The Effects of Workers' Compensation Benefits on Time Off Work, Medical Care, Health Outcomes and Welfare

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THESIS

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To my grandparents, parents, husband, fur child, and all the fluffy homeless kittens that deserve love.

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LIST OF ABBREVIATIONS

DID	Difference-in-Differences
TTD	Temporary Total Disability
TPD	Temporary Partial Disability
PPD	Permanent Partial Disability
PTD	Permanent Total Disability
SIC	Standard Industrial Classification
NAICS	North American Industry Classification System
PT	Physical Therapy
MME	Morphine Milligram Equivalents
OLS	Ordinary Least Squares
SCF	Survey of Consumer Finances

SUMMARY

Workers' compensation insurance benefits are frequently the first source and only form of compensation available to workers if they get injured on the job. It provides income benefits if a workplace injury causes an employee to miss work. Workers' compensation programs are mandatory, and most programs operate at the state level. This paper estimates how increases in the workers' compensation income benefits affect disability duration, medical care utilization, and health outcomes. Additionally, it assesses the welfare effect associated with the current benefit policy.

Looking at administrative claims data from self-insured companies from 2004 to 2016, I estimate the effects using variation in income benefits caused by the 2007 New York workers' compensation reform. I find that a 10 percentage point increase in the wage replacement rate ($77) led to an additional 3.4 days off work, implying that the duration-benefit elasticity is 0.53. However, medical care utilization did not increase as a result of expanded benefits and delayed return to work, and workers' health outcomes remained the same when they were on workers' compensation disability leave. Upon return to work, each extra day off work decreased the hazard rate of getting re-injured by 2.9 percent. Given these estimates, I find that the current benefit level in New York is close to optimal. Specifically, a $1 increase in the weekly benefits would increase a worker's utility by the equivalent of a 3.2 cent increase in the weekly wage.

New York has indexed the maximum benefit level to two-thirds of the state's average weekly wage. Given the universal requirement for workers' compensation insurance coverage, this study shows that New York has a reasonable benchmark which can be generalized to other states. Moreover, other public insurance programs must strike a balance between program costs and work incentives. The results from this study provide evidence for this trade-off and show that the long-term health effect should be taken into consideration when designing social programs.

CHAPTER 1

INTRODUCTION

Workers' compensation insurance benefits are frequently the first source and only form of compensation available to workers if they get injured on the job. The benefits are essential to worker well-being for three reasons. First, the mandate to offer workers' compensation benefits incentivizes employers to create a safe work environment and promotes early detection of occupational risk and injury (1). Second, the insurance provides medical benefits that ensure workers access to care and their ability to receive intensive medical treatments if needed. Third, the insurance provides income benefits which are a fixed amount of cash that compensate workers for lost income if the injury causes an employee to miss work. The last dimension of workers' compensation is the primary focus of this paper. I study how increases in workers' compensation income benefits affect disability duration, medical care utilization, and health outcomes. I additionally evaluate the welfare effect associated with the current benefit policy.

Each state has its own workers' compensation program, and the amount of benefits varies greatly from state to state. For example, in 2018, the maximum weekly income benefit level was $1,765 in Iowa (2), but it was only $905 in New York (3). The generosity of the benefits is an ongoing debate, as a low level of benefits may force workers to return to work before full recovery, while a high level of benefits introduces moral hazard. Some studies assess the adequacy of workers' compensation benefits offered by the states that have stringent policies and conclude that the income benefits only replace a small fraction of the income loss, and the earning loss persists after workers return to work (4). In a more recent study, Powell and Seabury (5) find that lower medical benefits lead to decreased post-injury earnings among workers with lower-back injuries. If workers do not receive sufficient benefits, they may return to work too soon and potentially forgo medical care, exposing themselves to the possibility of re-injury. But the other side of the coin is the moral hazard story. Studies have shown that higher benefits lead to an extended duration of benefit receipt and a higher frequency of claims filing (6) (7) (8) (9) (10) (11) (12) (13), especially for injuries that are difficult to diagnose (14) (15) (16). However, little is known about the causal effects of extended time off work on downstream health outcomes. If workers' health status gets improved in the long term, then delayed return to work is not completely due to moral hazard and will potentially lead to a welfare gain. Therefore, by assessing workers behavior toward time off work and acquiring medical care, I address whether benefit expansion relieves the pressure of returning to work and prompts better health outcomes, or induces workers to take an unnecessarily long time off work by distorting their incentives to return to work.

In New York and 35 other states, the weekly cash benefit is two-thirds of the average weekly wage that the worker earned for the previous year, subject to a minimum and maximum amount (17). In 2007, New York had a workers' compensation reform that increased the weekly maximum cash benefit levels through 2009 and has indexed the maximum to two-thirds of the states average weekly wage since 2009. The exogenous increase led some workers to receive higher pay when injured but not others. Using the variation in the wage replacement rate resulting from the annual increases in the weekly maximum benefit level, I conduct the study within a generalized difference-in-differences (DID) framework. The wage replacement rate is defined as the ratio of the benefit over the pre-injury wage. Workers with a wage replacement rate that always equals two-thirds compose the control group, and workers with a wage replacement rate that changes due to the increases in the maximum benefit level are the treatment group.

