265	-0.027	-0.074	0.177	0.323	0.107
Number of observations		350,887			184,372			166,277	

Notes: Results of probit estimation of Equation 3.1 in the text; robust standard errors in parentheses. Sample is pooled matched March CPS files from 1977/78- 2003/04, exluding 1985/86 and 1995/96. Each probit equation contains an intercept and a full set of year dummies. Benefit is for temporary total disability (TTD). For comparability, all elasticities are calculated at the mean WC participation rate (0.0127) for the full sample.

The results for the full sample conceal that the relationship between claims and benefits differs substantially for male and female workers. Of course, since men and women differ in the types of work that they perform, controlling for differing risk of work-related injury and illness is important. When occupation and industry dummies are included in Model (2), however, the difference in estimated benefit elasticities remains: The coefficients imply that a 10 percent increase in benefits would cause 2.7 percent more claims for men and a less than 1 percent increase in the number of female recipients. The difference in the magnitude of the benefit elasticities for men and women shrinks somewhat when state dummies are added to the model. Krueger (1990) also found that men and women appeared to differ in their responsiveness to variation in workers' compensation benefits; in fact, his findings indicated a negative (but statistically insignificant) coefficient on benefits for women. It was unclear from Krueger's study whether this difference may have been simply a result of a data set that was limited to just two years and contained only 290 recipients. My results, on the other hand, suggest a positive relationship between benefits and claims frequency for women, but one that indeed appears smaller than that for men.[18]

All else equal, after-tax wages should be negatively related to the likelihood of a workers' compensation claim, since a higher net wage increases the opportunity cost of receiving workers' compensation.[19] However, the estimated effects of wages on the probability of workers' compensation recipiency differ in sign and magnitude across samples

[18]One explanation might be that on average, women earn less than men and are less likely to have their potential workers' compensation entitlement limited by their state's maximum benefit level, thus reducing the variation in benefits for the female sample. However, restricting the sample to full-time workers only does not change the results significantly.

[19]Recall that the components of the after-tax replacement rate enter the specification separately and in logs, so that $\ln W$ and $ln(1-t)$ may take on different coefficients.

and specifications, and the coefficient on the net tax rate takes the unexpected sign irrespective of the specification employed, just as in Krueger (1990). That these unexpected findings remain even when I employ far more data than used in Krueger's analysis is troublesome and suggests further consideration of the model and specification. In the following section, I depart from Krueger's approach to explore these findings in greater depth using alternative specifications of the model.

The length of the waiting period has a significant negative effect on the probability of a workers' compensation claim, which is consistent with results in Krueger (1990) and elsewhere in the research. Using many more years of data than has been employed by other similar studies, I find that the length of the retroactive period also has a significant and negative impact on the likelihood of receiving workers' compensation.[20] My results, therefore, suggest that both of these workers' compensation parameters may be useful policy tools. Once state fixed effects are included in the model, however, too little variation remains in these variables to precisely identify their effects on participation in the program.

2.5. Determinants of Workers' Compensation Recipiency

2.5.1. Workers' Compensation Claims: Effects of Benefits, Wages, and Taxes

In what follows, I depart from the approach used in Krueger (1990) and seek more precise estimation of the determinants of workers' compensation claims. Table 2.4 shows the results of probit estimation of various specifications of the model.

[20]Previous research by Krueger (1990) and Hirsch et al. (1997) found only the waiting period to have a significant effect on workers' compensation claims frequency.

Table 2.4: Determinants of Workers' Compensation Benefit Recipiency

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log weekly WC benefit	0.139	0.125	0.093	0.089	0.153	0.147	0.030	0.035
	(0.022)	(0.023)	(0.023)	(0.028)	(0.032)	(0.032)	(0.038)	(0.038)
Log weekly wage	-0.026	-0.057	-0.016	-0.029	-0.065	-0.050		
	(0.018)	(0.021)	(0.022)	(0.026)	(0.025)	(0.025)		
Log (1-tax)	0.328	0.248	0.179	0.187	0.224	0.058	0.043	0.048
	(0.047)	(0.056)	(0.056)	(0.069)	(0.058)	(0.073)	(0.074)	(0.076)
Waiting period	-0.021	-0.023	-0.023	-0.021				
	(0.003)	(0.004)	(0.004)	(0.004)				
Retroactive period	-0.0017	-0.0022	-0.0022	-0.0025				
	(0.0008)	(0.0009)	(0.0010)	(0.0011)				
Male: Married with	0.070	0.072	0.0813	0.040	0.099	0.108	0.111	0.112
spouse present	(0.035)	(0.035)	(0.036)	(0.048)	(0.036)	(0.036)	(0.036)	(0.036)
Male: Divorced,	0.052	0.053	0.061	0.036	0.063	0.063	0.063	0.064
widowed or separated	(0.038)	(0.038)	(0.039)	(0.050)	(0.39)	(0.039)	(0.039)	(0.039)
Female: Married with	-0.086	-0.078	0.060	0.060	0.070	0.091	0.091	0.089
spouse present	(0.035)	(0.035	(0.037)	(0.049)	(0.036)	(0.037)	(0.037)	(0.037)
Female: Divorced,	-0.008	-0.005	0.124	0.1162	0.126	0.121	0.121	0.126
widowed or separated	(0.037)	(0.005)	(0.038)	(0.050)	(0.038)	(0.038)	(0.038)	(0.039)
Female: Never married	-0.222	-0.219	-0.010	-0.062	-0.106	-0.105	-0.103	-0.103
	(0.052)	(0.052)	(0.053)	(0.068)	(0.053)	(0.053)	(0.053)	(0.053)
Age	0.017	0.015	0.014	0.020	0.013	0.012	0.011	0.011
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Age^2	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Years of Schooling	-0.056	-0.055	-0.0266	-0.029	-0.026	-0.025	-0.025	-0.024
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Black	-0.043	-0.047	-0.077	-0.057	-0.054	-0.059	-0.056	-0.056
	(0.025)	(0.025)	(0.025)	(0.028)	(0.026)	(0.026)	(0.026)	(0.026)
Hispanic or other race	-0.064	-0.067	-0.068	-0.068	-0.163	-0.162	-0.162	-0.162
	(0.035)	(0.036)	(0.036)	(0.039)	(0.040)	(0.040)	(0.040)	(0.040)
Part-time worker		-0.096	-0.081	-0.072	-0.082	-0.075	-0.060	-0.059
		(0.025)	(0.026)	(0.029)	(0.026)	(0.026)	(0.027)	(0.027)
Union member				0.181				
				(0.035)				
Lagged (log) hh income						-0.060	-0.059	
						(0.017)	(0.017)	
Occupation dummies (19)	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies (46)	No	No	Yes	Yes	Yes	Yes	Yes	Yes
State dummies (44)	No	No	No	No	Yes	Yes	Yes	Yes
Wages spline (4)	No	No	No	No	No	No	Yes	Yes
Wages & income spline (24)	No	No	No	No	No	No	No	Yes
- Log likelihood	23153	22579	22200	16906	22050	22039	22022	22001
Benefit elasticity	0.359	0.325	0.240	0.229	0.395	0.379	0.077	0.090
Wage elasticity	-0.067	-0.147	-0.041	-0.075	-0.168			
Number of observations	350,917	350,917	350,917	278,214	350,887	350,744	350,744	350,744

Notes: Results of probit estimation of Equation 3.1 in the text; robust standard errors in parentheses. Sample is pooled matched March CPS files from 1977/78- 2003/04, excluding 1985/86 and 1995/96. Each probit equation contains year dummies and an intercept. Benefit is for temporary total disability (TTD). All elasticities are calculated using the mean WC participation rate (0.0127) for the full sample.

The first model includes as independent variables the workers' compensation parameters, (log) weekly wages in $t-1$, (log) net tax rates, and demographic controls for age and its square, education, race, marital status and gender. Because the initial estimates presented above differed notably for women and men, I interact marital status (i.e. never married, divorced/widowed/separated, or married with spouse present) with gender and for a more full set of controls. Controlling only for workers' compensation laws, after-tax wages, and demographic characteristics, the estimated elasticity of workers' compensation participation with respect to benefits is 0.359, implying that a 10 percent increase in benefits would result in a 3.6 percent increase in the overall number of workers' compensation recipients.

If part-time workers have both lower weekly wages and a lower risk of workplace injury simply because they are at work for fewer hours each week, then failing to control for a worker's part-time status may bias the estimated effect of weekly wages on workers' compensation claims upward. In Model (2), inclusion of a dummy variable for having worked (on average) fewer than 35 hours per week during year $t-1$ leads to a larger (and statistically significant) negative coefficient on the wage and reduces in magnitude the positive elasticity of claims with respect to benefits.

Next, Model (3) includes a detailed set of occupation and 2-digit industry dummies to control for differences in inherent job risk and compensating wage differentials. This reduces the estimated benefit elasticity to 0.24. The inclusion of occupation and industry controls also reduces the magnitude of the negative wage elasticity. That is, once we control for the positive correlation between job risk and wages, I find essentially no effect (on average) of wages on the probability of a workers' compensation claim. However, given a certain level of job risk, we would still expect after-tax wages to negatively impact the likelihood of a claim, as they represent the opportunity cost of being in the workers compensation program and forgoing labor income. Indeed, once state fixed effects are included in the model, the linear estimate of the relationship between wages and claims propensities is negative and significant.

In Model (4), I examine the effect of union membership on workers' compensation claims rates. The March CPS does not provide information on union membership prior to the 1983 survey, so I restrict the sample to the years 1983-2003 for this estimation. Union membership is found to have a positive and significant effect on the likelihood of a workers' compensation claim, as shown in Hirsch, Macpherson, and Dumond (1997). They interpret this result to reflect union workers receiving more information about workers' compensation benefits and receiving assistance in filing claims. It may also be the case that union workers are less subject to a perceived stigma from filing workers' compensation claims or are less likely to feel discouraged from filing a claim by their employers. On the other hand, unlike Hirsch et al. (1997), I do *not* find that failure to include union membership in the probit model biases the estimated elasticity of claims with respects benefits.[21]

State fixed effects can control for unobserved fixed state characteristics that may be correlated with workers' compensation benefit generosity and with the likelihood of workers' compensation benefit receipt, such as the manner in which the laws are administered or the extent to which claims are reviewed, scrutinized and approved/denied in a given state. When I include a set of state dummies in Model (5), the coefficient on the benefit

[21] Although not shown here, the coefficient on the benefit variable resulting from of probit estimation of Model (2) for the survey years 1983/84-2003/04 does not differ remarkably from that in column (4) here.

variable increases significantly, resulting in an estimated benefit elasticity of 0.395, compared to 0.240 in Model (3). The direction of the omitted variables bias suggests that perhaps states with more generous benefits are more restrictive in terms of the workers' compensation claims they approve or are more aggressive in encouraging workplace safety among firms.

Recall that the coefficient on the net tax rate takes an unexpected sign in Krueger (1990) as well as in the results presented above. The estimated effect of the net tax rate may be biased upward if taxes are positively correlated with some omitted variable that has an independent negative effect on the probability of a workers' compensation claim. Total family income is clearly positively related to an individual's marginal tax rate in the United States. Moreover, other things held equal, a worker whose family has a higher income outside his labor earnings may be less likely to file a claim for workers' compensation if there are positive costs (like transaction costs and/or stigma) to doing so, since he can depend on this income to smooth consumption over the period of injury. Indeed, including a control for (log) total family income in year $t-1$ reduces the coefficient on the net tax rate dramatically; although the sign remains positive, the estimate is no longer statistically different from zero.

As described above, the weekly workers' compensation benefit is a function of an individual's earnings history (specifically, his or her average gross weekly wage in the year preceding the claim). Without controlling carefully for this history, one is unable to disentangle the effects of workers' compensation generosity on participation rates from the influence of past wages.[22] We expect weekly wages to influence the decision of workers'

[22]See Anderson and Meyer (1997) for a similar discussion of this point as it relates to unemployment insurance take-up.

compensation take-up directly, as a worker compares his weekly wages and marginal disutility from work to the benefits he would receive under workers' compensation. However, past weekly earnings may also affect the decision to receive workers' compensation indirectly, in that they may capture commitment to the labor force or represent the resources outside of workers' compensation that are available to a worker who is injured on the job.

Because I have no reason to know the particular form that the relationship between wages and the workers' compensation participation decision assumes, in Model (7) I condition for the influence of past wages with a flexible spline in year $t-1$ wages. Specifically, let the $L-1$ selected quantiles of $ln(wage_{t-1})$ be $KW_2, ...KW_L$, respectively. Then the spline is formed by entering as regressors the variables $W_1, ...W_L$, where $W_1 = \ln(wage_{t-1})$, and $W_i = \max(0, W_1 - KW_i)$ for $i = 2, ...L$.[23] Choosing quartiles of the sample wage distribution as knot points, the resulting set of four variables forms a flexible function that controls for past wages and allows more precise identification of the effects of workers' compensation benefits on the number of claims filed.[24] Note that including the flexible controls for past earnings essentially removes any differences in workers' compensation participation propensities across people with different levels of earnings.

Including the four-piece spline in period $t-1$ weekly wages in Model (7) reduces the estimated responsiveness of claims to variation in workers' compensation benefits dramatically. Now, a 10 percent increase in the level of workers' compensation benefits is associated with an increase in claims frequency of less than 1 percent. In Model (8),

[23]See Piorier (1976) for a thorough discussion of regression using linear splines (as well as bilinear and bicubic splines). See Anderson and Meyer (1997) for an empirical paper that uses similar methods.

[24]Increasing the spline to 5 pieces by choosing quartiles as knot points or to 8 pieces by choosing octiles had very little effect on the coefficients of interest.

interacting the flexible controls for wages and total family income to form a 24-piece bilinear spline in past wages and family income does not change the results remarkably.[25]

In summary, the initial results presented above tell a fairly consistent story. Benefit generosity appears to have a positive effect on workers' compensation claims numbers, with benefit elasticities in the range of 0.2 to 0.4. These estimates are appreciably smaller than those derived in Krueger (1990) but are consistent with the majority of estimates provided elsewhere in the literature.

However, when a flexible linear spline is included to control for nonlinearities in the relationship between wages and workers' compensation participation, the elasticity of claims with respect to benefits is smaller than 0.1. This finding is an important contribution to the literature, as it suggests that researchers must carefully consider how to separately identify the effect of benefits and wages on participation in programs like workers' compensation, where benefits are a direct function of pre-injury wages. Moreover, the results suggest that moral hazard or negative work incentives in workers' compensation may warrant less concern than previously thought.

Additionally, when wages are entered into the specification linearly, the elasticity of workers' compensation claims with respect to wages is negative, irrespective of the model's specification. However, controlling for wages in this manner conceals important nonlinearities in the relationship between wages and workers' compensation claims. When a four-piece linear spline in wages is included in Model (7), the estimated wage effect is

[25]Here, let the $L-1$ selected quantiles of ln($weekly\ wage$) and ln($family\ income$) be $KW_2, ...KW_L$, and $KI_2, ...KI_L$, respectively. Then the bilinear spline is formed by entering as regressors the $2L+L^2$ variables $W_1, ...W_L$, $I_1, ...I_L$, WI_{11}, WI_{12}, WI_{21}, WI_{LL}, where $W_1 = \ln(weeklywage)$, $W_i = \max(0, W_1 - KW_i)$ for $i = 2, ...L$, $I_1 = \ln(familyincome)$, and $I_k = \max(0, I_1 - KI_k)$ for $k = 2, ...L$, and $WK_{ik} = W_i * I_k$ for $i = 1, ...L$ and $k = 1, ...L$.

positive (and significant) for the bottom quartile, statistically no different from zero for the second and third quartiles, and strongly negative for the top 25 percent of the wage distribution. Finally, I find that failing to control for the influence of lagged total family income on workers' compensation participation propensities may have biased estimates of the effect of net tax rates on workers' compensation claims, both in my initial results and in previous research.

2.5.2. Workers' Compensation Claims: Effects of Worker/Job Characteristics

Consistent patterns emerge in Table 2.3 when we examine the empirical relationships between various worker and job characteristics and the probability of workers' compensation recipiency. Irrespective of the model specification, older workers are more likely than younger counterparts to file a claim for workers' compensation, a result that is consistent with findings elsewhere in the research showing that the average severity of occupational injuries and illnesses increases with age. Education has a significant negative effect on the likelihood of a workers' compensation claim, even after controlling for a worker's occupation and industry. Non-whites are less likely to receive workers' compensation. On average, males are more likely than females to participate in workers' compensation programs, even once detailed occupation and industry controls are included. Within the subsamples of men and women, marital status appears to matter differently: Married men living with their spouses are more likely than single men to take up workers' compensation, while for women, those who are divorced, widowed, or separated are the most likely to receive workers' compensation.

My findings suggest that certain job characteristics affect the probability of a workers' compensation claim as well. While Krueger does not consider whether part-time status may affect workers' compensation claims, I find that accounting for part-time status is an important addition to the empirical model. Working fewer than 35 hours per week has a strong, negative impact on the likelihood of receiving workers' compensation, a result that is robust to the inclusion of both demographic and categorical occupation and industry controls. Given that the model also controls for other differences between part-time and full-time workers, the finding that part-time workers are significantly less likely to receive workers' compensation benefits is probably best explained by the fact that these workers are at their jobs fewer hours per week.

Finally, in Model (4), which includes controls for an individual's occupation and industry, I find additional evidence to support the conclusion that union membership has a strong and positive effect on workers' compensation claims propensities. Hirsch et al. (1997) suggest that relative to non-unionized workers, union members may be more responsive to benefit changes if they are better informed about the program's requirements and benefits and may have more access to helpful resources when filing a claim for workers' compensation.

2.6. Conclusions

This paper offers new evidence on the magnitude of incentive effects in workers' compensation. Using refined techniques for matching individuals across years of the March CPS, I compile a sample of over 350,000 individuals covering twenty-five years from

1976/77 to 2003/04. I estimate the reduced-form relationship between workers' compensation benefit generosity and the probability of transitions into workers' compensation receipt. My key findings suggest a positive relationship between benefit levels and workers' compensation claims; however, the magnitude of this relationship clearly depends on the extent to which I control for the influence of past wages on both benefits and the probability of a workers' compensation claim.

Following an approach similar to that used in Krueger (1990) results in estimates of the elasticity of claims with respect to benefits in the range of 0.2 to 0.4, depending on the specification. These estimates of the benefit elasticity are substantially smaller than those derived by Krueger for the years 1982/83 and 1983/84, suggesting that perhaps his estimates of benefit elasticities near 0.7 are an artifact of those particular years of data. Moreover, my estimates are consistent with those found elsewhere in the literature, both by researchers studying disaggregated micro data (e.g., Hirsch et al. (1997)) and in papers analyzing aggregate state or state-by-industry level data.[26]

On the other hand, expanding on previous work to include flexible controls for the influence of past wages on workers' compensation claiming propensities in my model results in a very different conclusion. Under a specification that includes a linear spline in past weekly wages, I estimate an elasticity of claims with respect to benefits that is smaller than 0.1. In other words, this result suggests that a 10 percent increase in benefits would result in less than a 1 percent increase in the number of claims for workers' compensation. The implications of this result are two-fold: First, researchers must think carefully about controlling for the influence of past wages on workers' compensation claims propensities in

[26]Examples include Butler (1994), Butler and Worrall (1983), Chelius (1982), Chelius and Kavanaugh (1988), and Ruser (1991).

order to precisely identify the effect of *benefits* on participation in the program. Moreover, this same caveat holds for similar research on other programs in which benefits are a direct function of previous wages.[27] Secondly, if one takes these results literally, the rather limited responsiveness of claims to changes in benefits indicated by my estimates implies that the distortionary effects of workers' compensation benefits on labor supply behavior may be much smaller than previously thought.