I conduct this study using unique workplace injury claims data collected by a third-party administrator. The injuries in my data occurred in the self-insured companies in New York from 2004 to 2016. Each claim is associated with medical records including doctor visits, drug use, hospitalization, and medical spending, which allows me to estimate the downstream health outcomes.

I find that workers responded to the benefit increase by staying off work longer. Specifically, a 10 percent increase in the wage replacement rate ($77) led to an additional 3.4 days off work (a 7 percent increase). The duration-benefit elasticity is 0.53, which is at the lower to middle point of the range estimated in the literature. This finding is consistent with the belief that self-insured employers have stronger incentives for cost saving than fully-insured employers,[1]

[1] Fully-insured companies pay a fixed premium to an insurance carrier.

and any policy that increases workers' compensation costs will lead self-insured employers to reinforce safety regulations and facilitate the return-to-work process. While the actions might be less aggressive for fully-insured companies since the risks are pooled across many companies, and the involvement of insurance companies further dampens employers motivation for cost saving.

Moreover, workers did not utilize more medical care services as a result of increased benefits and the delayed return to work, and the health outcomes when workers are on temporary disability leave (i.e., likelihood of going through hospitalization and surgery) remained unchanged. However, workers were 2.9 percent less likely to experience re-injuries upon return to work for each extra day off work, indicating that their health status was improved in the long term. One explanation is that most work-related injuries are soft tissue injuries that can only be mitigated by longer rest and less physical exertion, as opposed to receiving a battery of medical treatments.

Based on the estimates, I lastly perform a welfare calculation to show where the optimal benefit level should be in terms of minimizing workers' compensation costs and maximizing worker welfare. I use the optimal benefit formula derived by Chetty (18) and conclude that a $1 increase in the weekly benefit level is equivalent to a gain in the utility by a 3.2 cent increase in the weekly wage. The small magnitude indicates that the current benefit level in New York is close to optimal.

My study contributes to the existing literature in three areas. First, to my knowledge, this study is the first to isolate the causal effect of workers' compensation disability duration on medical care utilization and to provide potential rationale behind workers behavior. Previous studies have shown a positive correlation between disability duration and medical outcomes and medical spending (19) (20) (21). But reverse causality has been a concern because workers with more serious injuries tend to have longer disability duration and incur more medical care utilization. In fact, Powell and Seabury (5) finds that decreased medical benefits made workers return to work slower, indicating that the causality can indeed go the other way. Therefore, using unique claims data, I am able to identify the causal impact of disability duration on medical outcomes by exploiting the exogenous variation in benefit levels. Using the same variation, I also consider the downstream health outcomes by evaluating re-injury possibility.

Second, the sample consists of self-insured companies, which may behave differently than the fully-insured companies studied in the literature in responding to the increases in workers' compensation costs. Thus, this study provides information for comparison with conclusions generated from previous studies. Third, methodology-wise this study is the first study among the relevant literature to construct a continuous treatment variable, in contrast to a binary measure, to capture the intensity of the policy effect. This study also uses more variation than past studies; specifically, it encompasses 10 annual increases in the maximum weekly benefit levels from 2007 to 2016.

This study has two important policy implications. First, a policy that increases workers' compensation benefits tends to be costly to employers in terms of increased costs and delayed return to work, but the expenses are offset by savings associated with reduction in re-injuries. Workers benefit from the policy by enjoying more time off and subsequently suffering less from repeat injuries. New York has been adjusting the benefit levels for more than a decade. The welfare calculation shows that the current benefit level is almost optimal, indicating that setting the maximum benefit level at two-thirds of the state's average wage during the previous calendar year is a good benchmark for workers' compensation program. Given the universality of the program, the study findings are applicable to other states.

Second, major welfare programs such as Social Security Disability Insurance, Unemployment Insurance, and Medicaid must strike a balance between work incentives and benefit levels. This study provides direct policy implications for this trade-off and suggests that the long-term health benefits should be taken into consideration when designing social policies.

The paper is organized as follows. Section 2 provides relevant industrial background on workers' compensation laws and New York workers' compensation reform. I also discuss the relevant studies and the contributions of this paper. Section 3 develops theoretical frameworks analyzing employer and employee incentives in light of an increase in workers' compensation benefits. Sections 4 and 5 describe the data and the empirical approach. Section 6 presents the results on time off work. Section 7 assesses the possibilities of sample selection and endogeneity of wages. Section 8 focuses on the health services use and the health outcomes. Section 9 presents the welfare calculation, and Section 10 discusses and concludes.

CHAPTER 2

BACKGROUND

This section provides an overview of workers' compensation laws and describes income benefits in greater detail. Since this study uses variation from the benefit increase brought by the workers' compensation reform in New York, this section also specifies the changes following the reform.

2.1 Workers' Compensation Laws

Workers' compensation programs are mandatory, and most programs operate at the state level.[1] The majority of firms purchase their insurance from private insurance companies. Small firms are charged a premium based on the safety record of their industry, while large firms can qualify for experience-rating and receive a premium that is adjusted based on their own safety record. Large firms are also allowed to self-insure,[2] which is equivalent to having a perfect experience-rating (23).

Workers' compensation systems are "no-fault" systems, meaning that workers are entitled to the benefits awarded through workers' compensation without needing to prove that their employers negligence caused their injury at work. In exchange, workers forgo their rights to sue their employers over the covered injury. In general, if a worker is injured on the job, the worker needs to follow several steps. First, if necessary, the injured worker should obtain immediate medical treatment, either on site or at a doctors office. Second, the injured worker should notify the employer about the injury within a certain period of time. Failure to do so may lead to losing the right to the workers' compensation benefits. The period that workers have for notifying

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[1] Companies in Texas can choose to opt out of the workers' compensation system. Common exemptions from coverage are domestic service, agricultural employment, small employers, and casual labor. Many programs exempt employees of nonprofit, charitable, or religious institutions. Twenty-four states have state-run workers' compensation funds, while companies in the remaining states purchase workers' compensation insurance from commercial carriers.

[2] A few states do not permit employers to self-insure. In all other states, companies need to provide financial reports and meet certain solvency standards in order to self-insure (22).

their employers varies depending on the specific state. New York, for example, gives workers 30 days from the date of the incident to inform their employers about work-related injuries (3). Third, the worker or the employer files an injury claim with the workers' compensation board and the insurance agency is notified about the injury if the company is not self-insured. As with the initial notification, the window of time in which workers can file their claims varies by state. After a certain waiting period, injured workers are entitled to the income benefits, which are nontaxable cash payments. If the claim is not being disputed, the insurer continues making cash payments every two weeks until the workers return to work with no restrictions or modifications of their regular jobs.[1] If a worker returns to work with restrictions or modifications, the benefits are reduced to a fraction of the difference between the pay for the regular job and the pay for the modified job (24).

Workers' compensation insurance provides unlimited medical care payments for work-related injuries and provides a fixed cash benefit after a certain waiting period to compensate lost wages if a work-related injury cause workers to miss work. Approximately 75 percent of workers' compensation cases *only* involve medical care payments, but they account for a mere 7 percent of total workers' compensation payment (25). These medical-only claims do not involve lost work time longer than the waiting period for cash payments to start. During the waiting period, workers can use paid time off, sick leave, or unpaid leave of absence to cover the lost work time.

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[1] Disputed claims are subject to a different procedure, which is beyond the scope of this paper.

The rest 25 percent of workers' compensation cases involve both medical care payments and cash payments. Workers in this case are on disability leave and incur lost work time longer than the waiting period. There are four types of disability claims: temporary total disability (TTD), temporary partial disability (TPD), permanent partial disability (PPD), and permanent total disability (PTD).

TTD claims are the most common type of claims involving cash payments. An employee with a TTD is unable to work for a limited period but is expected to fully recover and return to the pre-injury job or to another job that requires equivalent skills. Typically, weekly cash payments for TTD are two-thirds of the average weekly wage that the worker earned for the previous year, subject to minimum and maximum amounts determined by the specific state. An employee with a TPD returns to work before full recovery and performs a job that requires reduced responsibilities at a lower salary. Typically, TPD benefit is a fraction of TTD benefit depending on the severity of impairment (24). Many states set the limit for receiving temporary disability benefit at 104 weeks, but sometimes it can be up to 500 weeks (26). Other states, including New York, rely on the opinion of a claimants treating doctor on whether the claimant should continue staying on disability leave or return to work.

A PPD is when the injury is deemed to have reached maximum medical improvement without a full recovery to pre-accident normal use, meaning that part of the employees wage-earning ability has been permanently lost. The factors used to determine PPD benefit vary across states. Workers in some states become eligible for PPD benefit when they have reached maximum medical improvement, while others receive PPD benefit simply as an extension of temporary disability benefit (27). Many disabilities later found to be permanent are initially temporary. PTD is the rarest and most severe type of injury, and workers with PTD have permanently lost all wage-earning ability. The PTD benefit amount varies significantly across states. Although temporary disability claims are the most frequent type for disability claims, permanent disability claims account for a much larger share of the total workers' compensation benefits paid (28) (25). In 2015, 135.6 million employees were covered under workers' compensation laws, which paid out a total of $31.1 billion in medical benefits and $30.8 billion in cash benefits (29).