Finally, consistent with previous research, my results indicate that the length of the waiting period has a significant negative impact on the number of claims filed for workers' compensation benefits, suggesting that increasing the waiting period for cash benefits may deter a substantial number of claims for minor injuries. Additionally, I find evidence that the length of the retroactive period significantly decreases the frequency of claims for benefits. These parameters, which serve as deductibles in state workers' compensation programs can clearly be important tools for policy-makers.

Despite the focus of this and several other papers on the incentive effects of workers' compensation programs, much less emphasis has been placed on the effects of workplace illnesses and injuries on other outcomes. While recent research has addressed the adequacy of workers' compensation benefits in replacing lost earnings (see Boden and Galizzi, 1999, for example), additional studies of the impacts of work-related injuries and illnesses on earnings and labor supply are certainly warranted. Researchers also have not examined the effects of on-the-job injuries on household income and its sources or the effects of work-related injuries on other measures of material well-being, like household consumption. While work disincentives associated with income replacement are certainly central

[27]See Meyer and Anderson (1997) for a discussion of this issue as it relates to unemployment insurance (UI).

issues for economic research, the effects of work-related injuries on economic outcomes for affected individuals and their families should also be of interest for policy makers. Therefore, an important direction for future research may be an increased focus on the material well-being of those affected by workplace injuries and the extent to which workers' compensation programs adequately protect their economic well-being. The following chapters explore these issues in greater depth.

CHAPTER 3

Workers' Compensation and Consumption Smoothing

3.1. Introduction

State workers' compensation programs are among the largest forms of social insurance, with a primary goal of providing income support to families facing unanticipated economic hardship when a worker is injured or becomes ill on the job. The programs also generate substantial controversy, and several states are well-known for recent political debates over whether the high costs of workers' compensation outweigh the social insurance benefits it provides. However, the existing literature on workers' compensation programs proffers remarkably little evidence on the benefits of workers' compensation for injured workers or the extent to which workers' compensation indemnity benefits help to protect the material well-being of these workers and their families.[1]

In this chapter, I investigate the consumption-smoothing effects of workers' compensation indemnity benefits for households affected by a work-related injury (or illness). In doing so, I seek to answer two key questions: First, at current benefit levels, to what extent do workers' compensation benefits help households to smooth consumption over the loss of earned income that results from a workplace injury? Second, what is the optimal level of workers' compensation benefits that balances the trade-off between the value of

[1]There is a small, but growing, body of research on the earnings losses experienced by workers who are injured on the job, which I discuss in more detail below. (See, for example: Biddle (1998), Reville (1999), Reville and Schoeni (2001), or Boden and Galizzi (1999, 2003)).

smoother consumption for affected households and the costs associated with distortionary effects on individual labor supply behavior?

To address the first of these questions, I use data from the Health and Retirement Study (HRS) to estimate the effects of workers' compensation benefit generosity on changes in household food and housing consumption for a sample of individuals who report having incurred a work-related, work-limiting health problem. My findings indicate a significant consumption-smoothing role for worker's compensation benefits: Specifically, I find that a 10 percent increase in workers' compensation benefit eligibility offsets the drop in household consumption when a worker becomes injured on the job by 2.5 to 4 percent. I also show that the consumption-smoothing benefits of workers' compensation are larger for households with limited pre-injury assets, and that the results are robust to several changes to the original specification. Moreover, my estimates indicate that if workers' compensation benefits were very low, equal to the 10th percentile of their current distribution, the implied drop in household consumption upon a work-related injury would be in the range of 20 to 30 percent. In short, my results suggest that workers' compensation benefits are indeed helping injured workers and their families to maintain smoother consumption.

Estimates of the degree of consumption smoothing provided by workers' compensation benefits should clearly be of interest to policy makers, in that they represent the relative success or failure of the program in helping to support the material well-being of injured workers and their families. However, the economic significance of the consumption-smoothing benefits of workers' compensation can only be determined when they are weighed against the costs associated with the incentive effects of the programs on the labor supply behavior of individuals.

Accordingly, a second goal of my analysis is to examine the inherent trade-off between the benefits and costs of increased workers' compensation generosity. To do so, I adopt from the public finance literature a model for optimal social insurance, developed by Baily (1978) and Chetty (2006) in a framework of unemployment risk. I adapt the model for the case in which workers instead face risk of on-the-job injury. The adapted model provides an explicit formula for the optimal level of workers' compensation benefits, which depends directly upon my empirical estimates of the consumption smoothing provided by workers' compensation. Applying my estimates from the first part of the paper to this formula, I find that the optimal level of wage-replacement for workers' compensation is lower than current values for plausible levels of risk aversion and for a range of empirical estimates of the distortionary effects of program generosity on individual behavior. That is, the consumption-smoothing benefits of workers' compensation are found to be economically small relative to the negative incentive effects of increased benefit generosity on labor supply behavior.

The existing literature on work-related injuries and state workers' compensation programs provides extensive empirical evidence on the costs of workers' compensation in terms of distortionary effects on labor supply behavior. As described in the previous chapter, there is a large volume of literature that estimates the effects of variation in workers' compensation benefits on outcomes like the frequency of injuries/claims and the duration of time spent out of work due to work-related injuries.[2] On the other hand,

[2]For examples, see Chelius (1982), Butler and Worrall (1985), Ruser (1985, 1991), Krueger (1990), Smith (1990), Card and McCall (1996), Meyer, Viscusi and Durbin (1995), and Neuhauser and Raphael (2004).

there is surprisingly little evidence in the literature as to the *benefits* of workers' compensation for the eligible population of workers injured on the job. A set of recent papers has examined the adequacy of workers' compensation benefits in replacing *earnings* losses associated with a work-related injury or illness; however, studies of earnings losses may yield an incomplete understanding of the impact of a workplace injury or illness on household well-being.[3] A need for additional research on the economic consequences of workplace injuries and illnesses has been suggested by Reville, Battacharya, and Weinstein (2001), who specifically call for evaluations of the adequacy of workers' compensation using measures other than earnings or income losses.

The results of this study provide new insight on the extent to which workers' compensation programs protect the material well-being of households affected by workplace injuries and illnesses. An additional contribution involves my use of data on household consumption expenditures to measure material well-being for households of injured workers. The underlying argument is that household consumption, as opposed to earnings or income, may provide a more appropriate and direct measure of material well-being for households affected by a work-related injury. Standard economic models of utility maximization are based on consumption rather than income, and with concave utility, households will prefer to smooth consumption over fluctuations in income, like that due to a work-related disability that is perceived to be temporary. To the extent that households are able to do so, current period consumption levels will provide a more complete

[3]Specifically, household income and material well-being rarely depend entirely upon the earnings of a single worker: The loss of earned income from a workplace injury or illness may be offset by increased labor supply of the spouse or other household members or may be mitigated by income from multiple government programs designed to help families in the case of such adverse labor market events (e.g. SSI, disability insurance, and welfare).

picture of a household's material well-being than will current period income measures (Cutler and Katz, 1992). Furthermore, Meyer and Sullivan (2003) provide convincing evidence that for households with fewer resources, consumption is measured more accurately than income in survey data and is more closely linked to material hardship. Meyer and Sullivan conclude that policy makers should examine consumption data when determining appropriate benefit levels and evaluating the effectiveness of transfer programs.

My work also complements related studies from outside the literature on work-related injuries and illnesses, like those of Stephens (2001) and Gruber (1997). Stephens (2001) uses data from the PSID to examine the long-run consumption effects of disability (not necessarily work-related) and finds a significant reduction in household food consumption in the long-run. The long-term change in consumption is not as large as the earnings decrease faced by the disabled individual, suggesting a degree of consumption smoothing for households affected by disability. However, while Stephens (2001) points out that disabled households benefit from increased transfer income, the paper does not specifically consider the effects of disabilities *caused by work* or whether workers' compensation is a source of consumption smoothing for these households. The methodological approach of my paper is similar to that of Gruber (1997), which finds significant consumption-smoothing effects of unemployment insurance benefits, using data from the PSID on individuals experiencing periods of job displacement. However, while unemployment insurance (UI) is somewhat similar to workers' compensation in design and objective, it is not clear whether workers' compensation should have a smaller or more substantial consumption-smoothing impact than unemployment insurance. Without moral hazard effects, on-the-job injuries are likely more unexpected than unemployment and can result in longer time out of work, so injured individuals are less likely to be able to rely on their own savings (or increased spousal labor supply) in order to smooth consumption. However, if many reported work-related injuries are actually planned or anticipated, individuals may be more prepared to smooth their consumption than those experiencing a job loss. Thus, the extent to which workers' compensation provides consumption-smoothing benefits for workers who experience a job injury remains an empirical question, to which I provide an answer.

The chapter proceeds as follows: Section 3.2 discusses the Health and Retirement Study (HRS) data used in the paper, specifically focusing on the information provided by the HRS on work-related disabilities and household consumption expenditures. Section 3.3 describes the key empirical methods used to estimate the consumption-smoothing benefits of workers' compensation, and Section 3.4 presents the main results of the paper. In Section 3.5, I explore several specification checks and alternatives to the original model. Section 3.6 performs an exercise to determine the optimal level of workers' compensation benefits, using empirical estimates from my own work as well as those obtained in previous research. Section 3.7 concludes and discusses implications for policy and future research.

3.2. Data

To examine the effects of workplace injuries on the material well-being of households, this paper uses nationally representative micro data from the Health and Retirement Study (HRS). The HRS has collected longitudinal data on individuals nearing (or of) retirement age biennially since 1992. The initial sample was comprised of almost 8,000 households that contained at least one individual born between 1931 and 1941. These age-eligible respondents and their spouses were interviewed, and the initial wave contained about 13,000 respondents. In 1998, a "War Baby" cohort of about 4,500 individuals born between 1942 and 1947 (and their spouses) was introduced to the HRS. This paper employs data on both original HRS respondents and members of the War Baby cohort, resulting in a sample of men and women born between 1931 and 1947 and their spouses. The HRS data include information on many topics, such as demographics, employment, health status, disability, as well as extensive information on income sources and program participation. More importantly, the HRS is the only nationally representative micro data set that provides information on food and housing consumption and permits identification of injuries related to work without conditioning on workers' compensation receipt.[4] The ability to identify individuals with work-related injuries who would be eligible to receive workers' compensation *without conditioning on receipt of benefits* is imperative to my study, since the decision to take up workers' compensation is endogenous with respect to changes in household consumption upon injury.

The HRS contains several important questions that allow researchers to identify individuals with work-related injuries, illnesses, or disabilities, who would be potential workers' compensation recipients. First, I limit the sample based on the question in the survey that asks, "Do you have any impairment or health problem that limits the kind or amount of work that you can do?" Because I am examining changes in consumption when a worker becomes ill or injured, the sample includes only those who report a work-related disability in a given period t, but who did not report a work-limiting health problem in period $t-1$.

[4]The National Longitudinal Survey of Youth (NLSY) and the Survey of Income and Program Participation (SIPP) also allow for identification of work-related injuries and illness without conditioning on workers' compensation receipt; however, neither of these surveys contain information on household consumption expenditures. The Panel Study of Income Dynamics (PSID), on the other hand, contains household consumption data for prime-age workers but does not permit identification of workers injured on-the-job except through workers' compensation receipt.

Next, to attribute such an injury/illness to the workplace, I include only those respondents who answered in the affirmative the question that asks whether the work-limiting impairment discussed above "was in any way caused by the nature of [the respondent's] work."[5] This definition of on-the-job injuries includes in the sample individuals with work-related illnesses or impairments like carpal tunnel syndrome, which would not have been caused by a specific workplace incident. Additionally, inclusion in the sample is conditional on employment in period $t-1$ because employment determines workers' compensation eligibility and because the primary effect of a workplace injury on household material well-being is through lost earnings of the injured worker.[6] Therefore, the final sample includes all individuals who are employed (without a work-limiting disability) at the $t-1$ interview and who report having a work-limiting disability caused by their work at the period t interview.[7]

Measures of both food and housing consumption expenditures are available in the HRS for all waves except Wave 4.[8] Three measures of household food consumption are reported in the HRS: 1.) food consumption at home (not including food stamps), 2.) food consumption away from home (including "take-out" or food "ordered in"), and 3.)

[5]The questionnaire also inquires whether "the impairment or health problem just mentioned was the result of an accident or injury," and if so, whether the accident took place at work, home, or elsewhere. An alternative would be to include only respondents who answer that their health problem is the result of an accident or injury that occurred at work.

[6]Because the HRS data are collected biennially, there could be some individuals who are unemployed at the time of the t -1 interview, but who accept a job and experience a work-related injury/illness before the period t interview. These individuals would be excluded from my sample.

[7]This sample only includes observations for which this is the first reported work-limiting disability in the HRS. Allowing for subsequent reports of work-related injuries would result in an additional 11 observations.

[8]Therefore, consumption changes are missing for Wave III to Wave IV (1996 to 1998) and Wave IV to Wave V (1998 to 2000). While measures of housing consumption are available for these years, I employ only the years of data for which I can measure changes in both food and housing consumption.

the value of food stamps used by the household.[9] These three types of food expenditures are first deflated into 1992 dollars using the corresponding component of the CPI-U in the month of the interview, and food consumption is measured as the sum of the real components. Although food expenditure information is a limited measure of household consumption, it has been used in a number of previous papers as a measure of household consumption behavior.[10] A benefit of using food expenditures to represent household consumption is that food is a non-durable good and should be closely tied to changes in household utility. A potential concern about representing household consumption with food expenditures is that food is a necessary good, and thus, food expenditures may not change as much as other types of household consumption in response to an income shock. However, as Stephens (2003) notes, empirical estimates of the income elasticity of food fall in a range around 0.6 to 0.7, implying that food consumption is indeed responsive to changes in income. Next, I measure housing consumption as the rent or mortgage payments paid toward the respondent's primary residence, deflated again by the appropriate CPI-U component. A problem with this measurement is that current payments toward housing may not accurately depict a respondent's value of housing consumption. For example, if a disabled worker moves in with his child or another friend or family member, his monthly expenditures on housing (if any) will likely not reflect the value he places on that consumption. More importantly, current period housing expenditures will not accurately reflect the value of housing consumed if a household has paid off its mortgage and owns

[9]In the HRS, the value of food stamps is not to be included in the reported value of spending on food consumed at home. Specifically, if the respondent has reported receiving any food stamps, the question regarding spending on food consumed at home reads, "In addition to what you bought with food stamps, about how much do you (or other family members now living here) spend on food that you use at home in an average week?"

[10]See, for example, Gruber (1997, 2000), Stephens (2003), and Haider and Stephens (2003).

its home outright; this may be relatively more common in samples of older individuals than in surveys of prime-age respondents. To address these concerns, I examine changes in food and housing consumption both together and separately.

One important issue with my measures of consumption is the timing of these questions in the HRS. The questions concerning food consumption refer to the point of interview: Households are asked how much they spend on food at home and food away from home in a "typical" week, while the value of food stamp expenditures is reported for the previous month.[11] The frame of reference for rent and mortgage payments is also the point of the HRS interview. Importantly, this timing is consistent with the information on whether an individual has a work-limiting disability as well as with the information used to construct respondents' pre-injury weekly wages. On the other hand, information on workers' compensation income is reported for the previous calendar year. Thus, a regression of household consumption changes on workers' compensation benefits received would be biased by measurement error. I avoid this bias by examining instead the relationship between consumption changes upon incurring a workplace injury and the potential workers' compensation benefit for which an individual is eligible. I discuss the use of workers' compensation benefit eligibility as the key independent variable in more detail below.

Table 3.1 reports mean characteristics for the sample of workers with work-related disabilities as well as for the sample of workers in the HRS who never experience a job-related injury or illness and the sample of workers who never experience any work-limiting disability. On average, when compared to the samples of respondents never injured on the job or never becoming disabled (at work or otherwise), workers in my sample are

[11]The HRS reports the value of food stamps received in the previous month rather than food stamp expenditures. I assume that all food stamps received are used by the household.

more likely to be male and have less education, and are slightly less likely to be married or non-white. Not surprisingly, workers reporting work-related injuries or illnesses have lower average weekly wages (and are thus eligible for lower weekly workers' compensation benefits.)

A noteworthy observation from the sample characteristics in Table 3.1 is that the fraction of the injured workers in my sample who report having received workers' compensation benefits in the last calendar year is only 15.1 percent. This take-up rate is low relative to other estimates in the literature. In a study of workers' compensation claiming behavior using administrative data on injured workers in Michigan, Biddle and Roberts (2003) document that only about 39 percent of these workers ever file for workers' compensation indemnity benefits. One explanation for an even lower participation rate in my sample is under-reporting of workers' compensation income in survey data sets like the HRS. Meyer, Mok, and Sullivan (2006) compare self-reports of the amount of transfer income received in several public-use micro data surveys to national administrative reports of benefit outlays and find substantial under-reporting of workers' compensation income. Specifically, the authors find that only about 40 percent of workers' compensation benefits received are reported in the SIPP and CPS, and the reporting rate is even lower for the PSID. The claiming rate from Biddle and Roberts (2003) and the reporting rate from Meyer, Mok, and Sullivan (2006) are remarkably consistent with the participation rate in my sample of injured workers in the HRS. That is, if only 39 percent of the sample of injured workers claims workers' compensation benefits, and only 40 percent of those claimants report their workers' compensation income in the HRS, I should observe about 15.6 percent of my sample receiving workers' compensation.

Table 3.1: Mean Characteristics of HRS Samples

Variable	Injured at work	Never injured at work	Never disabled
Age	57.9	57.8	57.5
	(5.5)	(5.8)	(5.8)
Male	0.575	0.464	0.464
	(0.495)	(0.499)	(0.499)
Married	0.744	0.780	0.790
	(0.437)	(0.414)	(0.407)
Less than high school	0.293	0.194	0.172
	(0.456)	(0.395)	(0.378)
High school graduate	0.531	0.508	0.506
	(0.500)	(0.500)	(0.500)
At least some college	0.176	0.298	0.322
	(0.381)	(0.457)	(0.467)
White	0.868	0.850	0.844
	(0.339)	(0.357)	(0.363)
Black	0.088	0.118	0.119
	(0.284)	(0.322)	(0.323)
Other race	0.044	0.033	0.038
	(0.205)	(0..178)	(0.191)
Household size	2.724	2.587	2.599
	(1.506)	(1.199)	(1.195)
Average weekly wage t-1	451.72	534.91	566.74
	(372.66)	(435.77)	(451.59)
Potential weekly WC benefit	256.16	276.04	286.44
	(131.71)	(139.77)	(139.51)
Receive workers' compensation	0.150	0.014	0.012
	(0.358)	(0.118)	(0.108)
Workers' compensation received	740.11	19.04	12.80
	(2708.62)	(344.44)	(285.41)
Food consumption t-1	5234.46	5438.24	5540.13
	(3073.55)	(5464.74)	(6045.72)
Housing consumption t-1	3754.61	4338.92	4623.60
	(4692.75)	(6232.41)	(6718.09)
Food+housing consumption t-1	8989.07	9777.17	10163.73
	(6208.15)	(8755.37)	(9513.19)
Change in food consumption	-117.50	-131.42	-104.18
	(2624.52)	(2306.64)	(2302.00)
Change in housing consumption	476.62	815.70	982.56
	(3325.34)	(4617.17)	(4948.98)
Change in food+housing consumption	374.90	722.85	913.67
	(4169.66)	(5408.67)	(5671.40)
Number of observations	273	12,689	8,935

Notes: Sample means are unweighted; standard errors are in parentheses. All values are deflated into 1992 dollars using the appropriate component of the CPI-U. All samples are conditional on employment in period t-1 and include only individuals with complete, non-missing consumption data. Samples of injured workers is all individuals who report a work-related, work-limiting disability in period t, conditional on having no disability in period t-1. Sample in second column is those who never experience a work-limiting disability related to their work. Sample in third column is those who never report having experienced a work-limiting disability at work or elsewhere.