2.2 New York Workers' Compensation Reform

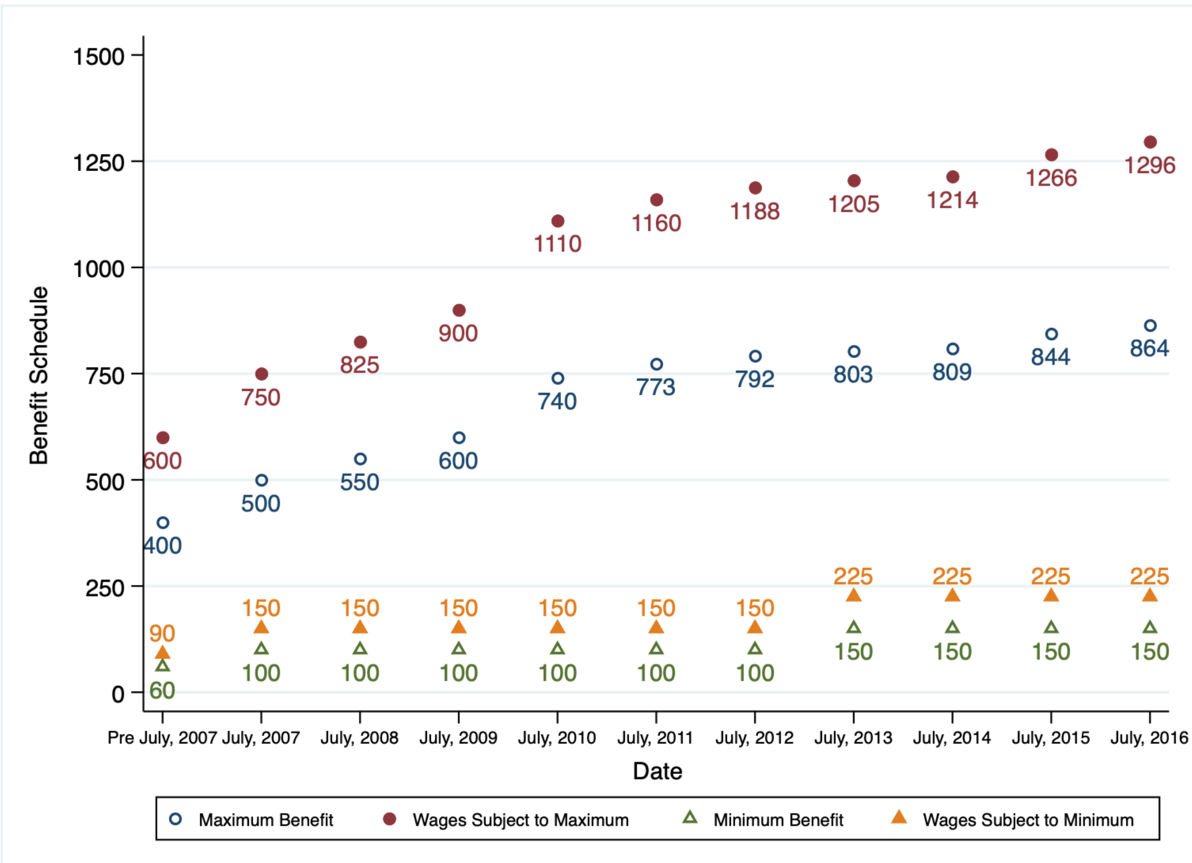
The specific amount of cash payments and the waiting period that workers must undergo before the cash payments start vary based on each states workers' compensation law. In New York, the waiting period for injured workers to receive the cash payments is seven days. Workers begin to receive the cash on the eighth day. If the disability lasts beyond 14 days, the payment will be applied retroactively to the first work day off the job. Prior to the 2007 workers' compensation reform, the maximum cash payment level in New York was set at $400 per week, which had been the same since 1992. In 2006, the $400 maximum cash payment level was so low that it was only 36 percent of the state's average weekly wage. As a result, many injured workers did not receive two-thirds of their weekly wages when on workers' compensation disability. The 2007 reform increased the maximum and the minimum cash payment levels through 2009, and the changes took effect on July 1, 2007. The subsequent maximum benefit levels after 2009 were indexed at two-thirds of the state's average weekly wage for the previous calendar year and were adjusted every July 1[1] (30) (24).

Figure 1 displays the maximum and minimum weekly cash payment schedules for New York from 2004 to 2016. The schedules are two-thirds of the pre-injury wages subject to the maximum cash payment levels. In 2007, the maximum weekly cash payment was increased from $400 to $500 (a 25 percent increase) and continuously increased through 2016. In 2016, the maximum level was $864, more than double the $400 cap prior to 2007. If a workers pre-injury wage falls above the wage that is subject to the maximum cash payment level, the worker receives the amount capped at the maximum level. If a workers pre-injury wage falls below the wage that is subject to the minimum cash benefit level, the worker receives cash payments at the minimum level. If a workers pre-injury wage falls between the wage that is subject to the minimum and maximum cash payment level, the worker receives two-thirds of his or her pre-injury wage as the cash payment. The 2007 reform also increased the minimum cash payment level from $60 to $100 per week, and it was set at $100 until May 2013. In May 2013, the Business Relief Act increased the minimum weekly benefit to $150 (31). Workers receiving the minimum payment amount ($150 per week prior to 2013 and $225 per week after 2013) represent 4 percent of the

[1] The new benefit levels only affect the injuries occurring on or after adjustment of the levels. Injuries occurring prior to this time point receive the previous benefit amount.

sample and are excluded from the study. Because the study period covers 13 years, inflation needs to be accounted for. All dollar values in this study are expressed in 2018 dollars unless otherwise noted.

Figure 1: Maximum and minimum weekly cash payment schedule



The 2007 reform was multipronged. It implemented a package of statutory and administrative changes to the New York workers' compensation system. Besides increasing the maximum and minimum weekly cash payments, the 2007 reform brought a mix of other benefit changes, premium reduction, anti-fraud initiatives, and administrative streamlining to facilitate the claim process (32) (33).[1] These simultaneous changes might have a joint impact on returning to work, which may raise concerns that I attribute the joint impact to the effect of increases in weekly cash payments alone. But to yield a biased estimate, other components of the workers' compensation reform would have to influence return to work differentially for workers who are affected and workers who are not affected by the changes in the maximum cash benefit level. For example, my estimate would be biased upward if anti-fraud provisions led affected (higher wage) workers to stay off work longer relative to unaffected (lower wage) workers. Given that anti-fraud provisions were applied to all workers regardless of wage, such a scenario does not seem to be plausible.