Another potential explanation for the relatively low rate of workers' compensation benefit receipt for this sample concerns the use of self-reported measures of disability status to identify potential workers' compensation recipients. The self-reported information on the presence of a work-limiting disability may not be accurate if individuals in my sample exaggerate the degree of their work-limiting health problem, perhaps in order to justify reduced labor supply or increased participation in other programs. However, in a recent study of the magnitude of bias in self-reported disability measures, Benitez-Silva et al. (2004) use data from the HRS and examine the validity of a disability status indicator similar to the one used in this paper to identify individuals with work-limiting health problems.[12] In assessing whether self-reported disability is systematically biased, relative to a more objective definition of disability used by the Social Security Administration, the authors find little empirical evidence to support the pervasive concern over using self-reported measures of disability in behavioral models. The results of their study are consistent with the view that individual respondents do not systematically misreport their health or disability status information in anonymous non-governmental surveys like the HRS.

3.3. Empirical Methods

To determine the consumption-smoothing benefits of workers' compensation, I estimate the effect of workers' compensation benefit eligibility on the change in consumption when a worker is injured (or becomes ill) at work. Using the sample of workers with

[12]The disability status indicator in Benitez-Silva et al. (2004) takes the value 1 if a respondent answers yes to both of the following questions: "Do you have any impairment of health problem that limits the amount of paid work you can do? If so, does this limitation keep you from working altogether?"

work-related disabilities described above, I estimate models of the form:

$$\Delta C_{ist} = \alpha + \beta_1 BEN_{ist} + \beta_2 X_{it} + \tau_t + \gamma_s + \beta_3 \varphi_{st} + u_{ist} \tag{3.1}$$

where ΔC_{ist} is the change in (log) household consumption for individual i when he becomes injured (in state s and year t), X_{it} is a vector of personal characteristics that may affect the magnitude of the consumption change upon injury, τ_t is a set of fixed time effects, γ_s is a set of fixed state effects, φ_{st} is a set of state/year-specific controls, and BEN_{ist} is the (log) workers' compensation indemnity benefit for which the individual is eligible. A positive coefficient on the benefit variable would represent a consumption-smoothing effect of workers' compensation.

For the dependent variable, I employ three measures of consumption: the change in total household food and housing expenditures, and the changes in household food consumption and housing consumption, separately. These dependent variables are top- and bottom-coded at the 99th and 1st percentile of their distributions, respectively.

The key independent variable of interest is clearly the benefit variable. For each individual in year t, I calculate a potential weekly benefit based on his or her gross weekly wage in year $t-1$, the replacement rate, and the maximum and minimum benefit amounts in his or her state during year t. Potential benefits are adjusted according to marital status and number of dependants in states and years where such allowances apply. I use temporary total disability (TTD) schedules in each state and year to compute the benefit variable because all workers' compensation claims are initially filed as temporary cases and because TTD cases comprise more than 70 percent of workers' compensation cases in any given year (Meyer, 2002). To be consistent with the measurement of household consumption changes, weekly workers' compensation benefits are deflated into 1992 dollars using the CPI-U for the year of injury.

The use of a "potential benefit" as the key independent variable, rather than the actual amount of workers' compensation benefits received, is crucial for several reasons. First, using benefit eligibility instead of actual benefits received avoids problems associated with noisy reporting of actual workers' compensation receipt.[13] Perhaps more importantly, take-up of workers' compensation and the amount of workers' compensation benefits received are endogenously determined with respect to the change in consumption upon incurring a work-related disability. Biddle and Roberts (2003) document that up to 60 percent of workplace injuries never result in a claim for workers' compensation indemnity benefits, and as discussed above, the participation rate for my sample of injured workers in the HRS appears to be even lower. To the extent that the factors determining the decision to file for workers' compensation and the amount of benefits received are correlated with consumption changes resulting from the injury, estimates of Equation 3.1 using actual benefits received cannot be used to predict the response to future changes in workers' compensation laws. An alternative method would be to predict workers' compensation benefits received with a measure of benefit eligibility that should be uncorrelated with the change in consumption other than through the workers' compensation system, using a two-stage instrumental variables approach rather than the reduced-form

[13]Under-reporting of income from workers' compensation benefits is examined in Meyer, Mok, and Sullivan (2006). The authors compare administrative reports of workers' compensation benefits paid out to self-reports of workers' compensation income received in the SIPP, the PSID, and the CPS, and find that only about 40 percent of workers' compensation income is reported in these surveys.

regression described above. This two-stage approach would solve the endogeneity problem described above, but it would yield an estimate of the effect of workers' compensation benefit *receipt* on changes in consumption.

However, the argument of this paper is that the policy variable of interest is the consumption-smoothing effect of legislated changes in workers' compensation benefits, since policy makers can control legislated benefits but cannot directly control workers' compensation take-up. This is the parameter estimated by β_1 in the reduced-form estimation of Equation 3.1. While β_1 is often referred to in this literature as a "reduced-form" effect, here it could also accurately be characterized as an estimate of the average intention-to-treat (AIT) effect (see, for example, Manski (1996) or Angrist, Imbens, and Rubin (1996)). The AIT measures the effect of the treatment (i.e., benefit amount) on eligible subjects, regardless of whether or not they participate in the program (i.e., take up workers' compensation benefits). As mentioned, the AIT is one of the most relevant parameters for policy analysis when the policy maker has little influence on whether eligible individuals take up the program.

To explore the importance of the various controls and for the sake of robustness, I employ four different specifications of Equation 3.1. Clearly, each of the four regression specifications will include the potential WC benefit variable described above. Because the potential workers' compensation benefit variable is a function of pre-injury wages, I must also control for the separate influence of pre-injury earnings on changes in household consumption when a worker becomes injured on the job. I therefore include in each regression the individual's (log) after-tax weekly wage in period $t-1$. That the model controls for *after-tax* weekly wages is crucial since workers' compensation benefits are not subject to income taxation. Because the HRS does not include detailed information on income taxation, marginal tax rates are constructed using the TAXSIM model, the NBER'S Fortran program to simulate total (state and federal) marginal tax rates for individuals.[14] TAXSIM permits the calculation of a total (state plus federal) marginal tax rate for each member of my sample based on information about the respondent's age, income, deductions, and number of dependants.[15]

The parsimonious model includes controls for age, sex, marital status, race, and education of the injured worker, as well as controls for family size (levels and changes), which will affect the consumption "needs" of the household. In Model 2, I expand the regressions to include state fixed effects in order to capture time-invariant state omitted variables, such as differences in the cost of living or industrial composition across states, which are likely to be correlated with both workers' compensation benefit levels and consumption expenditures. Once state fixed effects are included, identification of the model comes from changes in state workers' compensation laws over time, nonlinearities in benefit formulas, and individual benefit variation within states. Next, I must address the concern that workers' compensation benefit generosity may be correlated with consumption opportunities in a particular state and year. Benefits may be higher and consumption changes upon injury may be smaller in states experiencing economically prosperous times. To this end, Model 3 re-estimates the consumption-smoothing effects of workers' compensation benefits, including state/year unemployment rates and a state/year-specific housing price index (constructed from the Freddie Mac Conventional Mortgage Home Price Index) in

[14] See www.nber.org/~taxsim for more detailed information.

[15] Note that the input variables used in the computation of the marginal tax rates are values from period $t-1$, so that the simulated tax rates should not be confounded by workers' compensation receipt or by reduced labor income due to injury or illness.

the regression in order to capture differences in consumption opportunities across states and time.

Finally, recall that the level of workers' compensation benefits for which an individual is eligible is a direct function of his average weekly wage in the previous (i.e., pre-injury) period. In order to identify the effects of benefit generosity on household consumption changes, it may be important to condition more carefully upon past wages. We expect past weekly wages to influence the change in household consumption directly, as they represent the loss of earned income from the injured worker. However, past weekly earnings may also affect the change in household consumption indirectly if they capture, for instance, the accumulation of other resources that an injured worker may use to smooth consumption over the earnings loss, spousal commitment to the labor force, or eligibility for other income support programs. Since I have no reason to know the particular form that the relationship between wages and household consumption growth assumes, Model 4 flexibly conditions for the influence of past wages with a 5-piece linear spline in pre-injury average weekly wages. Specifically, let the $L-1$ selected quantiles of $ln(wage_{t-1})$ be $KW_2, ...KW_L$, respectively. Then the spline is formed by entering as regressors the variables $W_1, ...W_L$, where $W_1 = \ln(wage_{t-1})$, and $W_i = \max(0, W_1 - KW_i)$ for $i = 2, ...L$. Choosing quintiles of the sample wage distribution as knot points, the resulting set of five variables forms a flexible function that controls for past wages and allows more precise identification of the effects of workers' compensation benefits on household consumption changes upon injury.[16]

[16]Reducing the spline to 4 pieces by choosing quartiles as knot points had very little effect on the coefficients of interest. Expanding the spline to 8 pieces (choosing the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles as knot points) also did not change the coefficients of interest remarkably.

3.4. Results

Results from regressions of the reduced-form models given by equation 3.1 are presented in Table 3.2. For each model, in the first column, I report results of the regression which uses as the dependent variable the change in total food plus housing consumption upon a work-related disability; the second and third columns report results for the changes in food and housing consumption separately. Model 1 is the simple regression suggested by equation (1), wherein consumption changes are regressed upon the log of the individual's pre-injury average weekly wage, the log of his/her potential weekly workers' compensation benefit, a vector of personal characteristics, and a set of year dummies. Model 2 adds state fixed effects, Model 3 includes state-year specific controls (unemployment rates and an index of housing prices), and Model 4 includes a 5-piece linear spline in past wages.

The independent variable of most interest is the (log) of the weekly workers' compensation benefit entitlement. The estimated coefficients on the benefit variable are positive, representing a consumption-smoothing effect of workers' compensation benefits, irrespective of the model or dependent variable employed. For the simple model without state fixed effects, the estimate is statistically different from zero only for housing consumption. Specifically, the estimate of 0.184 indicates that a 10 percent increase in workers' compensation benefit eligibility is associated with a 1.84 percent increase in the change in housing consumption upon incurring a work-related disability.

Once state fixed effects are added in the second model, however, the results suggest a significant consumption-smoothing effect of workers' compensation for total food plus housing consumption, as well as for both food and housing consumption separately. For a

Table 3.2: Consumption-smoothing Effects of Workers' Compensation Benefits

	(Model 1)			(Model 2)			(Model 3)			(Model 4)		
	Food + Housing	Food	Housing	Food+ Housing	Food	Housing	Food+ Housing	Food	Housing	Food+ Housing	Food	Housing
Log potential weekly WC benefit	0.069	0.072	0.184	0.234	0.252	0.256	0.263	0.254	0.266	0.363	0.337	0.373
	(0.090)	(0.090)	(0.086)	(0.093)	(0.109)	(0.110)	(0.090)	(0.108)	(0.108)	(0.115)	(0.136)	(0.151)
Log after-tax weekly wage t-1	-0.055	-0.073	-0.062	-0.108	-0.107	-0.122	-0.134	-0.112	-0.128			
	(0.048)	(0.049)	(0.048)	(0.062)	(0.065)	(0.039)	(0.063)	(0.067)	(0.038)			
Age	-0.009	-0.012	0.004	0.001	-0.002	0.010	0.004	-0.001	0.010	0.002	-0.001	0.008
	(0.009)	(0.009)	(0.007)	(0.008)	(0.009)	(0.011)	(0.008)	(0.010)	(0.011)	(0.007)	(0.009)	(0.010)
Male	0.017	-0.120	0.025	-0.039	-0.150	0.032	-0.005	-0.134	0.033	0.014	-0.127	0.051
	(0.073)	(0.082)	(0.044)	(0.080)	(0.100)	(0.057)	(0.076)	(0.101)	(0.057)	(0.076	(0.109)	(0.059)
Married	-0.152	-0.148	-0.025	-0.189	-0.174	0.072	-0.216	-0.179	0.066	-0.206	-0.166	0.056
	(0.090)	(0.093)	(0.056)	(0.108)	(0.106)	(0.075)	(0.115)	(0.110)	(0.077)	(0.111)	(0.112)	(0.074)
Less than high school	-0.048	-0.048	-0.031	-0.028	-0.037	-0.091	-0.020	-0.038	-0.094	-0.012	-0.018	-0.080
	(0.069)	(0.081)	(0.052)	(0.074)	(0.094)	(0.059)	(0.071)	(0.097)	(0.061)	(0.072)	(0.100)	(0.063)
More than high school	0.160	0.027	0.058	0.186	0.005	0.049	0.215	0.013	0.052	0.175	0.003	0.051
	(0.096)	(0.076)	(0.102)	(0.118)	(0.089)	(0.092)	(0.121)	(0.090)	(0.092)	(0.111)	(0.093)	(0.088)
White	0.085	-0.080	-0.020	0.055	-0.048	-0.031	-0.047	-0.093	-0.043	-0.117	-0.156	0.001
	(0.165)	(0.165)	(0.210)	(0.178)	(0.231)	(0.218)	(0.177)	(0.235)	(0.229)	(0.189)	(0.219)	(0.235)
Black	0.273	0.398	0.090	0.199	0.180	0.099	0.139	0.161	0.086	0.080	0.114	0.141
	(0.212)	(0.226)	(0.211)	(0.230)	(0.280)	(0.237)	(0.215)	(0.282)	(0.237)	(0.227)	(0.255)	(0.252)
Household size t-1	0.034	0.003	0.038	0.021	0.005	0.031	0.029	0.007	0.034	0.022	0.005	0.036
	(0.025)	(0.027)	(0.027)	(0.030)	(0.026)	(0.031)	(0.030)	(0.026)	(0.031)	(0.028)	(0.027)	(0.030)
Change in hh size	0.102	0.048	0.117	0.142	0.149	0.107	0.166	0.159	0.110	0.182	0.171	0.112
	(0.040)	(0.062)	(0.036)	(0.051)	(0.055)	(0.048)	(0.051)	(0.056)	(0.047)	(0.047)	(0.058)	(0.047)
State-year unemp. rate							-0.169	-0.047	-0.037	-0.166	-0.044	-0.029
							(0.058)	(0.034)	(0.047)	(0.051)	(0.035)	(0.049)
State-year housing price index							-0.009	-0.004	-0.001	-0.009	-0.005	-0.001
							(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Implied % Δ in C at 10th %tile benefits	-4.4%	-4.8%	-7.0%	-18.3%	-19.9%	-13.0%	-20.6%	-20.1%	-13.8%	-28.2%	-26.7%	-21.9%
Implied annual Δ in C at 10th %tile benefits	-282	-112	-147	-1262	-734	-396	-1593	-762	-828	-2044	-1183	-996
State dummies?	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Earnings spline?	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
R^2	0.1338	0.1082	0.2816	0.3857	0.3884	0.4589	0.4294	0.3966	0.4610	0.4684	0.4166	0.4684

Notes: All values are deflated into 1992 dollars using the appropriate component of the CPI-U. Consumption data are measured weekly. All regressions have 248 observations and include dummies for the year of injury. Standard errors are corrected for clustering within state and year.

10 percent increase in the potential workers' compensation benefit entitlement, the drop it total food plus housing consumption is offset by 2.34 percent, while the change in food consumption is increased by 2.52 percent, and the change in housing consumption is increased by 2.56 percent. The coefficient on the benefit variable is now statistically significant at the two percent level for each measure of the consumption change.

The fact that state fixed effects increase the magnitudes of the consumption-smoothing estimates so substantially is somewhat puzzling. The change in the results from Model 1 to Model 2 indicates an omitted variables bias in the first model and suggests a negative correlation between state fixed effects and workers' compensation benefit levels. In other words, workers' compensation benefits are more generous in states in which the adverse effect of injury on household consumption is larger. One possibility is that the fixed effects are picking up the industrial/occupational composition of the state population. That is, perhaps benefits are more generous, and the adverse effects of injuries on consumption are larger in states with a higher proportion of workers in injury-prone industries and occupations. However, including thirteen industry and nine occupation dummies in Model 1 does not change the results noticeably.[17] Another possible explanation, given the small sample size, is that a few individual observations are exerting undue influence on the results, and state fixed effects are picking up the influence of these outliers. In results not shown here, I examine the sensitivity of the results to influential observations by running median regressions for the pooled sample (i.e., Model 1). The results of these median regressions, however, look very similar to the estimates for Model 1 in Table 3.2.,

[17]More detailed occupation and industry classifications based on the 3-digit census codes are considered restricted access HRS data but will be available to me for future versions of this paper.

suggesting that state fixed effects are not simply controlling for the influence of individual outliers.

Including state/year-specific controls in the third model does not change the parameters of interest dramatically. The results from Model 3 suggest that a 10 percent increase in potential weekly benefits would offset the drop in total consumption by 2.63 percent, the change in food consumption by 2.54 percent, and the decrease in housing consumption by 2.66 percent. The coefficient on the state-year unemployment rate is negative, suggesting larger drops in consumption for injured workers in states with higher unemployment; however, the estimate is statistically significant only for total food plus housing consumption.

Under the specification of Model 4, a 5-piece linear spline in wages is included to control more carefully for the influence of past weekly wages on household consumption changes upon injury. When I flexibly condition for the influence of past wages in this way, the estimated consumption-smoothing effects of workers' compensation benefits increase substantially in magnitude. Specifically, a 10 percent increase in benefit eligibility now offsets the loss in total consumption by 3.63 percent, the decrease in food consumption by 3.37 percent, and the decline in housing consumption by 3.73 percent.

The bottom of the table describes the predicted changes in annual consumption if workers' compensation benefits were very low, equal to the 10th percentile of their current distribution. Under Model 2, at 10th percentile benefit levels, the predicted drop in annual food plus housing consumption would be about $1262, which amounts to a decrease of 18.3 percent. Decreases in food consumption and housing consumption account unequally for this change; the estimates predict a decrease in food consumption of $734 (or 19.9

percent) and a drop in housing consumption of $396 (13.0 percent). Under Model 3, which includes state/year-specific controls like state unemployment rates and a housing price index, the predicted drop in total consumption is larger than the Model 2 results suggest. Specifically, at 10th percentile benefits, the predicted decrease in annual total (food plus housing) consumption is $1,593 (or 20.6 percent). This change in the predicted decrease in total consumption appears to be coming from a larger predicted drop in housing consumption under Model 3. Finally, the results from Model 4 suggest even larger drops in consumption if benefits were set at a level equal to the 10th percentile of their current distribution. The predicted drop in total consumption is now $2044 (or 28.2 percent), while the predicted loss in annual food consumption is $1183 (26.7 percent), and the predicted loss in annual housing consumption is $996 (21.9 percent).

In summary, I find that if workers' compensation benefits were very low relative to current levels, work-related injuries would be associated with decreases in household food and housing consumption in the range of 20 to 30 percent. Moreover, the implied 20 to 30 percent declines in food and housing consumption represent more than a loss in material well-being for the injured worker; they also indicate a substantial decrease in material well-being for the other members of his or her household (i.e., his spouse and/or dependent children). Thus, workers' compensation programs appear to be providing important and substantial social insurance benefits for both injured workers and their families.

3.5. Specification checks and alternative methods

One might be concerned about selection bias to the reduced-form estimates of β_1 if increased generosity of workers' compensation benefits causes more workers to experience a workplace injury (e.g., through reduced effort devoted to workplace safety, as in Krueger, 1990). If those marginal workers who are induced by a change in benefits to become injured have systematically different consumption preferences that are not controlled for in my model, my estimates of β_1 will be biased.[18]

The existing literature on the incentive effects of workers' compensation provides mixed evidence on the magnitude of this effect. Several papers find evidence of a positive relationship between workers' compensation benefits and non-fatal injury rates (e.g., Chelius (1982), Ruser (1985, 1991)) or between benefit levels and program participation rates (e.g., Krueger (1990), Hirsch, Macpherson, and Dumond (1997), Raphael and Neuhauser (2004)). The estimated elasticities from these studies, which differ widely in terms of data sources and methodologies, range from non-significant to 0.7. However, the only paper that estimates these effects using nationally representative micro data for the years of interest in this paper, Bronchetti (2006b), finds essentially no effect of benefit generosity on the number of workers' compensation claims once one controls carefully for the influence of past earnings.

Because none of these papers directly examines the question of the responsiveness of injury rates to workers' compensation benefit generosity for the years of interest or for older workers like those in my sample, I estimate a probit model of the effect of

[18] Another way in which workers could differentially select into the sample is if increases in benefits cause longer injury durations so that with increased benefit generosity, individuals are more likely to be observed with a work-limiting health problem at the point of interview.

workers' compensation benefit generosity on the likelihood of incurring a work-related, work-limiting disability using a sample of HRS respondents. Specifically, the model takes the form of Equation 3.1, where the dependent variable is a dummy variable for becoming injured or ill on the job, and the sample includes both workers who experience a workplace injury and those who do not. The probit specification includes the same controls as Model 3 of the reduced-form regressions, namely demographic controls, state and year fixed effects, and state-year economic controls (unemployment rates and an index for housing prices).

The probit results are reported in the top panel of Table 3.3. The coefficients on the demographic variables generally have the expected sign. The estimated effect of a 10 percent increase in workers' compensation benefit levels on the marginal probability of a work-related injury or illness is 0.0033, and the corresponding probit coefficient on the benefit variable (0.0729) is not statistically different from zero. These results suggest that sample selection is not likely to be causing significant bias to my estimates of the consumption-smoothing effects of workers' compensation benefits.

3.5.1. Consumption-Smoothing for Households with Limited Assets

All else equal, the consumption-smoothing effects of workers' compensation benefits should be larger for households without substantial assets upon which to draw when an on-the-job injury is incurred. The HRS provides detailed information on the financial resources available to households, including information on the values of real estate assets, resalable vehicles, owned businesses, stocks, bonds, IRA accounts, certificates of deposit,

Table 3.3: Effects of WC Benefits on Likelihood of Becoming Injured On-the-Job

Selection Probit	Average Derivative	Probit Coefficient
Log potential weekly WC benefit	0.0033	0.0729
	(0.0038)	(0.0828)
Log after-tax weekly wage t-1	-0.0046	-0.0996
	(0.0026)	(0.0056)
Age	-0.0002	-0.0040
	(0.0002)	(0.0049)
Male	0.0122	0.2587
	(0.0027)	(0.0548)
Married	-0.0087	-0.1720
	(0.0032)	(0.0582)
Less than high school	0.0088	0.1729
	(0.0032)	(0.0574)
More than high school	-0.0105	-0.2553
	(0.0023)	(0.0639)
White	0.0021	0.0468
	(0.0056)	(0.1308)
Black	-0.0033	-0.0763
	(0.0060)	(0.1469)
Household size t-1	0.0002	0.0034
	(0.0010)	(0.0210)
Change in household size	-0.0007	-0.0156
	(0.0015)	(0.0318)
State unemployment rate	-0.0022	-0.0474
	(0.0024)	(0.0517)
State-year housing index	-0.0001	-0.0017
	(0.0001)	(0.0024)
Year dummies?	Yes	Yes
State dummies?	Yes	Yes

Notes: Results from probit estimation described in text; standard errors are corrected for dependence between repeated observations on the same individuals. For consistency with the consumption-change regressions, I include only observations from 1992-94, 1994-96, and 2000-02.

checking accounts, and other savings. Along with this data on households assets, the HRS surveys also provide a measure of outstanding debt for these households. In this section, I refer to “net household assets” as the difference between the value of the assets listed above and the value of debt outstanding.

In order to examine whether the consumption-smoothing effects of workers' compensation benefits differ according to the value of pre-injury household assets, I estimate the reduced-form effect of benefit eligibility on household consumption growth, splitting the sample according to the level of net household assets. Specifically, I employ the version of Equation 3.1 that includes the (log) potential weekly WC benefit, the (log) after-tax weekly wage, demographic controls, year and state fixed effects, and the state-year unemployment rate and housing price index. The expected result is a larger coefficient on the benefit variable for the subsample of households with lower pre-injury assets.

The results from the corresponding regressions of Equation 3.1 are presented in Table 3.4. Regardless of whether the regressions include a separate control for the level of pre-injury net assets, the estimates are as expected. That is, workers' compensation benefits have a more significant consumption-smoothing effect for households who have accumulated less in assets up to the point of injury and therefore have fewer alternative resources available to them with which to smooth their consumption. This result holds across the different measures of consumption. The results in the first row are for regressions of Equation 3.1 that do not include a control for the level of the household's (real) pre-injury assets. In other words, under this specification, the level of pre-injury assets is assumed to affect household consumption changes only through its interaction with other independent variables, most importantly, workers' compensation benefit eligibility. The second row of results, for the model in which a separate control for the level of pre-injury assets is included in the regression, strengthens the conclusion that workers' compensation benefits have larger consumption-smoothing effects for households with low pre-injury wealth. A 10 percent increase in potential workers' compensation

Table 3.4: Consumption-smoothing Effects of WC According to Pre-Injury Assets

	Assets Below 25th Percentile			Assets Above 25th Percentile		
	Food+ Housing	Food	Housing	Food+ Housing	Food	Housing
(Without control for real assets)						
Log potential weekly	0.277	0.385	0.649	0.181	0.138	0.338
WC benefit	(0.226)	(0.622)	(0.687)	(0.119)	(0.141)	(0.132)
Implied %Δ in C at	-22.2%	-23.9%	-29.1%	-14.3%	-9.2%	-20.1%
10th percentile benefits						
(With control for real assets)						
Log potential weekly	0.403	0.328	0.736	0.197	0.165	0.337
WC benefit	(0.251)	(0.702)	(0.763)	(0.109)	(0.133)	(0.131)
Implied %Δ in C at	-29.1%	-20.8%	-34.0%	-16.2%	-11.7%	-20.3%
10th percentile benefits						
Number of observations		65			183	

Notes: Results from reduced-form regressions of Equation 3.1; standard errors in parentheses. For this sample, the 25th percentile of the distribution of net household assets is $6547.40 (in 1992 dollars). All values deflated into 1992 dollars using tte appropriate component of the CPI-U. Consumption data are measured weekly. All regressions include the (log) after-tax weekly wage in t-1, demographic controls, state and year dummies, state-year unemployment rates and housing price indices. Standard errors are corrected for clustering by state and year.

benefits offsets the drop in total food plus housing consumption by 4.03 percent for those with assets below the 25th percentile. For the group of injured workers with assets above the 25th percentile, an increase in benefits of the same magnitude offsets the drop in total consumption by only 1.97 percent.[19] The result of larger consumption-smoothing effects for the low asset group also holds when I examine food and housing consumption separately, although the estimates are no longer as precise.

[19]The estimated effects of benefits on total food plus housing consumption are statistically significant for both asset groups.

3.5.2. Two-stage Least Squares Estimation

Thus far I have argued that the parameter of most policy interest is the estimate of the effect of workers' compensation benefit eligibility on the change in consumption upon becoming injured/ill on the job (the average effect of intention-to-treat, or the AIT). Indeed, the estimates presented above represent the consumption-smoothing effects of legislated changes in the generosity of workers' compensation benefits, which can be directly controlled by policy makers, rather than the effects of benefit receipt, which cannot.

On the other hand, one may also be interested in measuring the *direct* effect of workers' compensation income received on the change in household consumption upon a workplace injury or illness. This structural parameter can be estimated with a two-stage least squares approach, using potential workers' compensation benefit eligibility as an instrument for workers' compensation benefits received. I pursue this instrumental variables method, estimating the following system of equations:

$$WC_{ist} = \alpha_0 + \alpha_1 BEN_{ist} + \alpha_2 X_{it} + \tau_t + \gamma_s + \alpha_3 \varphi_{st} + \epsilon_{ist} \tag{3.2}$$

$$\Delta C_{ist} = \pi_0 + \pi_1 WC_{ist} + \pi_2 X_{it} + \tau_t + \gamma_s + \pi_3 \varphi_{st} + u_{ist} \tag{3.3}$$

where WC_{ist} is the (log) amount of workers' compensation benefits received by the injured worker, BEN_{ist} is the (log) potential weekly workers' compensation benefit for which the individual is eligible, and the remaining variables are defined as above (see Equation 3.1). In an expanded version of the two-stage least squares model, I estimate this system of equations, using three variables to predict benefits received in the first stage: the potential weekly workers' compensation benefit entitlement (BEN_{ist}) and the waiting and retroactive periods in an individual's state and year.

Direct comparison of the two-stage least squares estimates to the reduced-form results presented in Section 3.4 would require using in the first stage a measure of weekly workers' compensation income received at the point of interview. Instead, the measure of workers' compensation income used in the first stage is *total benefits received in the last calendar year*, and, complicating matters further, the HRS data on the duration of workers' compensation receipt is not reliable. Therefore, the two-stage least squares estimates presented below should not be compared to the reduced-form estimates in the usual way. However, this alternative approach provides an additional test of a relationship between workers' compensation benefits and changes in household consumption for workers incurring a work-related injury or illness.

For the second-stage estimate, π_1, to be valid, one must be willing to assume that potential workers' compensation benefits are uncorrelated with the change in log consumption except through the workers' compensation system (after controlling for the other covariates included in the model). One way to check this assumption is to consider the relationship between potential benefits and consumption changes in samples for whom there should be no consumption-smoothing effect of benefits. That is, if it is true that benefit eligibility impacts changes in household consumption upon injury only through the workers' compensation system, then I should find no relationship between benefit eligibility and consumption changes for comparison groups of workers not experiencing work-related disabilities. Indeed, when I estimate the reduced-form model given by Equation 3.1 for the comparison groups of individuals never injured on the job and workers never becoming disabled (at work or elsewhere), I find no significant effect of benefit eligibility on household consumption changes (see Appendix Table 1).

A potential source of bias to the estimate of π_1 is an "option value" to workers' compensation benefits. That is, if there is a stigma to receiving workers' compensation benefits, injured workers may delay filing a claim but reduce their consumption less because they know that workers' compensation is available. This would result in an upward bias to the 2SLS estimate. However, given that injured workers risk denial of benefits by delaying filing a claim, I am less concerned about this source of bias to the 2SLS estimates than if the program in question were, for instance, unemployment insurance or TANF, in which potential recipients may be more likely to delay take-up of benefits. In theory, this problem can be surmounted if there exists another instrument with which one can model the take-up decision. I therefore employ two IV models, one that uses only benefit eligibility as the instrumental variable, and a second model that also includes the waiting and retroactive periods in the individual's state and year as instruments.

Finally, an important caveat in interpreting the estimate of π_1 is that it measures the effect of workers' compensation benefit receipt on those individuals who are *induced* by the instrument to change the amount of workers' compensation benefits they receive (e.g., by choosing to take up benefits).[20] If these individuals at the margin have systematically different consumption responses to benefit receipt after controlling for covariates, π_1 will not estimate the average effect of workers' compensation benefits received on household consumption changes. Instead, the two-stage least squares estimate of π_1 will only

[20] Another way in which behavior of individuals at the margin is affected by the instrument is if some individuals are induced to remain on the workers' compensation rolls for longer when benefits increase. This effect may be especially present in my estimation, since the dependent variable in the first stage is the amount of workers' compensation income in the last calendar year.

represent the consumption-smoothing effect of benefits received for these individuals who are induced by benefit variation to participate, ignoring the consumption-smoothing effect of benefits for households who would participate regardless of benefit generosity.

The results of the two-stage procedure are presented in Table 3.5. The estimates from both models indicate the presence of a consumption-smoothing effect of workers' compensation benefit receipt. The estimates from Model 1, in which actual benefits are instrumented using only the potential weekly benefit for which the individual is eligible, suggest that a 10 percent increase in the amount of workers' compensation benefits received by an injured worker mitigates the drop in total food plus housing consumption by 2.29 percent. Separating the two consumption categories, I find that such an increase in benefits received offsets the decrease in food consumption by 2.06 percent and lessens the decline in housing consumption by 1.84 percent. However, the consumption-smoothing effects of workers' compensation are imprecisely estimated, and the coefficient on benefits is statistically significant only for housing consumption.

The second two-stage least squares model includes two additional instruments (along with the potential weekly benefit variable) to predict workers' compensation benefit receipt in the first-stage equation: the waiting period and the retroactive period in an individual's state and year. Recall that if there is an option value to workers' compensation for non-recipients, the 2SLS estimates from Model 1 will be biased upward. Including additional instruments in the first-stage equation predicting benefit receipt should reduce the upward bias. Indeed, compared to the original 2SLS estimates, the results from Model 2 indicate a smaller positive effect of workers' compensation receipt on household consumption growth. Specifically, a 10 percent increase in the amount of benefits received

Table 3.5: Consumption-smoothing Effects of Workers' Compensation Benefit Receipt

	(Model 1)			(Model 2)		
	Food+ Housing	Food	Housing	Food+ Housing	Food	Housing
Log predicted WC benefits received	0.229	0.206	0.184	0.093	0.127	0.075
	(0.262)	(0.274)	(0.086)	(0.028)	(0.027)	(0.029)
Log after-tax weekly wage t-1	-0.059	-0.097	-0.062	-0.028	-0.033	-0.027
	(0.063)	(0.101)	(0.048)	(0.037)	(0.044)	(0.028)
Age	0.012	0.015	0.004	0.008	0.013	0.001
	(0.016)	(0.015)	(0.007)	(0.006)	(0.008)	(0.005)
Male	-0.091	-0.162	0.025	-0.023	-0.123	0.009
	(0.193)	(0.197)	(0.044)	(0.070)	(0.090)	(0.072)
Married	-0.109	-0.045	-0.025	-0.169	-0.079	-0.004
	(0.187)	(0.171)	(0.056)	(0.091)	(0.097)	(0.062)
Less than high school	-0.174	-0.164	-0.031	-0.060	-0.098	-0.140
	(0.264)	(0.252)	(0.052)	(0.107)	(0.136)	(0.079)
More than high school	0.305	0.141	0.058	0.232	0.099	0.073
	(0.213)	(0.267)	(0.102)	(0.086)	(0.139)	(0.059)
White	-0.343	-0.356	-0.020	-0.146	-0.242	-0.082
	(0.451)	(0.468)	(0.210)	(0.149)	(0.176)	(0.166)
Black	0.067	0.152	0.090	0.062	0.150	0.128
	(0.235)	(0.237)	(0.211)	(0.208)	(0.219)	(0.165)
Household size t-1	0.102	0.074	0.038	0.066	0.053	0.057
	(0.075)	(0.082)	(0.027)	(0.028)	(0.035)	(0.020)
Change in hh size	0.187	0.180	0.117	0.172	0.172	0.044
	(0.097)	(0.093)	(0.036)	(0.050)	(0.065)	(0.055)
State unemployment rate	-0.149	-0.097	-0.149	-0.160	-0.100	-0.041
	(0.086)	(0.101)	(0.086)	(0.040)	(0.072)	(0.053)
State-year housing index	-0.011	-0.008	-0.011	-0.008	-0.006	-0.002
	(0.006)	(0.007)	(0.006)	(0.002)	(0.003)	(0.002)
State dummies?						
Instrument(s) used in first stage	Potential WC benefit			Potential WC benefit Waiting period Retroactive period		

Notes: Results from 2SLS regressions, weighted using person-level sample weights; robust standard errors in parentheses. Consumption data are measured weekly. Regressions have 248 observations and include dummies for the year of injury. In Model 1, results are obtained from 2SLS estimation of the system given by Equations 3.2and 3.3, where the potential weekly WC benefit is the only instrumental variable. Model 2 uses the lengths of waiting and retroactive periods in an individual's state/ year as additional instruments.

by an injured worker offsets the drop in total (food plus housing) consumption by 0.93 percent, the decline in food consumption by 1.27 percent, and the decrease in housing consumption by 0.75 percent. The increased statistical precision of the estimates in the second model is largely a result of the fact that the first-stage equation is now more fully identified.[21]

Taken in conjunction with the reduced-form estimates presented in Section 3.4, the 2SLS results provide further evidence of a consumption-smoothing role for workers' compensation benefits. While the reduced-form estimates reflect a positive effect of workers' compensation benefit generosity on the consumption changes of potentially eligible recipients, the 2SLS estimates suggest a positive and direct response of changes in household consumption to the amount of workers' compensation benefits actually received.

3.6. Optimal Workers' Compensation Benefits

Estimates of the consumption-smoothing effects of workers' compensation should be of concern to policy makers because they reflect the benefits of a social insurance program that is designed to support workers facing economic hardship brought on by a workplace injury or illness. The results presented in this paper indicate a substantial consumption-smoothing role for workers' compensation benefits when a worker becomes injured on the job. Across many different consumption measures and model specifications, I find that a

[21]The coefficients on the benefit variable and the retroactive period have the expected signs in the first-stage regressions. The coefficient on the waiting period is actually positive (although statistically insignificant). The waiting period acts as a deductible so that in state-years with longer waiting periods, the individuals who end up receiving workers' compensation are those with longer-lasting injuries who will, on average, have received more in WC benefits over the last calendar year. If this composition effect outweighs the negative take-up effect of higher waiting periods, the positive coefficient on the waiting period is sensible. Under Model 2, the F-statistic from the first-stage regression is large enough to conclude that the instruments are jointly significant at the 10 percent level.

10 percent increase in workers' compensation benefit generosity is associated with a 2 to 4 percent smaller drop in household consumption for individuals who incur a work-limiting disability caused by their jobs.

While the magnitudes of these estimated consumption-smoothing effects are interesting on their own, their substantive meaning can only be determined by weighing them against the distortionary effects of workers' compensation on individual behavior (i.e., the effects of benefit variation on the frequency and durations of injuries). The public finance literature provides a starting point for analyzing the social welfare implications of varying the generosity of workers' compensation benefits. A classic paper by Baily (1978) approaches the question of optimal unemployment insurance benefits in a two-period model in which individuals consume and save in the first period and face an exogenous probability of unemployment in the second period. Upon job loss in the second period, the individual can then deterministically vary his unemployment duration (e.g., by varying search effort) according to the level of unemployment benefits provided. Baily derives a formula for optimal unemployment insurance benefits that involves three empirically estimable parameters: the change in household consumption upon unemployment (as a function of unemployment benefits), the coefficient of relative risk aversion, and the elasticity of unemployment duration with respect to benefits. In short, the optimal benefits formula balances the costs of work disincentives from an increase in benefits with the welfare gains in terms of smoother consumption for affected workers.

Chetty (2006) expands upon this analysis in two key ways. First, Chetty shows that Baily's result depends on an assumption that third and higher-order terms of the utility function are ignorable (i.e., individuals have no precautionary savings motives), and he provides a formula for the optimal level of unemployment insurance benefits when this assumption is relaxed.[22] Second, he extends the two-period model in Baily (1978) to a continuous-time, dynamic framework in which workers face a persistent risk of unemployment. Here, he shows that a Baily-type expression for optimal benefits still holds, subject to a set of weak regularity conditions. Moreover, Chetty (2006) shows that the conclusions for optimal benefit levels hold even when one allows for leisure value of unemployment, borrowing constraints, private insurance decisions, and other extensions of Baily's model.