2.3 Literature and Contributions

Since the 1980s, several papers have studied the impact of workers' compensation benefit level on the duration of injury claims. Research shows that an increase in the workers' compensation benefits is generally associated with a longer period of absence from work (6) (7) (8) (9) (10) (11) (12) (13) and a lower hazard rate to return to work (34) (35) (36) (37) (38). A few stud-

[1] Table XII details other changes implemented by the 2007 reform.

ies specifically target lower-back injuries, which are the most frequent type of work-related injuries (39) (40). Depending on econometric methods, the characteristics of claimants (36), and the level of difficulty in diagnosing injuries (14) (15) (16), these studies yield a wide range of duration-benefit elasticities, from a minimum of no elasticity (6) (8) (38) to a maximum of 1.67 (9).

This paper contributes to the literature in three ways. First, this paper is the first study to my knowledge that isolates the causal effect of disability duration on workers' compensation medical services use. Although past literature has shown that disability duration is positively associated with the workers' compensation medical benefit component (19) (20) (21), the reverse causality is always a concern since more severe injuries tend to incur more medical spending and more days off work. The variation in wage replacement rate used in this study allows me to evaluate whether increases in cash benefits and disability duration *cause* more medical care consumption, rather than the other way around. Using the same variation, this study is also the first to consider the downstream health outcome by assessing the possibility of re-injury after returning from the previous injury.

Second, a majority of studies have focused on employees working at fully-insured companies, and this paper contributes to the literature by being among the first few analyses pertaining to self-insured employers (41) (9). Since self-insured employers bear all the workers' compensation cost, increases in workers' compensation benefits will motivate them to create a safer environment and monitor the duration of benefit receipt. The incentive in cost saving is unambiguous for self-insured employers, while the incentives might be dampened among fully-insured companies due to the risk-sharing mechanism and involvement of an insurance company. Literature has shown that employees of self-insured firms tend to return to work faster than employees of fully-insured firms (9). The literature has also shown a smaller positive association between benefit generosity and injury rate (42) or lost workdays (43) among highly experienced-rated firms. Therefore, this study offers an opportunity to compare the estimates with those from earlier literature that examined fully-insured companies.

Third, this paper extends the past research methods by conducting multiple experiments and measuring the treatment effect differently. Specifically, I exploit variation generated by the 10 annual changes in maximum benefit levels from 2007 to 2016, and I construct a continuous treatment variable to capture the intensity of policy effect. These two unique features enable me to perform robustness checks, which bolster the credibility of my findings.

CHAPTER 3

THEORETICAL MODEL

This section presents a theoretical model for evaluating the incentive effects on employers and employees due to increasing in cash benefits. I first discuss the effects from the employers perspective and then from the workers perspective.

3.1 Employer Incentives

For a single self-insured firm, expected profit can be represented as:[1]

$$\Pi = R(p_o, n, \pi(b)) - W(\pi(b))(1 - \pi(b))n - p\pi(b) - bw\pi(b)n$$

where Π is expected profit;

$R(\cdot)$ is the expected revenue function;

p_o is the output price;

n is the number of workers;

π is the value indicating the level of workplace hazards, which is a function of benefits b with $\pi'(b) < 0$, meaning that an increase in the benefits leads employers to reduce workplace hazards;

[1] The model is a variation of Kniesner in 2014 (44).

b is the level of weekly benefits provided to workers if injured;

$W(\pi)$ is the wage function that depends on the level of hazard at the workplace with $W'(\pi) > 0$, meaning riskier jobs are associated with higher wages;

p is the price to produce a certain level of safety work environment; and

w is the number of weeks that the benefits last.

By differentiating the equation above with respect to b and rearranging the terms, the employers responses to a chance in benefit level can be shown by setting up $\frac{\partial \Pi}{\partial b} = 0$:

$$\frac{\partial R}{\partial \pi}\frac{\partial \pi}{\partial b} - \left[\frac{\partial W}{\partial \pi}(1-\pi(b)) - W(\pi(b))\right]\frac{\partial \pi}{\partial b}n - (\pi(b) + b\frac{\partial \pi}{\partial b})wn = p\frac{\partial \pi}{\partial b}$$

$\frac{\partial R}{\partial \pi}\frac{\partial \pi}{\partial b}$ is the increased revenue gained by reducing the workplace hazards π. The term $\left[\frac{\partial W}{\partial \pi}(1-\pi(b)) - W(\pi(b))\right]\frac{\partial \pi}{\partial b}n$ is the wages that employers pay to workers, which increase as the jobs get riskier. The third term $(\pi(b)+b\frac{\partial \pi}{\partial b})wn$ is the workers' compensation expenses that employers pay to injured workers. The terms on the left side of the equation together represent the marginal benefit of higher benefits, which is a safer working environment. On the right side, the term $p\frac{\partial \pi}{\partial b}$ is the marginal cost of higher benefits, which equals the price paid to reduce an additional unit of workplace hazard.