3.6.1. Modeling Optimal Benefits for Work-related Disabilities

Both models can be carefully extended to the case of work-related injuries and illnesses. To emphasize the intuition of the resulting formula for optimal workers' compensation benefits, I limit the majority of my discussion to a very simple and illustrative model motivated by Chetty (2006).

Consider a one-period model in which a worker faces risk of on-the-job injury only at the beginning of the period, and then lives until the end of the period. Suppose the worker arrives at the beginning of the period having accumulated wealth equal to W_0. With probability p, he incurs an on-the-job injury, making him temporarily unable to work, and then receives workers' compensation benefits, b, for the duration of time he spends away from work.[23] With probability $(1-p)$, he receives no injury and continues to work

[22] Specifically, Chetty's formula requires only that fourth and higher order terms are small ($u'''' \approx 0$). Chetty demonstrates that ignoring third-order terms of u can lead to substantial approximation error in Baily's solution.

[23] Note that there is no take-up decision modeled here; if a worker is injured on the job and is temporarily unable to work, he automatically receives workers' compensation benefits for the duration of time out of work due to the injury.

at his job that pays wage w, with no further risk of job loss or injury, for the remainder of his life. In the framework of injury risk, I assume that the probability of injury (and thus, of benefit receipt), p, is exogenous with respect to the level of workers' compensation benefits. This assumption is supported by some of the evidence in the literature: The second chapter of this dissertation, for example, finds that the reduced-form effect of workers' compensation benefit generosity on the number of workers' compensation claims is not statistically different from zero when one controls for the confounding influence of wages on both benefits and claims decisions.[24]

In the employed and uninjured state, the worker pays a lump-sum tax of τ, which finances workers' compensation. In reality, if a worker is injured on the job, there is an exogenous component to the duration of his injury in the time necessary for him to recuperate; however, beyond that time, he may extend the duration of time out of work by devoting less effort to rehabilitation, exaggerating the seriousness of his injury, et cetera. For now, assume for simplicity that the duration of time out of work due to an injury can be entirely determined by the worker.[25] Let $D(b)$, denoted D below, be the fraction of the period that the worker spends away from work due to his injury or illness, which will be a function of the amount of benefits available to him. By definition, D must be greater than or equal to zero.

[24]There are other papers that are unable to document a significant effect of variation in benefit generosity on the number of claims, including Bartel and Thomas (1985) and Lanoie (1992).

[25]Allowing for a stochastic component to injury duration introduces further uncertainty for workers. If the stochastic and deterministic parts of D enter additively, the optimal benefits formula can be written as in (9), but requires a positive correction factor that augments the consumption drop upon injury.

Finally, suppose that the costs of effort devoted to rehabilitation and return-to-work, the benefits of increased recovery time in terms of better return-to-work outcomes (assuming that the effects of increased health outweigh those of potential loss in human capital), and any leisure value of non-work due to injury can be captured in an increasing, concave function of D, denoted $g(D)$.

In this framework, the individual takes b and τ as given and chooses consumption if employed, c_e, consumption if injured, c_i, and D to

$$\max(1-p)U(c_e) + p[U(c_i) + g(D)] \tag{3.4}$$

subject to a budget constraint in each state:

$$\begin{aligned} W_0 + (w - \tau) - c_e &\geq 0 \\ W_0 + bD + w(1-D) - c_i &\geq 0 \end{aligned}$$

Here, the utility function, $U(\cdot)$, is assumed to be strictly concave and state-independent, implying that an individual values a given level of consumption equally, regardless of whether he is employed or away from work due to injury. An additional implicit assumption is that the utility functions of those workers who become injured take the same form as for those workers who do not ever become injured. Finally, note that to guarantee an interior solution (i.e., that the individual's optimal choice of D takes a non-zero value), $g(D)$ must be sufficiently concave (or $g'(D)$ must be sufficiently high at low levels of D).

Let $V(b,\tau)$ denote the maximal value for the expression above for a given level of workers' compensation benefits, b, and taxes, τ. Then, taking the optimizing behavior of workers as given, the social planner's problem is to choose the optimal set of workers' compensation benefits and taxes, (b, τ), to

$$\max V(b, \tau) \quad s.t.\ pbD = (1-p)\tau \tag{3.5}$$

Since τ is a function of b by the government balanced budget constraint, we observe that $V(b, \tau)$ can be written:

$$\begin{aligned} V(b) &= \max(1-p)U(c_e) + p[U(c_i) + g(D)] + \\ &\quad \lambda_e[W_0 + w - \tau - c_e] + \lambda_i[W_0 + bD + (1-D)w - c_i] \end{aligned} \tag{3.6}$$

The partial derivatives of V with respect to the parameters c_e, c_i, and D, are all zero given the maximizing behavior of workers (an application of the Envelope Theorem). The optimizing behavior of agents also implies that the Lagrange multipliers, λ_e and λ_i, are equal to the marginal utilities of consumption in each state, so the optimality condition ($\frac{dV}{db}(b^*) = 0$) can be expressed as

$$U'(c_e)\left[1 + \frac{b}{D}\frac{dD}{db}\right] = U'(c_i) \tag{3.7}$$

which requires that the marginal benefit of raising c_i by \$1 (the right hand side) be equal to the marginal cost of raising τ in the employed state to cover the \$1 increase in b. The key technique to turn this optimality condition into an approximate formula for the optimal benefit rate involves rearranging and approximating $\frac{U'(c_i)-U'(c_e)}{U'(c_e)}$ by taking a Taylor series expansion around the average worker's utility at the consumption level in the employed state. If third and higher-order terms of $U(\cdot)$ are ignored, the condition for optimal workers' compensation benefits can be expressed as:

$$\gamma \frac{\Delta c}{c}(b^*) \approx \varepsilon_{D,b} \tag{3.8}$$

where

$$\begin{aligned}
\frac{\Delta c}{c} &= \frac{c_e - c_i}{c_e} = \text{consumption drop due to a work-related injury} \\
\gamma &= -c\frac{u''(c)}{u'(c)} = \text{coefficient of relative risk aversion} \\
\varepsilon_{D,b} &= \frac{d \log D}{d \log b} = \text{elasticity of expected injury duration w.r.t. benefits.}
\end{aligned}$$

This formula is analogous to that derived in Baily (1978) and is intuitively simple. The optimal benefit is defined by setting the proportional drop in consumption due to a work-related injury, times the degree of relative risk aversion, equal to the elasticity of injury duration with respect to a change in benefits. Thus, the welfare gains of a marginal increase in benefits in terms of smoother consumption for households affected by work-related injury risk, the magnitude of which will depend on the degree of risk aversion, are balanced against the social welfare costs of a marginal increase in benefits in terms of increased time spent away from work due to a work-related injury. Relative to the environment of unemployment risk, the formula's predictions for optimal workers' compensation benefits will differ if the frequency of injuries is permitted to vary with benefits, if the parameter reflecting risk aversion takes on different values for injured workers and the unemployed, and to the extent that the consumption-smoothing effects of workers' compensation benefits are of different magnitudes than those for unemployment insurance.

3.6.2. A More General Formula for Optimal Benefits

The formula in (8) can be generalized in several important ways. First, a crucial step in deriving the approximation for optimal benefits above involves taking a Taylor series expansion around the worker's marginal utility at the level of consumption when employed. As an approximation, the formula in (8) disregards third and higher-order terms of the utility function when doing so, essentially ignoring precautionary savings motives for individuals. However, Chetty (2006) finds that ignoring third-order terms of the utility function can lead to substantial approximation error when calculating optimal benefits.

When this assumption is relaxed, the formula for optimal benefits depends not only on the coefficient of relative risk aversion but also on the coefficient of relative prudence. Specifically, when I assume instead that only fourth and higher-order terms of U are small in the Taylor series expansion described above, the approximation for optimal workers' compensation benefits is given by:

$$\gamma \frac{\Delta c}{c}(b^*) \left[1 + \frac{1}{2}\rho \frac{\Delta c}{c}(b^*)\right] \approx \varepsilon_{D,b} \tag{3.9}$$

where all terms are defined as above, and

$$\rho = -c\frac{U'''(c)}{U''(c)} = \text{the coefficient of relative prudence.}$$

Another important contribution of Chetty (2006) is to extend the static analysis to a continuous-time, dynamic lifetime utility model in which workers face a persistent risk of unemployment. The result is that the formula for optimal benefits in the dynamic model coincides with the formula in (9) with two exceptions. The parameters now represent average behavioral responses across states (employed/uninjured and injured) and time. The elasticity term on the right hand side represents the effect of a 1 percent change in b on the fraction of his *life* that the individual spends out of work due to work-related injuries or illnesses, and the change in c is now the mean proportional change in c upon work-related injury. The second difference between the formula for the dynamic model is that $\varepsilon_{D,b}$ is multiplied by $\frac{1}{1-D}$ (where D is the fraction of life spent out of work due to injury). This represents a feedback effect of raising benefits on tax revenues: Raising consumption while injured by $1 not only increases costs in terms of inducing longer claim durations, but it also reduces tax revenue since workers spend less of their lives employed.[26] In short, the conclusion is that the formula for the optimal level of benefits described above applies in a much more general setting than was previously thought, because the key parameters in 3.9 remain sufficient for computing the optimal level of benefits.

3.6.3. Implementing the Optimal Benefits Formulas

The formulas above in Equations 3.8 and 3.9 can be implemented using empirical estimates of their key inputs in order to calculate the optimal level of workers' compensation indemnity benefits. First, consider the parameter $\varepsilon_{D,b}$, which, in the general case, is the effect of a 1 percent increase in benefits on the fraction of his life that the agent spends out of work due to work-related injury(ies) or illness(es). If the frequency of workplace injuries is not affected by b, then $\varepsilon_{D,b}$ is equivalent to the elasticity of average injury/claim

[26]As an approximation, we can ignore this effect when implementing the optimal benefits formula, since $1-D$ is likely to be very close to one.

Table 3.6: Evidence on the Effects of WC Benefit Generosity on the Duration of Claims

Study	Dependent variable	Elasticity with respect to benefits
Butler and Worrall (1985)	Length of claims for low-back injuries in Illinois	0.2 - 0.4
Krueger (1991)	Length of claims for all injuries in Minnesota in 1986	> 1.5
Meyer, Viscusi, and Durbin (1995)	Length of claims for all injuries in Kentucky and Michigan in the early 1980s	0.3 - 0.4
Neuhauser and Raphael (2004)	Duration of TTD claims in California before and after 1994 and 1995 benefit increases	0.3 (0.6 to 0.8 with selection correction)

duration with respect to benefits.[27] This relationship has been examined in the empirical literature, and the resulting evidence on the magnitudes of the duration elasticities is reviewed in Krueger and Meyer (2002) and in Fortin and Lanoie (1998). Table 3.6 briefly describes the results of a few key studies on the incentive effects of workers' compensation benefits. In the exercise below, I consider multiple values for $\varepsilon_{D,b}$, incorporating these estimates of the duration elasticities in computing optimal benefits. Lastly, note also that the parameter $\varepsilon_{D,b}$ involves the total derivative of $D(c,x)$ with respect to b, which would include any effects of b on other behaviors that feed back into the choice of D. Fortunately, reduced-form studies that compare workplace injury durations across states/times that differ only in benefit levels actually identify this total derivative of interest.[28]

This paper provides the first empirical estimates of the extent of consumption smoothing provided by workers' compensation benefits (i.e., the parameter $\frac{\Delta \bar{c}}{c}(b)$). Depending

[27]Recall that the assumption that the probability of an injury/claim is exogenous with respect to benefits is maintained in the model above and is supported by the empirical results in Bronchetti (2006b).

[28]The same applies for the parameter $\frac{\Delta \bar{c}}{c}(b)$ and the reduced-form estimates from Section 5 of this paper.

on the regression specification employed, my reduced-form estimates of the consumption-smoothing effects of workers' compensation benefits suggest that a 10 percent increase in benefit levels offsets the loss in household consumption due to a work-related injury/illness by about 2.5 to 4 percent (or elasticities in the range of 0.25 to 0.4). In calculating the optimal level of workers' compensation benefits, I use two different estimates of the effect of benefits on the change in total food plus housing consumption. First, I calculate the optimal rate of wage-replacement based on the reduced-form consumption-smoothing estimate from Model 3 (0.263), which includes state fixed effects and state-year economic controls. Next, I recalculate the optimal benefit level using the estimated consumption-smoothing effect from Model 4 (0.363), which adds a 5-piece linear spline in pre-injury wages.

To be clear, it is important to note that in applying the optimal benefit formulas, $\frac{\Delta \bar{c}}{c}(b) \approx -\Delta \log C$, where $\Delta \log C$ is a function of the *replacement rate* of benefits to pre-injury wages. Instead, my estimates from Model 3, for example, imply that $\Delta \log C = -0.243 + .263 \log(BEN)$.[29] Dividing the coefficient on the benefit variable (0.263) by the mean replacement rate for my sample (0.782) allows me to calculate the optimal replacement rate, R, from $\Delta \log(C) = -0.243 + .3363R$.

Table 3.7 presents the results of optimal benefit calculations using my estimates of the consumption-smoothing effects of workers' compensation benefits and considering several different values for $\varepsilon_{D,b}$, all of which are consistent with empirical estimates provided in the literature. In either panel, the first column considers a "base case," in which the elasticity of time out of work with respect to benefits equals 0.3, which is consistent with

[29]The reduced-form regression results from Model 3 imply that in the absence of workers' compensation benefits, the average percentage decline in (log) total household consumption is 24.3%.

the estimated effect of benefit variation on the duration of claims from Meyer, Viscusi, and Durbin (1995). Applying my estimate of the impact of benefit generosity on total food and housing consumption changes from Model 3 to the formula in (8), motivated by Baily (1978), I find that the optimal benefit-wage ratio ranges from zero (at very low levels of risk aversion) to 0.544 at the highest level of risk aversion considered ($\gamma = 5.0$). Using my consumption-smoothing estimate from Model 4 and the formula in (8), the optimal rate of wage replacement is higher for every level of risk aversion, topping out at about 56 percent for the very highest value of γ. The last column of each panel examines the optimal benefit-wage replacement rate for this base case (where $\varepsilon_{D,b} = 0.3$), employing instead the more general optimal benefits formula in (9). Here, I find that for all levels of risk aversion, optimal benefits are more generous than when calculated under the original formula. For very high levels of risk aversion, the optimal rate of wage-replacement is approximately 60 percent. However, for this relatively small estimate of the distortionary behavioral effects of workers' compensation benefits, the optimal benefit-wage ratio is substantially less than the mean for my sample (0.782), regardless of which formula is employed.

The second column in each panel calculates optimal benefit levels from equation (8) when $\varepsilon_{D,b} = 0.4$. This case would be consistent with larger estimates of the duration-benefit elasticity from Meyer, Viscusi, and Durbin (1995) or from Butler and Worrall (1985). This slightly larger estimate of $\varepsilon_{D,b}$ decreases the optimal rate of wage replacement relative to the base case by 10 to 50 percent, depending on the level of risk aversion. In case 3, I allow the distortionary effects of worker's compensation benefits on injury frequency and duration to be even larger, setting $\varepsilon_{D,b}$ equal to 0.7. In this state of

Table 3.7: Optimal Workers' Compensation Benefit Calculations

Optimal Benefit Level Calculated Using Regression Results from Model 3 (state effects and state-year economic controls)

Coefficient of Relative Risk Aversion	Optimal benefits from Baily (1978) Base Case ($\varepsilon_{D,b}$= 0.3)	Case 2 ($\varepsilon_{D,b}$= 0.4)	Case 3 ($\varepsilon_{D,b}$= 0.7)	Case 4 ($\varepsilon_{D,b}$= 1.0)	Optimal Benefits from Chetty (2006) Base Case ($\varepsilon_{D,b}$= 0.3)
1.0	0	0	0	0	0.004
1.5	0.128	0	0	0	0.230
2.0	0.277	0.128	0	0	0.347
2.5	0.366	0.247	0	0	0.420
3.0	0.425	0.326	0.029	0	0.469
3.5	0.468	0.383	0.128	0	0.504
4.0	0.500	0.425	0.202	0	0.531
4.5	0.524	0.458	0.260	0.062	0.551
5.0	0.544	0.485	0.306	0.128	0.568

Optimal Benefit Level Calculated Using Regression Results from Model 4 (with earnings spline)

Coefficient of Relative Risk Aversion	Optimal benefits from Baily (1978) Base Case ($\varepsilon_{D,b}$= 0.3)	Case 2 ($\varepsilon_{D,b}$= 0.4)	Case 3 ($\varepsilon_{D,b}$= 0.7)	Case 4 ($\varepsilon_{D,b}$= 1.0)	Optimal benefits from Chetty (2006) Base Case ($\varepsilon_{D,b}$= 0.3)
1.0	0.004	0	0	0	0.167
1.5	0.256	0.113	0	0	0.330
2.0	0.364	0.256	0	0	0.415
2.5	0.429	0.343	0.081	0	0.468
3.0	0.472	0.400	0.185	0.072	0.503
3.5	0.503	0.441	0.256	0.117	0.529
4.0	0.526	0.472	0.310	0.149	0.548
4.5	0.544	0.496	0.352	0.208	0.563
5.0	0.558	0.515	0.386	0.256	0.575

Notes: For both the Baily (1978) and Chetty (2006) optimal benefits formulas, the underlying utility function is assumed to be of the CRRA form with coefficient of relative risk aversion = γ. The coefficient of relative prudence, used in calculating the Chetty (2006) optimal benefit level, is simply $\rho = \gamma + 1$.

the world, optimal workers' compensation benefits are found to be extremely low: The optimal rate of wage-replacement is positive only for higher levels of risk aversion, and even at $\gamma = 5.0$, optimal benefits only replace 30 percent of pre-injury after-tax wages (or 43 percent using my estimate from Model 4). In the final case, where $\varepsilon_{D,b}$ equals 1.0, optimal benefits are only non-zero for the highest levels of risk aversion, and are always lower than 25 percent, regardless of which consumption-smoothing estimates or levels of risk aversion are used.

The key result of my optimal benefit calculations is that the average real rate of wage replacement in my sample, which is over 75 percent, is higher than optimal. For plausible levels of risk aversion and a wide range of estimates of the effects of workers' compensation benefit variation on the average duration of work-related injuries, the optimal rate of after-tax wage replacement is found to be lower than 50 percent. Even for the highest levels of risk aversion examined, the optimal benefit-wage ratio is never higher than 60 percent.

3.7. Conclusions

This study provides the first and only evidence as to the adverse effects of work-related injuries and illnesses on household consumption and the extent to which workers' compensation benefits help to dampen those effects. I have shown that workers' compensation indemnity benefits provide significant consumption smoothing to households affected by a work-related injury or illness. A 10 percent increase in benefit generosity is found to offset the adverse effect of a workplace injury on household consumption by about 2.5 to 4 percent. The result holds across several alterations to the specification and does not appear to be a product of differential selection into the sample of injured workers. My findings also indicate larger consumption-smoothing benefits of workers' compensation for households with limited pre-injury wealth. Moreover, my results suggest that if workers' compensation benefits were at very low levels (equal to the 10th percentile of their current distribution), the drop in household consumption upon incurring a work-related injury would be in the range of 20 to 30 percent. Thus, workers' compensation benefits appear to play an important role in protecting the material well-being of households impacted by work-related, work-limiting injuries and illnesses.

The extent of consumption smoothing provided by workers' compensation is a crucial parameter for determining the optimal level of workers' compensation benefits. Despite the finding of a considerable consumption-smoothing role for workers' compensation benefits, this paper also demonstrates that current benefit levels are higher than optimal. Even for the most optimistic of my consumption-smoothing estimates, relatively high levels of risk version, and small estimates of the distortionary effects of workers' compensation on the duration of workers' compensation claims, the optimal benefit-wage replacement rate is more than 20 percentage points lower than the mean replacement ratio for my sample of injured workers (78 percent). In essence, the distortionary effects of workers' compensation insurance on individual labor supply behavior are large enough to outweigh the substantial consumption-smoothing benefits of the insurance for injured workers documented herein.

If one takes the results of the optimal benefits calculations literally, it is natural to ask why real workers' compensation wage-replacement rates are much higher than my calculations indicate is optimal. One possibility is that the estimates in this paper understate the consumption-smoothing effects of workers' compensation for the entire population of working-age adults for whom workers' compensation benefits are legislated. The Health and Retirement Study (HRS) is the only national micro data set appropriate for studying the extent to which workers' compensation benefits help offset consumption losses upon a work-related injury; however, the HRS samples primarily individuals who are of (or near) retirement age. Clearly, the consumption-smoothing effects of workers' compensation benefits could differ in magnitude for older workers, relative to their prime-aged counterparts. My estimates may understate the consumption-smoothing effects of workers' compensation for the working-age population if workers becoming injured or ill on the job later in their working lives have accumulated more wealth with which to smooth consumption, or if older workers are more likely than younger workers to perceive a given injury as permanent (in terms of return-to-work probability) and reduce post-injury consumption accordingly. Were it possible to estimate the consumption-smoothing effects of workers' compensation for a sample of prime-aged injured workers without conditioning on workers' compensation receipt, such an exercise would provide valuable evidence as to the external validity of this paper's results. Unfortunately, alternative data sets with information on both household consumption and the incidence of work-related injuries and illnesses for individuals of prime working age are not available at this time.

Because the optimal benefits formulas were originally derived in a framework of unemployment insurance (UI), it is also worthwhile to compare my consumption-smoothing estimates for workers' compensation to those of Gruber (1997) for UI. The estimated consumption-smoothing effects of these two programs are on the same order of magnitude, despite the fact that legislated workers' compensation benefits are much more generous than those prescribed by the UI system. Specifically, Gruber (1997) finds that a 10 percentage-point increase in the rate of wage replacement provided by UI offsets the drop in household consumption upon job loss by 2.65 percent, while my reduced-form estimates from Model 3 suggest that a 10 percentage-point rise in the workers' compensation benefit-wage replacement rate would reduce the decline in household consumption by 3.36 percent.

I find that current workers' compensation benefits are much higher than optimal, while Gruber (1997) shows that the current UI benefit-wage replacement rate is close to the optimal level. If in fact my estimates of the consumption-smoothing benefits of workers' compensation are generalizable to the working population for which benefits are legislated, this discrepancy may reflect differences in the two systems that are not captured by the optimal benefits model above. A fairly obvious example is that workers' compensation benefits may also be compensating workers for the physical discomfort or pain caused by work-related injuries and illnesses, an element which is absent in the discussion of unemployment. Moreover, the discussion above disregards the effects of workers' compensation for firms, who benefit from reduced uncertainty in firm costs of work-related injuries relative to a system in which workers could sue employers for damages due to on-the-job injuries and illnesses. It may be the case that higher-than-optimal wage-replacement is, in a sense, compensating workers for forfeiting the option to do so. Also, the model above considers only the optimal rate of wage-replacement provided by workers' compensation benefits. It ignores, among other things, key structural features of state workers' compensation programs like the waiting periods and retroactive periods, which serve as deductibles that must be paid in order to receive benefits. Incorporating these components of workers' compensation programs may yield different predictions for the optimal level of benefits.

This paper's key contribution is to offer new evidence on the effects of work-related injuries on household material well-being and the relative success of workers' compensation in protecting the well-being of households affected by a workplace injury. However, the evidence provided here is hardly sufficient for understanding the economic impacts of work-related injuries on workers and their families. Despite the large volume of research on workplace injuries and workers' compensation programs, we still know remarkably little about the effects of work-related injuries on longer-term outcomes like health, return-to-work labor supply and earnings capacity, reliance on other transfer programs, and the probability of re-injury. Given these deficiencies, future research on both short and long-term effects of workplace injuries on outcomes reflecting worker well-being would be useful.

CHAPTER 4

Work-related Injuries and the Earnings and Labor Supply of Older Workers

4.1. Introduction

Work-related injuries and illnesses can have serious and long-lasting impacts on the health of older workers. On-the-job injuries and illnesses are, on average, more disabling and of longer duration for older workers than for their younger counterparts: They involve more days away from work, greater likelihood of receiving permanent disability workers' compensation benefits (as opposed to benefits for temporary disability), and a lower probability of returning to work.[1] Moreover, injuries and illnesses at work are a common source of work limitations among the older population: For instance, of people ages 51 to 61 whose health limits the amount or kind of work that they can do, 36% are disabled because of an accident, injury, or illness incurred at work (Reville and Schoeni, 2004).

These facts, together with the aging of the American workforce, rising medical costs and high workers' compensation costs, and an increasing prevalence of work disability at older ages, all suggest the importance of understanding the impacts of work-related injuries on the economic situations of older workers. To date, however, economists know

[1] Using data from the National Health Interview Survey (NHIS), Burton and Spieler (2001) find that work-related injuries result in an average of over 20 weeks of restricted activity for workers ages 45-64, compared to 14 weeks restricted activity for workers ages 25-44. Biddle, Boden, Reville (2001) study injured workers in Wisconsin, Washington, and California, and find that older workers experience larger initial wage losses, lower workers' compensation wage replacement rates, and more injury-related non-employment.

relatively little about the effects of late-career work injuries and illnesses on economic outcomes like labor supply (including employment, hours worked, and retirement propensities) and earnings.

The primary goal of this paper is to provide preliminary evidence on the effects of incurring a work-related injury (or illness) on earnings and labor supply for a sample of workers nearing retirement age. Using data from eight waves of the Health and Retirement Study (HRS), I examine changes in these outcomes at both the point of injury and for several years before and after the worker becomes injured on the job.

This paper contributes to the literature in several ways. First, the existing literature on work-related injuries and illnesses has largely focused on the incentive effects of state workers' compensation programs on the behavior of firms and workers.[2] Only recently have researchers begun to consider the impacts of on-the-job injuries on the economic well-being of affected workers. This strand of the literature includes a small set of papers that analyze the effects of workplace injuries on injured workers by estimating earnings losses incurred by these workers, as well as their short- and long-run employment outcomes.[3] However, these studies are all limited to data on one or a few states, and most of them focus only on injuries and illnesses involving permanent disability benefits.[4] Furthermore, none of these papers focuses specifically on the impacts of work-related injuries on older workers who are nearing retirement age. While the evidence provided in this paper is

[2]See Chapter 2 for further discussion of key studies in the literature examining the relationship between workers' compensation benefit generosity and the frequency and duration of workers' compensation claims.

[3]See Biddle (1998), and Boden and Galizzi (1999, 2003), for examples of studies of earnings losses from workplace injuries and illnesses. Reville (1999) and Reville and Schoeni (2001) analyze impacts of workplace injuries on both earnings and employment.

[4]Boden and Galizzi (1999, 2003) are exceptions.

surely preliminary, this is the first analysis of both short- and long-term effects of work-related injuries and illnesses on earnings and labor supply for a nationally-representative sample of workers late in their careers.

Another question that has not been considered in the literature on workplace injuries is the extent to which late-career work injuries impact retirement probabilities. Given the evidence that workplace injuries and illnesses tend to be more disabling and of longer duration for older workers than for their younger peers, one might expect that many older workers simply leave the labor force when injured on the job, rather than planning to return to work upon recovery. Moreover, much of the retirement literature suggests that unexpected decreases in health are strongly correlated with early retirement and labor force exit (e.g., McGarry, 2004, and Coile, 2004). If work-related injuries and illnesses are unforeseen and cause workers to depart from the work force earlier than planned, these injuries may be associated with insufficient retirement income for affected workers and their households. To date, however, there is no evidence on the impact of work-related injuries and illnesses on retirement behavior. In this paper, I provide the first such evidence, estimating the impact of incurring a work-related injury or illness on the likelihood of labor force exit and retirement.

The key findings suggest significant losses in earnings and labor supply for older workers who are injured or become ill on the job. A workplace injury is associated with a decrease in annual hours worked in the year of onset of about 24 percent for those with "mildly disabling" injuries, a drop in working hours of about 37 percent for those with "moderately disabling" injuries, and a 40 percent decline in hours for those with the most severe workplace injuries. Moreover, for all three groups, hours remain substantially lower than pre-injury levels for the six years after an injury is incurred. I find a large decline in annual earnings for injured workers by the second year after injury onset, ranging from a loss of about $4,500 for those with mild injuries to a decline of $7,300 for those with the most severe injuries. Interestingly, earnings appear to recover somewhat in the years thereafter for those with mild and moderate injuries; on the other hand, the most severely disabled injured workers experience even larger earnings losses in subsequent years. Finally, my results indicate that being injured on the job between two survey waves has a strong positive impact on the probability that a worker exits the labor force or retires in the year of injury onset.

The remainder of the paper is organized as follows: Section 2 discusses my use of data from the Health and Retirement Study (HRS) to study both short- and long-term effects of workplace injuries on the earnings, labor supply, and retirement propensities of affected workers. In Section 3, I describe the empirical approach employed to estimate the immediate impact of incurring an on-the-job injury on annual hours worked, labor earnings, and retirement behavior, which involves treating a workplace injury between two waves of the HRS as an exogenous health shock, and I present the corresponding results. Section 4 focuses instead on changes in labor supply and earnings for several years before and after a work-related injury or illness. The panel data techniques used to estimate changes due to a workplace injury are laid out, and estimation results are discussed. Section 5 concludes and discusses directions for future research.

4.2. Data

The data used in this paper come from waves I through VII of the Health and Retirement Study (HRS), covering the years from 1992 through 2004. The HRS provides detailed longitudinal information on health, employment, earnings, retirement expectations, financial and material well-being, and demographic characteristics for a sample of older workers nearing (or of) retirement age. Importantly, the HRS is one of few nationally representative data sets that permits identification of workers who experience a work-related injury or illness, independent of whether they receive income from workers' compensation.[5]

Specifically, the HRS contains several questions that allow me to identify workers who experience a job-related injury or illness between two waves of the survey. Each wave contains a question that asks, "Do you have any impairment or health problem that limits the kind or amount of work that you can do?" I am able to attribute such an injury/illness to a respondent's workplace if he or she answers in the affirmative the question that asks whether this work-limiting impairment "was in any way caused by the nature of [the respondent's] work" or answers that the impairment "was the result of an accident.... that occurred at work". This definition of on-the-job injuries includes both individuals with work-related illnesses or impairments like carpal tunnel syndrome, which would not have been caused by a workplace accident, as well as those with disabilities that resulted directly from a specific incident at work. In both parts of the empirical

[5]Other microdata sets that include information on work-related injuries and illnesses beyond receipt of workers' compensation income include the National Longitudinal Survey of Youth (NLSY) and the Survey of Income and Program Participation (SIPP).

analysis that follows, I use this definition to identify workers who are injured or become ill on the job.

Because there is likely to be wide variation in the extent of work limitation caused by these work-related injuries and illnesses, I also look for differences in the impacts of on-the-job injuries across different subsamples of injured workers. One approach is to classify injured workers based on the *origin* of their injury or illness, using the questions described above to divide the sample of affected workers into those whose injuries were caused by specific accidents at work and those whose injuries and illnesses are simply related to the nature of their work.

A second approach used in this paper is to classify injured workers according to the *severity* of their injury or illness. The HRS does not provide a direct measure of an injury's severity. However, I can construct an instrument for the severity of disability brought on by a workplace injury or illness using the detailed information provided in the HRS on the degree of difficulty respondents experience in performing activities of daily living (ADL). Specifically, the HRS asks individuals whether they have any difficulty in performing 15 common tasks, ranging from activities like eating, dressing, and bathing, to somewhat more demanding physical activities, like jogging one mile or climbing several flights of stairs. I first create an "ADL index" based on the number of these activities with which a respondent reports having difficulty and measure changes in this ADL index between waves of the survey. An injured worker is then assigned to a "severity" group based on the magnitude of the *change* in his ADL index from 2 years prior to injury to the year of onset: A worker with a change in his ADL index of 1 or fewer activities is assigned to the group of "mild" injuries, workers with a change of 2 to 4 activities are considered "moderately" disabled by their injury, and workers with a change of 4 or more activities are designated as "severely" injured. While self-reports of difficulty with daily activities by no means provide a perfect measure of the severity of a work-related injury, changes in the ADL index upon injury should at least be highly correlated with the extent of work limitation faced by the injured worker.

Individuals are included in the sample if they were interviewed in the first wave (1992), and are between the ages of 45 and 69 in any year t between 1992 and 2004. Additionally, I also restrict the sample to those respondents for whom information is available in all seven waves between 1992 and 2004, in order to obtain sufficient information on the outcome variables both before and after injury onset. The primary sample for this analysis is a seven-wave panel of 7,323 individuals, 708 (or about 10%) of whom experience a work-related, work-limiting disability at some point during the years of interest. In the first part of the empirical analysis, this sample is treated as a repeated cross-section and restricted further, as described below.

4.3. Impacts of Work-Related Injuries on Earnings, Labor Supply, and Retirement at the Point of Injury

4.3.1. Estimation

The first part of the paper examines the impact of becoming injured or ill at work on earnings, labor supply, and retirement probabilities at the point of injury. For this part of the empirical analysis, I treat the sample described above as a repeated cross-section and observe whether a worker becomes injured on the job between two waves of the survey. Person-year observations are included in the sample if for a given survey year

t, the individual was employed in year $t-1$ and did not report any work-limiting disability at that interview. This allows me to observe changes in earnings and labor supply from a state of uninjured employment to the state in which the worker has incurred a work-limiting disability. Given these restrictions, there are 19,181 person-year observations remaining in the sample.[6]

Sample means for these observations are shown below in Table 4.1. On average, older workers who are injured on the job between two survey waves experience much larger declines in annual earnings and labor hours than do their uninjured peers. Just over 40 percent of injured workers decrease their working hours to zero in the first year in which they report a work-related, work-limiting disability, and 18 percent report that they have retired between the previous wave and the year of onset.[7] Of those who are injured or become ill on the job during the survey, just over half incur "mild" injuries that are associated with a change in the ADL index of no more than one activity. Moderate injuries, which are classified as those associated with an increase in the ADL index of two to four activities, account for 29 percent of workplace injuries. The remaining 18 percent of injured workers have severe injuries, defined as causing an increase in the ADL index of more than four activities.

Notably, I also observe that injured/ill workers are more disabled in the year *prior* to their injuries than are uninjured workers, experiencing difficulty in an average of 2.64 daily activities (compared to an ADL index of 1.33 for the uninjured sample). This suggests the importance of controlling for pre-injury levels of functioning in the regressions below.

[6]Note that all standard errors in the regressions described below are corrected for repeated observations on the same individuals.

[7]Recall that the sample is conditional on employment in period $t-1$. I consider workers to have retired only if they report being "completely retired" in year t.

Table 4.1: Means for the HRS Sample of Workers Ages 45 - 69

	Overall Sample		Injured at Work		Not Injured at Work	
Variable	Mean	Std. Dev.	Mean	Std. Dev	Mean	Std. Dev.
Change in annual earnings ($2003)	-1299	(43017)	-2883	(22090)	-1260	(43410)
Change in annual hours	-363	(921)	-888	(1139)	-350	(911)
Exited labor force	0.170	(0.376)	0.407	(0.492)	0.164	(0.371)
Retired	0.100	(0.300)	0.182	(0.386)	0.098	(0.298)
Any work-related injury/illness	0.024	(0.154)				
Injured/Ill - Accident at work						
Injured/Ill - Related to work, not accident						
Injured/Ill - Mild	0.013	(0.113)	0.533	(0.499)		
Injured/Ill - Moderate	0.007	(0.084)	0.289	(0.454)		
Injured/Ill - Severe	0.043	(0.066)	0.178	(0.383)		
ADL index in wave t -1 (1 - 15)	1.363	(1.713)	2.642	(2.53)	1.332	(1.675)
Change in ADL index	0.327	(1.849)	1.927	(2.862)	0.287	(1.798)
Age	59.21	(4.84)	59.11	(4.47)	59.21	(4.85)
Less than high school	0.208	(0.406)	0.345	(0.476)	0.205	(0.404)
High school graduate	0.501	(0.500)	0.537	(0.499)	0.501	(0.500)
At least some College	0.290	(0.454)	0.118	(0.323)	0.294	(0.456)
Male	0.453	(0.498)	0.516	(0.500)	0.452	(0.498)
Married	0.758	(0.428)	0.730	(0.444)	0.759	(0.427)
Household size	2.420	(1.155)	2.642	(1.346)	2.419	(1.150)
White	0.836	(0.371)	0.833	(0.373)	0.836	(0.371)
Black	0.131	(0.337)	0.120	(0.325)	0.131	(0.337)
Hispanic and other	0.033	(0.181)	0.047	(0.212)	0.034	(0.180)
Household Net Assets (median)	44,401	(284,512)	30,000	(86,176)	44,600	(150,512)
Number of observations	19,181		467		18,714	

Notes: Standard deviations in parentheses. Person-year observations are included in the sample if the respondent was employed without a work-limiting disability in year t -1.

Not surprisingly, I also find that daily functioning becomes somewhat more difficult for both uninjured and injured older workers between waves of the survey. However, while the average ADL index of uninjured workers increases by 0.287 between survey waves, the average change in the ADL index for injured workers is much larger at 1.927.

Demographically, individuals injured at work differ from those who do not experience a work-related injury in that they are less educated, more likely to be male, and slightly less likely to be married. Although occupation and industry percentages are not shown here, the sample of injured workers are significantly more likely to have worked in blue-collar jobs (e.g., operatives or construction workers) and in higher-risk industries like manufacturing and mining, as opposed to professional, white-collar occupations and industries.

I measure the impact of a workplace injury or illness on annual hours worked and annual labor earnings by estimating simple regression models with the changes in these outcome variables (from the previous interview to the interview at which the individual first reports a work-related, work-limiting disability) as the dependent variables. The key independent variable is a dummy for having become injured or ill on the job since the last survey. The regressions control for personal characteristics like age and its square, education, marital status, and household size, total household net assets, two-digit industry and occupation dummies, and a full set of year dummies. To assess the impact of a work-related injury or illness on the probabilities of employment and retirement, I estimate probit models with the same controls.

4.3.2. Results

The first panel of Table 4.2 shows the results of regressions in which the dependent variable is the change in annual hours worked from the previous wave to the interview in which the respondent first reports a work-related, work-limiting disability. In the first column, the coefficient on the dummy variable for having become injured or ill on the

Table 4.2: Effects of Work-Related Injuries and Illnesses on Labor Hours and Earnings

	Dependent Variable: Change in annual hours				Dependent Variable: Change in annual earnings			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Injured dummy	-532.17	-514.91			-2933.47	-2981.40		
	(54.26)	(58.96)			(1102.31)	(1154.19)		
Injured - Mild			-346.01	-322.72			-2934.46	-2952.47
			(69.48)	(71.28)			(1720.36)	(1723.95)
Injured - Moderate			-552.64	-393.16			-1414.79	-1509.40
			(98.96)	(101.87)			(1696.04)	(1760.09)
Injured - Severe			-1075.58	-1194.07			-5532.13	-5698.48
			(134.42)	(142.62)			(1715.64)	(1902.99)
ADL index in t-1		-14.47		-16.910		126.51		-21.81
		(6.25)		(6.24)		(199.18)		(131.15)
SS Eligible		-254.98		-259.46		-1161.38		-737.71
		(50.97)		(50.90)		(1578.16)		(1163.71)

All regressions include controls for age and its square, education, gender, marital status, race, household size, net household assets and industry and occupation, as well as a full set of year dummies. Standard errors are corrected for repeated observations on the same individuals. Dollar amounts are converted into 2003 dollars using the CPI-U.

job indicates a significant negative impact of a workplace injury on the number of annual hours worked. This impact does not change significantly when I include a control for the individual's ADL index at the interview prior to injury and a dummy variable for whether he is age-eligible to receive Social Security retirement benefits. However, we observe that these controls have significant effects on the change in hours: The decrease in annual hours is larger for those with greater disability prior to the injury. Being greater than 62 years old, or eligible to receive Social Security retirement benefits, has a strong negative impact on the change in working hours upon experiencing a job-related injury or illness.[8]

[8] The indicator for Social Security eligibility could be picking up an effect of being older than 62 in addition to the effect of being eligible for retirement benefits. Continuous controls for age and its square are, however, included in the model.