Therefore, an increase in b leads to an increase in the marginal benefit of greater safety. To reap the benefits of greater safety, employers can reduce workplace injuries and more closely monitor disability duration to keep w low. Compared to fully insured companies, it is even more important for self-insured employers to strive to reduce workplace injuries and monitor disability duration because they bear all the workers' compensation cost.

3.2 Employee Incentives

Employees face the problem of choosing the level of consumption and leisure associated with an occupation and a firm in order to maximize expected utility, while also being subject to the budget constraint. Using a standard labor supply model, a workers expected utility can be represented as follows:

$$\overline{U} = (1-\pi)U(C, L) + \pi\widetilde{U}(\widetilde{C}, \widetilde{L})$$

$$\text{s.t.} \quad C = W(\pi)(L_o - L) + R; \; \widetilde{C} = b\widetilde{L}$$

Where $\overline{U}$ is the expected utility;

$U(\cdot)$ is the utility function if the worker is working;

$\widetilde{U}(\cdot)$ is the utility function if the worker is injured and off work;

C is the consumption the worker chooses to have if working;

L is the leisure the worker chooses to have if working;

$\widetilde{C}$ is the consumption the worker chooses to have if injured;

$\widetilde{L}$ is the leisure the worker chooses to have if injured;

L_o is the maximum amount of time the worker can work, which consists of leisure and work;

$W(\pi)$ is the wage function that depends on the level of hazard at the workplace with $W'(\pi) > 0$;

b is the level of weekly cash benefits provided to workers if injured; and

R is the earnings the worker earns outside of the labor market.

Assuming that consumption and leisure are separable in utility, let $U(C, L) = \ln C + \ln L$ and $\widetilde{U}(\widetilde{C}, \widetilde{L}) = \ln\widetilde{C} + \ln\widetilde{L}$, so the first-order condition is as follows:

$$\frac{C*}{L*} = W(\pi),\ L* = \frac{W(\pi)L_o + R}{2W(\pi)}$$

$$\frac{\widetilde{C}*}{\widetilde{L}*} = -b,\ \widetilde{L}* = \frac{-R}{2b}$$

The impact of a change in wage when the worker is working is obtained by differentiating $L*$ with respect to W, and the impact of a change in cash payments when the worker is out of work is obtained by differentiating $\widetilde{L}*$ with respect to b:

$$\frac{\partial L*}{\partial W} = -\frac{R}{2W^2} < 0,\ \frac{\partial \widetilde{L}*}{\partial b} = \frac{R}{2b^2} > 0$$

The model shows that an increase in wage decreases the leisure the worker chooses to have while working, and an increase in cash payments increases the leisure the worker chooses to have if injured.

Since C and L are functions of $W(\pi)$ and R, and $\widetilde{C}$ and $\widetilde{L}$ are functions of b and R, the utility function can be written as:

$$\overline{U} = (1-\pi)U(W(\pi), R) + \pi\widetilde{U}(b, R)$$

By differentiating the equation above with respect to π and rearranging the terms, it can be shown that the worker chooses an optimal level of workplace hazard when

$$(1-\pi)U'\frac{\partial W(\pi)}{\partial \pi} = U(W(\pi), R) - \widetilde{U}(b, R)$$

$(1-\pi)U'\frac{\partial W(\pi)}{\partial \pi}$ is the marginal benefit the worker gets by choosing a riskier job. $U(W(\pi), R) - \widetilde{U}(b, R)$ is the marginal cost of taking on a riskier job that includes a higher probability of getting injured and lowers both income and utility. An increase in cash payment lowers the marginal cost of getting injured, so a worker is more likely to either take on a riskier job or use less caution when performing tasks.

To summarize, an increase in cash payments is likely to incentivize employers to invest more in workplace safety and help injured workers return to work more quickly. Meanwhile, the increase may induce workers to take fewer safety precautions and stay off work longer if injured. Therefore, the increase in cash benefits motivates employers and employees to take opposing actions. The estimate of the effect on return to work from my study is the net effect of these actions.

CHAPTER 4

DATA

4.1 Analytical Sample

The data were obtained from a nationwide third-party administrator that manages workplace injury claims. For each claim, the dataset includes information on the claim, claimant, company, claimants employment status, and medical record. Table XIII contains detailed information on the steps I take to construct the sample to estimate the impact of benefits on return to work, medical care utilization, and health outcomes. [1] The sample consists of 16,139 workplace injury claims that occurred in 326 companies from 2004 to 2016. Therefore, the sample contains 13-year repeated cross sectional data at claims level and 13-year panel data at company level. Because my analysis only focuses on workers who are on TTD, it would be subject to sample selection if the workers who file TTD claims are systematically changing their health status as a response to increased benefits. I also perform a series of tests by including additional claims to infer whether any systematic change occurs in the injured population.

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[1] The sample construction steps are the same as what described in Jinks (45).

4.2 Summary Statistics

The summary statistics on employment characteristics, injury characteristics, and claimant characteristics are displayed in Table I and Table II.[1] The workers are categorized into control and treatment groups based on their average pre-injury weekly wage. The weekly wage is inflation-adjusted and is expressed in 2008 dollars. Workers with weekly wages between $113 and $450 are referred to as the control group because their wage replacement rates are not affected by the changes in the benefit schedule and have always equaled two-thirds during the study period. Workers with weekly wages between $450 and $5425 are referred to as the treatment group since their wage replacement rates are either partially or totally affected by the changes in the benefit schedule across years. The pre-reform period refers to the period from January 1, 2004, to June 30, 2007, and the post-reform period refers to the period from July 1, 2007, to December 31, 2016.

Table I lists summary statistics on employment characteristics. The proportion of full-time regular employees in the sample increased from 93 to 96 percent for the treatment group, while it decreased from 79 to 72 percent for the control group. In terms of industry category, I map the Standard Industrial Classification (SIC) code to the North American Industry Classification System (NAICS) code so that the statistics in my sample can be related to the public available data from the federal statistical agencies. Most injuries occurred in transportation/warehousing

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[1] Summary statistics on outcomes are displayed in Table XIV and Table XV.

TABLE I: SUMMARY STATISTICS ON EMPLOYMENT CHARACTERISTICS

Variables	All	Pre-reform Control[a]	Pre-reform Treatment[b]	Post-reform Control	Post-reform Treatment
Employment Status	percent	percent	percent	percent	percent
-regular	89.63	78.99	93.30	72.46	96.39
-part time	7.16	15.07	0.94	24.32	2.04
-other	3.20	5.94	5.76	3.22	1.57
North American Industry Classification System Code	percent	percent	percent	percent	percent
-construction	1.55	1.19	4.42	0.15	0.99
-manufacturing	13.71	6.82	21.49	4.39	15.39
-wholesale trade	12.70	4.13	18.45	2.82	15.76
-retail trade	18.03	29.12	5.45	52.89	8.77
-transportation & warehousing	23.65	25.35	25.85	14.67	25.37
-information	6.49	0.67	2.69	0.22	11.39
-finance & insurance	2.40	3.25	3.32	1.83	2.03
-real estate & rental	0.86	0.83	0.82	0.81	0.91
-professional/scientific services	0.30	0.36	0.25	0.40	0.27
-administrative/support services	2.13	3.9	0.91	3.40	1.75
-educational services	0.55	0.52	1.10	0.15	0.47
-health care & social assistance	4.67	7.54	2.35	8.60	3.60
-entertainment & recreation	0.13	0.16	0.19	0.29	0.05
-accommodation & food services	6.62	10.43	6.05	5.56	6.30
-other services	0.74	1.03	0.60	0.99	0.65
-NOC	5.47	4.70	6.08	2.82	6.28
Working in NYC	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd
	0.32	0.32	0.30	0.32	0.33
	(0.47)	(0.47)	(0.46)	(0.47)	(0.47)
Days of Service	3152.2	1563.1	3959.4	1060.8	3903.8
	(3252.5)	(2099.0)	(3505.2)	(1608.9)	(3340.0)
Number of Observations	16139	1937	3192	2734	8276

[a]Workers with wages between $113 to $450. Mean: $301; Medium: $307.

[b]Workers with wages between $450 to $5425. Mean: $904; Medium: $800.

TABLE II: SUMMARY STATISTICS ON INJURY AND CLAIMANT CHARACTERISTICS

Variables	All	Pre-reform Control[a]	Pre-reform Treatment[b]	Post-reform Control	Post-reform Treatment
Injured Body Part	percent	percent	percent	percent	percent
-head	10.67	14.71	6.30	26.26	6.26
-neck	2.35	2.12	2.63	1.39	2.61
-upper extremities	24.52	25.04	24.31	23.01	24.98
-trunk	31.79	27.57	36.25	21.84	34.34
-lower extremities	23.96	23.85	23.31	22.17	24.83
-multiple body parts	6.72	6.71	7.21	5.34	6.98
Cause of Injury					
-burn or cold exposure	8.97	9.45	7.74	12.87	8.05
-caught in or between	9.39	6.20	9.93	5.67	11.16
-cut, punctured, or scrape	2.83	3.20	1.44	4.02	2.89
-fall or slip	19.44	20.91	19.11	20.45	18.90
-motor vehicle	2.08	2.32	2.63	1.35	2.05
-strain	39.71	35.93	42.14	35.00	41.22
-strike against or step on	5.14	5.63	5.08	4.72	5.20
-struck	9.75	13.68	9.05	13.42	7.89
-miscellaneous causes	2.67	2.69	2.88	2.49	2.65
Male	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd
	0.67	0.54	0.75	0.47	0.74
	(0.47)	(0.50)	(0.43)	(0.50)	(0.44)
Claimant Age	40.54	36.58	42.18	35.55	42.49
	(11.60)	(11.77)	(10.37)	(12.66)	(10.90)
Number of Dependents	0.32	0.26	0.53	0.19	0.31
	(1.21)	(0.77)	(1.09)	(1.98)	(0.96)
Marital Status	percent	percent	percent	percent	percent
-not married	43.31	52.14	29.98	60.28	40.78
-married	36.87	34.64	45.49	26.23	37.58
-unknown	19.82	13.22	24.53	13.50	21.64
Number of Observations	16139	1937	3192	2734	8276

[a]Workers with wages between $113 to $450. Mean: $301; Medium: $307.
[b]Workers with wages between $450 to $5425. Mean: $904; Medium: $800.

and retail trade industries. The proportion of workers employed in New York City remained at 32 percent for the control group and increased from 30 to 32.5 percent for the treatment group. The days of service declined since the reform for both groups. On average, the treatment group workers had been employed at their companies more than twice as long as their control group counterparts.