The results in columns (3) and (4) indicate that the impacts of work-related injuries on annual labor hours differ substantially depending on the degree of disability brought on by the injury. For those who experience a change in their ADL index of 1 or fewer activities between the interview prior to onset and the wave in which the work-limiting disability is first reported, a work-related injury is associated with a decrease of .about 300 hours. The decrease in hours upon injury is somewhat larger for those with moderately disabling injuries, whose ADL index increases by 2 to 4 activities. Finally, the most severely disabled workers, whose ADL indices increase by 4 or more activities of daily living, experience a decrease in annual labor hours in the range of 1,100 hours.

The second panel of Table 4.2 displays the results of similar regressions, in which the dependent variable is the change in annual gross labor earnings between the interview wave prior to injury and the year of injury onset. Here, I find evidence that work-related injuries and illnesses have significant detrimental effects on the labor incomes of affected workers. Results from the first two regressions suggest that a workplace injury or illness is associated with a decline in annual earnings of about 3,000 dollars. Again, these effects differ depending on the degree of disability associated with the onset of injury. However, while the most severely disabling injuries have the largest negative impact on labor earnings as expected, the results suggest that moderate injuries are associated with a smaller decline in earnings compared to the least disabling group of injuries.

Next, I turn to examine the impacts of a work-related injury or illness on labor supply at the extensive margin. Table 4.3 displays the estimated marginal effects from probit models for which the dependent variables are an indicator for hours going to zero in the year of injury onset and an indicator for the respondent reporting that he has "completely retired," respectively.[9] The result in the first column indicates that a workplace injury or illness is associated with a 24 percent increase in labor force exit in the year of injury onset. This estimate shrinks only slightly when controls are included for levels of functioning in wave $t-1$ and age-eligibility for Social Security (SS) retirement benefits, both of which have positive and significant effects on the likelihood of working zero hours in year t. Splitting the sample of injured workers according to the degree of disability brought on when the injury is incurred yields the expected pattern: A mild injury is associated with a 12 to 16 percent increase in labor force exit upon injury, moderate injuries increase labor force exit 13 to 23 percent, and severe injuries raise the likelihood of labor force exit in the year of onset by about 50 percent.

Of course, an injured worker may reduce his labor hours to zero in the year of injury onset without considering himself fully retired if he plans to return to work at a later date. In the second set of probit models, I examine the effect of work-related injuries and illnesses on the probability of retirement. Here, the dependent variable equals 1 if the individual, who was employed in $t-1$, reports that he considers himself "completely retired" in period t. Indeed, the results in columns (5) through (8) suggest that many of those who reduce labor hours to zero in the year of injury do not yet consider themselves to have retired. I find that a work-related injury or illness increases the probability of retirement in the year of onset by about 9 percent, and this impact is reduced to 6 percent when I control for pre-injury ADL index and SS retirement eligibility. Again, I find that incurring an on-the-job injury increases the probability of retirement in the year of onset more for injuries that are associated with larger decreases in daily functioning.

[9] Since sample selection is conditional on employment in period $t-1$, these dependent variables represent transitions from a state of employment in $t-1$ to non-employment or retirement in wave t.

Table 4.3: Effects of Work-Related Injuries and Illnesses on Labor Force Exit and Retirement

(Average Derivatives from Probit Estimation; Robust Standard Errors in Parentheses)

	Dependent Variable: Zero Hours Indicator				Dependent Variable: Considers Self Retired Indicator			
	(1)	(2)	(3)	(4)	(9)	(10)	(11)	(12)
Injured dummy	0.239	0.220			0.092	0.054		
	(0.024)	(0.023)			(0.018)	(0.016)		
Injured - Mild			0.157	0.128			0.053	0.029
			(0.031)	(0.033)			(0.022)	(0.019)
Injured - Moderate			0.233	0.136			0.134	0.082
			(0.044)	(0.048)			(0.036)	(0.031)
Injured - Severe			0.510	0.481			0.155	0.086
			(0.057)	(0.065)			(0.050)	(0.041)
ADL index in t-1		0.008		0.009		0.008		0.010
		(0.002)		(0.002)		(0.001)		(0.001)
SS Eligible		0.084		0.087		0.056		0.057
		(0.019)		(0.019)		(0.007)		(0.008)

Results are from probit models that include controls for age and its square, education, gender, marital status, race, household size, net household assets and industry and occupation, as well as a full set of year dummies. Standard errors are corrected for repeated observations individuals . Results from estimation of linear probability models were essentially identical to those presented above

While the results presented in this section support the concern that work-related injuries and illnesses cause substantial economic losses for older workers at the time of injury onset, they do not yield insight into the long-term effects of workplace injuries on labor market outcomes for these workers. Whether or not earnings and labor supply recover from the initial negative impacts of an on-the-job injury remains an open question, which the next empirical exercise seeks to address.

4.4. Changes in Earnings and Labor Supply Before and After a Work-Related Injury

4.4.1. Estimation

Evidence from the existing literature on workplace injuries suggests that job-related injuries and illnesses can have impacts on economic outcomes for affected workers that persist long after the point at which the injury occurs. Therefore, the second part of the paper takes advantage of the panel design of the HRS to estimate changes in earnings and labor supply for several years before and after the onset of injury. In what follows, I employ the full seven-wave panel of 7,302 individuals between the ages of 45 and 69.

The empirical approach in this part of the paper involves estimation of the following fixed effects model:

$$y_{it} = X_{it}\beta + \sum_{j} \rho_j D_{jit} + \varphi_t + a_i + \varepsilon_{it} \tag{4.1}$$

where y_{it} is the either the number of hours worked or annual labor earnings, for person i in year t, X_{it} is a vector of personal characteristics that vary over time, including age and its square, marital status,education, and household size, φ_t is a set of year dummies, and a_i is an individual-level fixed effect.

The key independent variables are a set of mutually exclusive and exhaustive indicator variables, D_{jit}, which equal 1 if person i is a worker who ever becomes injured or ill on the job, and in year t, he is j years from incurring this injury or illness. This approach is similar to that of Stephens (1999), Charles (2001), and Meyer and Mok (2006), all of which use data from the Panel Study of Dynamics (PSID) to estimate changes in the economic situations of prime-aged workers who become disabled, although not necessarily on the job.

I consider the point of injury onset to be the first year of the survey in which the worker reports a work-related, work-limiting health problem, conditional on not having reported a work-limiting disability in the previous wave. Throughout the paper, I focus on outcome variables from two years prior to the occurrence of a workplace injury through 8 years after the injury is first reported, so that $j \in \{-4, 6\}$.[10] Thus, the coefficients on the injury dummies indicate the change in the outcome j years from the onset of injury, relative to the value of the outcome more than four years prior to the work-related injury.

There is, of course, wide variation in the extent to which workplace injuries and illnesses limit an individual's ability to work. Therefore, after examining changes in hours worked and earnings for the overall sample of injured workers, I also split the injured sample according to the origin of the injury and according to an instrument for the severity of disability associated with the onset of injury. The fixed effects model is:

$$y_{it} = X_{it}\beta + \sum_j \sum_k \rho_j D^k_{jit} + \varphi_t + a_i + \varepsilon_{it} \tag{4.2}$$

where k represents the injury/illness group to which an individual belongs. First, using the questions described above allows me to separate workers whose work-limiting health problems were caused by a specific workplace accident from those whose impairments are simply related to the nature of their work. Whether we should expect average changes in earnings and hours worked to be larger or smaller for workers whose injuries were caused

[10]Recall that the HRS is conducted biennially, so these outcomes are observed at two-year intervals rather than every year.

by specific accidents is not clear; the differences in the impacts of work-related injuries on earnings and labor supply for these two groups remain an empirical question.

Secondly, I use the information described above on difficulty performing activities of daily living (ADL) to divide the sample of injured workers according to the extent of disability brought on by a work-related injury or illness. As in the first part of the empirical analysis, I assign each injured worker to a severity group based on the change in his ADL index between the survey prior to injury onset and the interview at which he first reports a work-related health problem. In this specification, the key independent variables, D^k_{jit}, are simply indicators representing the interactions between the distance from onset dummies and the severity group dummies.[11]

4.4.2. Results

First, I explore the impacts of a work-related injury or illness on labor supply by examining changes in annual hours worked before and after the onset of a work-related health problem. Here, the dependent variable is the number of annual hours typically worked at the point of interview.[12] Table 4.4 shows the changes in annual hours worked for the sample of injured workers as a whole, as well as for the subsamples of injured workers whose injuries or illnesses were caused by accidents at work, and those whose injuries/illnesses were simply related to the nature of their work (but not caused by

[11] An alternative method of grouping injured workers would be to classify their injuries based on their "degree of persistence" as in Meyer and Mok (2007) or Charles (2003). To do so requires classifying injured workers based on the number of waves for which they report having a work-limiting, work-related disability *after* the year of onset. This measure is likely to vary more for a sample of prime-aged workers, however, than for my sample of older workers nearing retirement age.

[12] Specifically, workers are asked how many weeks per year and how many hours per week they typically work at their current job. My measure of annual hours worked is the product of these two variables, *not* the number of hours worked in the previous calendar year.

Table 4.4: Hours Worked Before and After Onset of Work-Related Injury or Illness, by Origin of Disability

	Overall Injured/Ill Sample		Caused by Accident at Work		Related to Work; Not Accident	
Years from Injury	Annual Hours	Implied % Change	Annual Hours	Implied % Change	Annual Hours	Implied % Change
-4	57.49	4.0%	67.99	4.8%	94.23	6.6%
	(46.12)		(77.77)		(56.32)*	
-2	16.09	1.1%	47.54	3.3%	5.10	0.3%
	(45.49)		(77.08)		(54.62)	
0	-443.78	-31.0%	-448.85	-31.4%	-394.63	-27.6%
	(45.33)***		(77.00)***		(53.80)***	
2	-476.51	-33.3%	-551.24	-38.5%	-403.01	-28.2%
	(50.05)***		(85.97)***		(58.64)***	
4	-383.43	-26.8%	-420.44	-29.4%	-321.53	-22.5%
	(53.74)***		(92.88)***		(62.36)***	
6	-438.90	-31.0	-561.49	-39.3%	-316.53	-22.1%
	(59.57)***		(105.68)***		(67.85)***	

Notes: Standard errors in parentheses. Implied percentage change is coefficient divided by the mean number of hours worked for the overall injured group prior to four years before the onset of the work injury/illness (1430 hours). Fixed effects models include controls for age and its square, marital status, household size, and a full set of year dummies.

specific workplace accidents). As expected, we observe a sharp decline in the total number of hours worked at the interview at which an individual first reports having incurred a work-related injury or illness: An individual who is injured or becomes ill on the job in my sample works, on average, 443 fewer hours in the first year of reported injury, compared to his annual hours more than four years prior to the injury. For the overall sample, the decline in hours worked is even larger two years after the injury is first reported. While total hours worked recover slightly in the interviews thereafter, injured workers still work significantly fewer hours (relative to four years prior to the injury/illness) as many as six years after injury onset.

Somewhat different patterns appear when the sample of injured workers is divided based on whether the injury or illness can be attributed to a specific accident that occurred at work. The second and third columns of Table 4.4 show these results. First, for individuals who were injured or became ill due to a workplace accident, we observe an slight increase in hours worked in the two interviews prior to the onset of injury, relative to average hours more than four years before the injury. Second, I find that workers injured in a workplace accident experience a decline of 448 working hours at the onset of injury (or 31.4 percent of hours worked more than four years earlier) , which is almost somewhat larger than the decline of 394 hours for those whose injury or illness was simply related to the nature of their work. However, in the years after injury onset, those with non-accident related disabilities appear to fare somewhat better than those injured in on-the-job accidents. Six years after the onset of injury, for example, workers injured in a workplace accident are working an average of 561 fewer hours than they were more than four years prior to the injury, a decline in hours nearly twice that of those with injuries not caused by accidents.

Next, I examine the extent to which changes in labor supply differ for injured or ill workers depending on the severity of their work-related disability, estimating the fixed effects model in equation 4.2 with sets of injury indicators for three different severity groups. The results, shown below in Table 4.5 and illustrated graphically in Figure **??**, indicate substantial differences for these three groups of workers in the changes in hours worker after a work-related injury or illness.

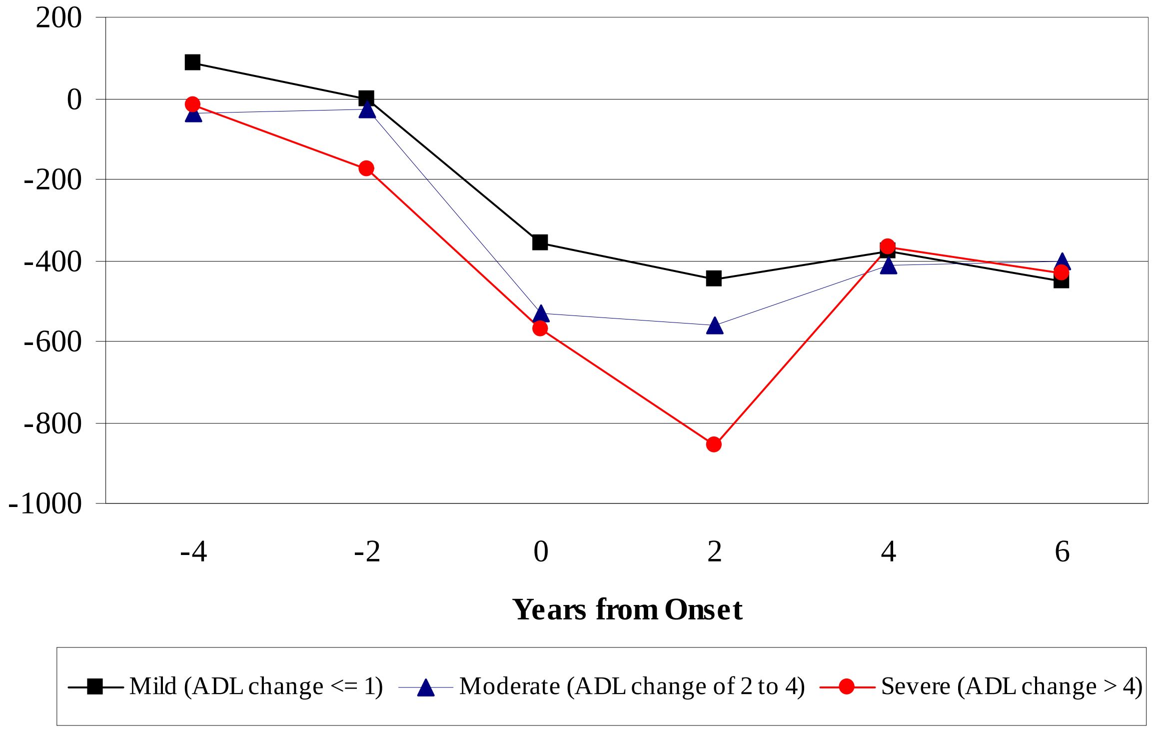
First, at the interview in which the work-related, work-limiting disability is first reported, the results are rather consistent with those from Section 4.3 (see Table 4.2, column

Table 4.5: Hours Worked Before and After Onset of Work-Related Injury or Illness, by Severity of Injury

	Overall Injured/Ill Sample		Mild (Change of <=1 ADL)		Moderate Injuries (Change of 2 to 4 ADLs)		Severe Injuries (Change of >4 ADLs)	
Years from Injury	Annual Hours	Implied % Change	Annual Hours	Implied % Change	Annual Hours	Implied % Change	Annual Hours	Implied % Change
-4	57.49	4.0%	88.55	6.2%	-39.40	-2.8%	-19.38	-1.4%
	(46.12)		(50.40)***		(87.76)		(183.11)	
-2	-16.09	-1.1%	-3.38	-0.2%	-29.43	-2.1%	-174.12	-12.2%
	(45.49)		(50.17)		(72.83)		(181.18)	
0	-443.78	-31.0%	-360.35	-25.19%	-531.72	-37.1%	-570.86	-39.9%
	(45.33)***		(52.88)***		(65.82)***		(80.71)***	
2	-476.51	-33.3%	-449.04	-31.2%	-561.13	-39.2%	-855.56	-59.8%
	(50.05)***		(52.47)***		(92.77)***		(199.70)***	
4	-383.43	-26.8%	–379.95	-26.6%	-411.89	-28.8%	-370.22	-25.9%
	(53.74)***		(57.41)***		(89.89)***		(204.08)**	
6	-438.90	-31.0	-454.28	-31.8%	-400.76	-28.0%	-429.79	-30.0%
	(59.57)***		(63.36)***		(104.28)***		(360.57)	

Notes: Standard errors in parentheses. For comparability, implied percentage change is coefficient divided by the mean number of hours worked for the overall injured sample prior to four years before the onset of the work injury/illness (1430 hours). Fixed effects models include controls for age and its square, marital status, household size, and a full set of year dummies.

Figure 4.1: Changes in Annual Hours Before and After a Work-Related Injury or Illness, by Severity Group



(4), for instance). Annual hours worked for those in severity group 1 are 360 hours lower than their level more than four years prior to injury onset. Those with moderate injuries face a significantly larger decline: Annual hours worked for this group are decreased by 531 hours (or 29 percent) relative to four years earlier. Finally, as expected, the decline in hours worked is largest for workers with the most disabling injuries, whose work-related disabilities are associated with a change in the ADL index of more than four activities. Relative to four years earlier, these workers face a decline of 570 hours worked upon incurring a workplace injury or illness.

Moreover, these differences among the severity groups persist for several years after the onset of injury: The decline in hours relative to pre-injury levels tends to be largest for those with more disabling injuries and illnesses, irrespective of the length of time since the injury occurred. It is also interesting to compare the paths of changes in hours worked over time for these three groups: For all three severity groups, the decline in hours is even larger in the second year after onset than in the year of onset and is somewhat smaller in the fourth post-onset year. However, by the sixth year after injury onset, hours worked for all three groups are about 30 percent lower than they were more than four years prior to onset, suggesting that work-related injuries and illnesses have severe long-term impacts on labor supply for all but the least severely injured workers.[13]

Next, I turn to examine short- and long-term changes in annual labor earnings for workers who are injured or become ill on the job.[14] Results for the fixed effects regressions with annual earnings as the dependent variable are shown in Table 4.6. I use changes in the level of annual earnings rather than its log so as not to exclude those with zero earnings (28 percent of injured workers have zero earnings by two years after first reporting a work-related disability). An interesting finding is that while there is no notable decline in earnings in the year of onset, earnings are substantially decreased two years after the first report of a work-related injury or illness. Recall that the dependent variable here is gross labor earnings for the last calendar year, whereas the questions determining work

[13]Another interesting result in Table is that in the years leading up to the onset of injury, we observe that hours worked are significantly higher (relative to levels four years prior to injury onset) for the group of workers affected by "mild" injuries.

[14]Here, the dependent variable is gross labor earnings in the last calendar year, which is the sum of an individual's pre-tax wage and salary income, earnings from a professional practice or trade, earnings.from bonuses, tips and commission, and earnings from non-primary jobs.

Table 4.6: Annual Earnings Before and After Work-Related Injury or Illness, by Origin of Injury

	Overall Injured/Ill Sample		Caused by Accident at Work		Related to Work; Not Accident	
Years from Injury	Annual Earnings	Implied % Change	Annual Earnings	Implied % Change	Annual Earnings	Implied % Change
-4	574.93	2.6%	-328.88	-1.5%	1148.62	5.1%
	(906.02)		(1549.88)		(1094.97)	
-2	1819.45	8.1%	3359.83	15.0%	1483.05	6.6%
	(888.88)**		(1530.49)**		(1082.36)	
0	-674.66	-2.7%	-580.12	-2.6%	-648.18	-2.9%
	(904.03)		(1543.74)		(1082.37)	
2	–3925.30	-17.5%	-5659.54	-25.2%	-3242.67	-14.4%
	(998.68)***		(1725.53)***		(1181.74)***	
4	-2056.88	-9.2%	-2949.03	-13.1%	-1688.56	-7.5%
	(1079.70)**		(1879.08)		(1265.64)*	
6	-1549.19	-6.9%	-3866.02	-17.2%	-548.73	-2.4%
	(1215.96)		(2176.33)*		(1397.91)	

Notes: Standard errors in parentheses. Implied percentage change is coefficient divided by the mean level of earnings worked for the overall injured sample prior to four years before onset ($22,455). Models include controls for age and its square, marital status, household size, and a full set of year dummies. Earnings are measured in 2003 dollars.

injury status refer to the point of interview.[15] The fact that reported earnings are lagged with respect to the report of injury status likely explains why we do not observe a large drop in annual earnings in the year of onset.

While no substantial decline in earnings is observed at the year of onset, by the second year after onset, annual earnings for the overall sample of injured workers are almost $4,000 lower than average earnings more than four years prior to injury. In the following years, the drop in earnings shrinks, and annual earnings are only 7 percent lower than

[15]Of course, or a person becoming injured or ill on the job in my sample (i.e., who reports having a work-related, work-limiting disability in any given year of the HRS but did not report one during the previous wave), the actual onset of injury or illness could have occurred any time during the two years between survey waves.

pre-injury levels by the sixth year after the injury occurs. Again, differences emerge when we separately examine the subsamples of injured workers based on the nature of their work-related disability. For those whose injuries or illnesses can be directly attributed to a workplace accident, we observe that beginning in the second year after injury onset, earnings losses are consistently larger and slower to recover than those faced by workers whose injuries and illnesses are not related to specific accidents.

Estimated changes in earnings before and after a workplace injury are shown in Table 4.7 and Figure **??** for subsamples of workers classified by the severity of disability brought on by their work-related injuries and illnesses. Again, we do not observe a significant drop in earnings in the year of onset for any of the groups, but by the second year after onset, earnings are much lower than their average values more than four years prior to injury. From the second year after onset, earnings losses are generally largest (in any given year) for those most severely disabled by their job-related injuries or illnesses.

Although statistical precision is decreased for the more severe injury groups (which are relatively small samples), at least one important difference among the groups appears evident. By six years after the work-related injury or illness is incurred, earnings of those with those with "mild" and moderate" injuries appear to nearly recover to pre-injury levels. On the other hand, for those with the most severely disabling injuries, earnings are over 40 percent lower than pre-injury levels six years after injury onset.

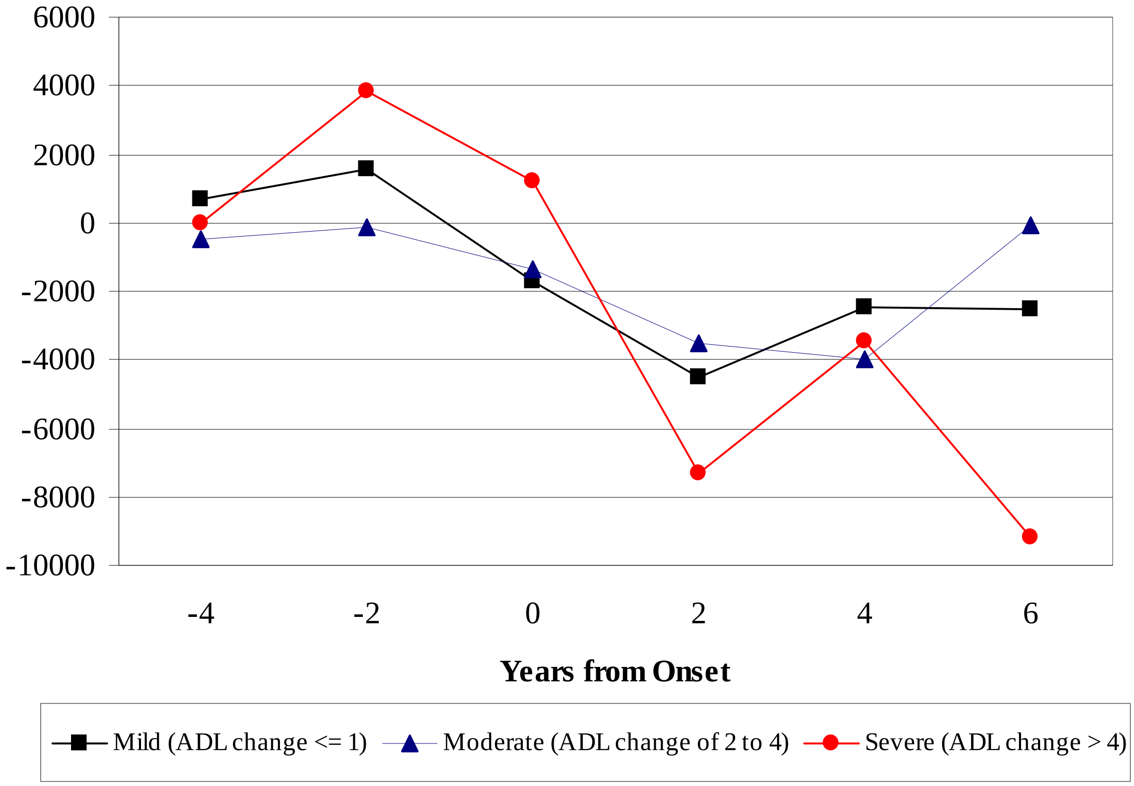
In short, my estimates of the changes in annual hours worked and annual labor earnings before and after onset of a workplace injury or illness suggest that these injuries have substantial and often long-lasting deleterious impacts on the economic situations of affected workers. Moreover, these losses in earnings and labor supply for injured workers

Table 4.7: Annual Earnings Before and After Work-Related Injury or Illness: Results by severity of injury

	Overall Injured/Ill Sample		"Mild" Injuries		"Moderate" Injuries		"Severe" injuries	
Years from Injury	Annual Earnings	Implied % Change	Annual Earnings	Implied % Change	Annual Earnings	Implied % Change	Annual Earnings	Implied % Change
-4	574.93	2.6%	694.24	3.1%	-467.87	-2.1%	-26.29	-0.1%
	(906.02)		(1058.49)		(1969.75)		(4212.13)	
-2	1819.45	8.1%	1578.98	7.0%	-156.25	-0.7%	3857.64	17.2%
	(888.88)**		(999.44)		(1587.33)		(4183.52)	
0	-674.66	-2.7%	-1699.82	-7.6%	-1379.72	-6.1%	1214.51	5.4%
	(904.03)		(1042.27)*		(1371.28)		(1759.50)	
2	–3925.30	-17.5%	-4496.70	-20.0%	-3504.01	-15.6%	-7314.56	-32.5%
	(998.68)***		(978.83)***		(2032.91)*		(4467.18)*	
4	-2056.88	-9.2%	-2475.34	-11.0%	-3989.26	-17.8%	-3479.05	-15.5%
	(1079.70)**		(1087.33)**		(1931.79)**		(4709.11)	
6	-1549.19	-6.9%	-2508.10	-11.2%	-72.78	-0.3%	-9170.23	-40.8%
	(1215.96)		(1223.93)**		(2264.80)		(7542.75)	

Notes: Standard errors in parentheses. For comparability, implied percentage change is coefficient divided by the mean level of earnings for the overall injured sample prior to four years before onset ($22,455). Models include controls for age and its square, marital status, household size, and a full set of year dummies. Earnings are measured in 2003 dollars.

Figure 4.2: Changes in Annual Earnings Before and After a Work-Related Injury or Illness, by Severity Group



are larger and more persistent the more disabling is the workplace injury or illness they have incurred.

4.5. Conclusions

The empirical results in this study indicate that work-related injuries and illnesses have significant detrimental effects on the labor supply and earnings of older workers, particularly when they involve a substantial change in the level of difficulty faced by the worker in performing routine activities. Moreover, this paper provides further evidence that work-related injuries negatively impact the earnings and employment of older workers both at the point of injury and for several years thereafter.

Section 4.3 studies the extent to which incurring a work-related, work-limiting disability between two survey waves affects earnings and labor supply at the time of injury onset (i.e., at the first interview at which the disability is reported). I find that a work-related injury or illness is associated with a decrease in annual hours worked upon onset of injury of about 400 to 500 hours for the average injured worker, and a decrease in earnings of almost $3,000. My findings also suggest a significant effect of work-related injuries on labor supply at the extensive margin: Incurring a work injury between two interviews is associated with a 24 percent increase in the probability of working zero hours in the year of onset and about a 10 percent increase in the probability of retirement upon injury onset.

The magnitudes of these estimates differ, however, when one divides workplace injuries according to the severity of disability an injured worker reports. My results consistently indicate substantially larger impacts the more severely an injured worker's functioning is impaired: Workers with the most severe injuries experience a decline in annual hours worked of 800 to 1000 hours, while those with mild injuries lose about 300 working hours in the year of injury onset. The negative impacts of a work-related injury on the probabilities of retirement and labor force exit in the year of onset are about three times as large for workers with the most serious injuries as for those with mild injuries that do not significantly limit daily functioning.

The paper also provides estimates of changes in labor supply and earnings for several years before and after a work-related, work-limiting disability is incurred. Taking advantage of the panel design of the Health and Retirement Study (HRS), I estimate fixed-effects models in which the dependent variables are the number of hours worked annually and the level of gross annual labor earnings. The key findings are decreases in hours and earnings that persist for several years after the onset of a job-related injury or illness: Relative to their levels more than four years prior to injury, injured workers are working 360 fewer hours in the year of onset. The decline in hours worked is even larger in the second year after injury onset, and working hours remain substantially reduced four and six years after the injury occurs. The results for labor earnings are somewhat different: By the second year after injury onset, annual earnings are lowered by almost $4,000; however, for all but the most severe injuries, annual earnings losses shrink somewhat in the years that follow.

Finally, the patterns of changes in labor supply and earnings before and after injury also vary depending on the degree of disability suffered by the injured worker. For workers with mild injuries, annual hours worked are lowered by 25 percent by the second year after onset and are 32 percent lower than pre-injury levels by the sixth year after injury. While these workers experience a sharp decline in earnings in the two years after injury, my results suggest that their annual earnings recover somewhat six years after injury onset. For moderately disabled workers, the annual working hours are decreased 400 to 500 hours even several years after injury. Workers with the most severely disabling injuries incur dramatic losses in earnings and labor supply: Annual earnings for these workers are lowered by over $7,000 by the second year after onset and over $9,000 by the sixth post-onset year. Relative to average hours worked more than four years before injury onset, their annual working hours are lowered by over 40 percent by the sixth year after the injury is incurred.

This paper offers preliminary evidence on the impacts of work-related injuries and illnesses on the labor supply and earnings of workers nearing retirement age. However, several issues remain unexplored. While the results presented here suggest serious losses for these workers in terms of their labor market outcomes, this paper does not analyze the magnitude of losses in total household income or the extent to which other income sources help mitigate against lost earnings when a worker is injured on the job. An expanded version of this study might consider changes before and after an injury in other measures of economic well-being, like total household income, transfer income from public programs like workers' compensation, Social Security disability, and Supplemental Security Income (SSI), spousal labor supply and earnings, and household consumption.[16] Such an analysis might also help to shed light on how older workers are replacing lost earnings from a workplace injury and whether programs like workers' compensation are adequately supporting the material well-being of these workers and their households.

Another useful avenue for future research would be to compare the impacts of on-the-job injuries for older workers to those for a younger sample. Applying the methods in this paper to a nationally-representative sample of prime-aged workers like those in the National Longitudinal Survey of Youth (NLSY) or the Survey of Income and Program Participation (SIPP) would permit such a comparison.

[16]See Meyer and Mok (2006) for an example of a study in which changes in many of these measures of economic well-being are examined for individuals who become disabled in the PSID.

In general, the literature on work-related injuries and illnesses should be expanded to include more studies of their impacts on the economic situations of affected workers and their households. What little we do know about the impacts of workplace injuries and illnesses paints a picture of severe long-term hardship for injured workers and their families. The results in this paper corroborate the existing evidence of substantial economic losses for these workers and suggest a need for further analysis of the effects of workplace injuries on both labor market and non-labor market outcomes.

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APPENDIX

1. Data Appendix to Chapter 2

Because the March CPS data do not include a unique individual identifier, individuals are matched across years as follows: First, respondents are matched according to their "month in sample" (MIS). As described in the text, the design of the CPS is such that households are interviewed for four consecutive months, are not interviewed for the next eight months, and are then interviewed again for four more months. Thus, an individual with MIS=5 in any given March survey must have MIS=1 in the previous year's March survey (likewise, an MIS of 6 goes with 2, 7 with 3, and 8 with 4).

Next, the CPS assigns to each member of a household a unique household identification number (HHID), a line number (LINENO) within a household, which should, in theory, remain the same for a given individual over time). However, the combination of HHID and LINENO do not uniquely identify individuals across years of the CPS because, for instance, if a given respondent moves out of a household between one March survey and the next, his HHID and LINENO could be reassigned to a new person moving in. Generally, an additional variable, HHNUM, is used to identify such cases: HHNUM increases by one if a household member is replaced by another between two surveys. Therefore, in the absence of recording errors, the combination of HHID, LINENO, and HHNUM should unique identify individual respondents across surveys of the CPS. I refer to the set of matches obtained using only these three variables as "naive matches," and the percentage of all possible merges that are successful using this method as the "naive merge rate."

However, perhaps because the CPS was not designed for use as a panel data set, inconsistencies in these variables do arise, leading a researcher matching on HHID, LINENO, and HHNUM to obtain some "false positives" (i.e., matches that do not represent two observations on the same individual). Thus, I must choose a set of criteria on which to delete such false matches from my initial sample of naive merges. Almost all years of the March CPS contain a variable reporting whether an individual lived in the same residence one year prior (MIGSAM). Since the CPS does not follow households that move between two surveys, I first delete any individuals who report having lived in a different house or dwelling at the time of the previous year's interview. There are several years (e.g., 1977-79, 1980, 1985) for which this variable is not available; for these years, false positive matches are deleted according to the demographic criteria described in what follows.

After using this migration variable to refine the set of naive matches, I turn to demographic characteristics to help delete remaining "false positives." For a match that truly represents the same individual in year t-1 and t,the individual's reported gender and race should generally not differ, nor should his age differ by more than 0 or 2 years. Deleting those naive matches who moved residences between surveys or whose age, gender, or race differ unrealistically as just described provides my set of refined matches, from which I draw the sample of eligible workers used in the paper. Appendix Table A.1 shows the naive and refined merge rates for each year used in Chapter 2.

Table A.1: Naive and Refined Merge Rates for Matching Observations Across March CPS Surveys

Survey Year	Naive Merges	Naive Merge Rate	Percent of naive merges who lived in same house at $t-1$	Percent of naive merges who lived in same house at t-1 and meet race-gender-age criterion
1977-78	56,577	70.9	——	89.5
1978-79	55,097	71.3	——	89.2
1979-80	55,920	72.2	——	88.1
1980-81	66,814	73.4	97.5	94.2
1981-82	58,877	65.8	97.4	94.3
1982-83	59,269	72.7	97.8	94.6
1983-84	57,746	71.3	97.6	94.4
1984-85	56,253	69.8	——	90.6
1986-87	53,867	69.0	97.3	93.6
1987-88	54,944	70.7	97.5	93.4
1988-89	51,504	65.8	97.4	93.0
1989-90	52,179	71.9	97.3	93.1
1990-91	56,564	71.3	97.4	92.5
1991-92	55,545	70.8	97.4	92.7
1992-93	54,964	71.2	97.1	92.6
1993-94	41,420	53.0	97.2	93.5
1994-95	36,392	52.5	96.4	94.9
1996-97	47,441	72.4	96.4	93.5
1997-98	47,740	71.9	96.7	93.4
1998-99	47,719	72.1	96.9	93.5
1999-00	47,714	71.6	96.8	94.4
2000-01	46,059	77.2	97.1	95.2
2001-02	46,027	71.9	96.6	88.2
2002-03	57,401	53.9	96.6	87.2
2003-04	57,814	54.2	97.0	88.7

2. Consumption-Smoothing Benefits of WC for Comparison Groups in Ch. 3

Table A.2: Consumption-Smoothing Benefits of WC for Comparison Groups
(Results from reduced-form regression of Equation 3.1; standard errors in parentheses)

	Never injured on the job			Never disabled		
	Food + Housing	Food	Housing	Food + Housing	Food	Housing
Log potential weekly WC benefit	0.008	-0.020	0.032	0.025	-0.004	0.023
	(0.027)	(0.025)	(0.021)	(0.035)	(0.023)	0.023)
Log after-tax weekly wage t - 1	-0.0201	0.0091	-0.0045	-0.0274	0.0141	0.0054
	(0.0261)	(0.0149)	(0.0210)	(0.0329)	(0.0089)	(0.0173)
Age	-0.004	0.001	-0.006	-0.005	0.001	-0.008
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Male	-0.004	0.008	-0.005	-0.013	0.005	-0.004
	(0.016)	(0.014)	(0.014)	(0.021)	(0.015)	(0.020)
Married	-0.008	-0.028	0.050	-0.026	-0.036	0.048
	(0.019)	(0.016)	(0.015)	(0.023)	(0.027)	(0.017)
Less than high school	0.004	-0.007	0.001	0.003	-0.027	-0.001
	(0.016)	(0.014)	(0.014)	(0.021)	(0.015)	(0.020)
More than high school	-0.043	0.003	0.023	0.036	0.001	0.016
	(0.016)	(0.010)	(0.012)	(0.019)	(0.011)	(0.016)
White	0.036	-0.023	0.054	-0.018	-0.039	0.021
	(0.044)	(0.031)	(0.031)	(0.053)	(0.042)	(0.043)
Black	0.020	-0.020	0.046	-0.018	-0.039	0.021
	(0.049)	(0.036)	(0.037)	(0.053)	(0.042)	(0.043)
Household size t - 1	0.020	-0.001	0.016	0.024	0.005	0.016
	(0.007)	(0.006)	(0.007)	(0.009)	(0.007)	(0.007)
Change in household size	0.092	0.101	0.028	0.089	0.094	0.030
	(0.012)	(0.012)	(0.009)	(0.013)	(0.016)	(0.009)
State unemployment rate	-0.006	0.006	0.014	-0.001	0.014	0.014
	(0.007)	(0.007)	(0.010)	(0.009)	(0.009)	(0.010)
State-year housing price index	0.0014	0.0002	0.0024	0.0014	0.0001	0.0026
	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0004)
State dummies?	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations		11,464			8,083	

Notes: Consumption data are measured weekly and deflated into 1992 dollars using the CPI-U. Standard errors are corrected for correlation between individuals in the same state. Both samples include only observations with complete, non-missing consumption data.