Injury and claimant characteristics are shown in Table II. The majority of the injuries occurred in the trunk of the body and were caused by straining. In the control group, about half of the workers were male, while about 75 percent of workers in the treatment group were male. The treatment group also tended to be older, has more dependents, and were more likely to be married.

To summarize, significant differences are present in the pre-injury characteristics between the treatment and control groups. The differences make sense because the treatment group (higher wage workers) and the control group (lower wage workers) do not generally share many similarities. For example, with regard to pre-injury characteristics, higher wage workers are more likely to be full-time employees, to have served longer in their firms, and to be male. That said, because of the exogeneity of the policy change, the differences in pre-injury characteristics are not likely to bias the study results.

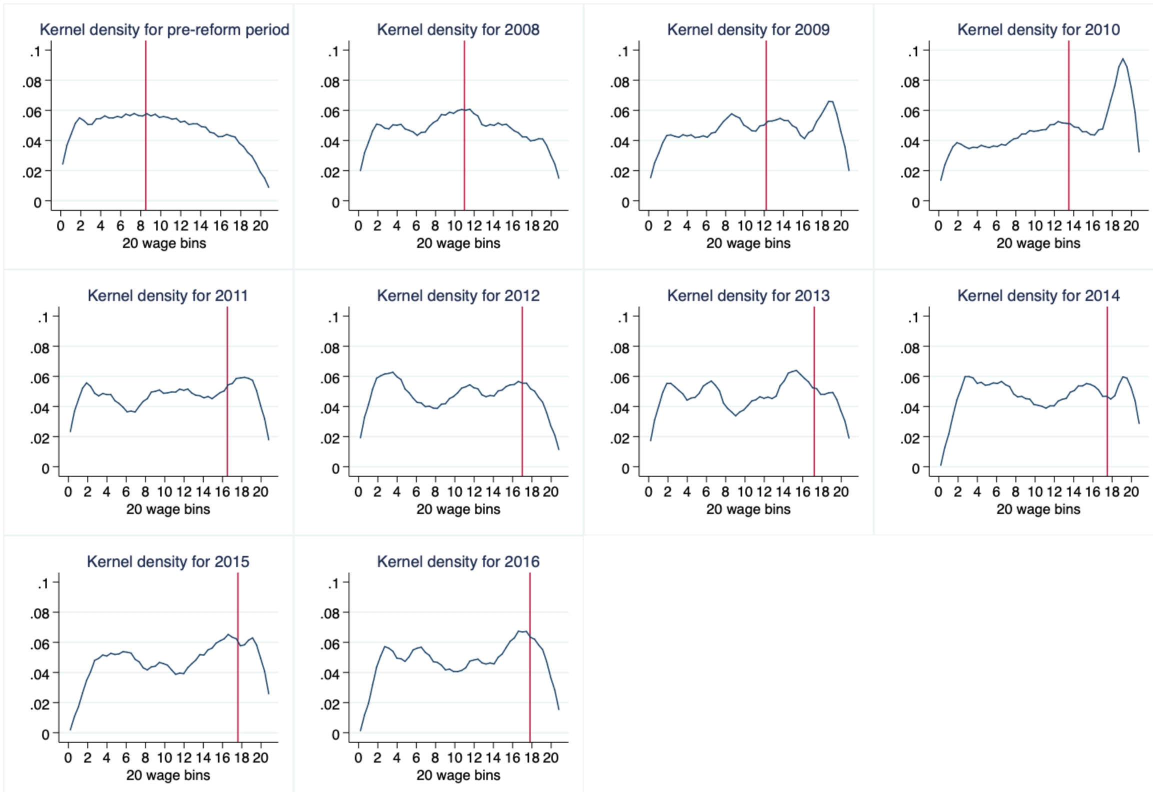
4.3 Kernel Density of Number of Claims across Wage Bins

Since the effect of increases in maximum benefit level depends on the wages, wages need to have a large enough spread to ensure a sufficient number of workers get treated. Figure 2 presents the graphs on kernel density of the number of claims filed across the 20 wage bins. The wages are not adjusted for inflation because the graphs are displayed separately by year. The vertical line refers to the workers earning $600 per week in that year. The workers with wages to the right of the vertical line are either partially or totally affected by the increases in the maximum benefit level, and the workers with wages to the left of the vertical line are not affected by the benefit change in that year. Across the study period, the vertical line gradually shifts to the right, yielding an adequate number of individuals in the treatment group every year.

4.4 Number of Lost Days across Wage Bins

Figure 3 shows the distribution of lost days across workers in different wage quantiles. To reduce the noise associated with each mean estimate, I plot the distribution across five wage bins instead of 20. The wages are not adjusted for inflation because the Y-axis shows the unadjusted outcome in the current year. The treated group starts from the second quantile, and the control group are the workers to the left. The control group had very similar trends in the number of lost days before and after the reform, indicating that nothing else was going on during that time. Had the reform not happened, the treatment group would have similar trends before and after the policy change. However, the trends diverge for the treated group, so the reason that can explain the treated group taking more days off work after the reform

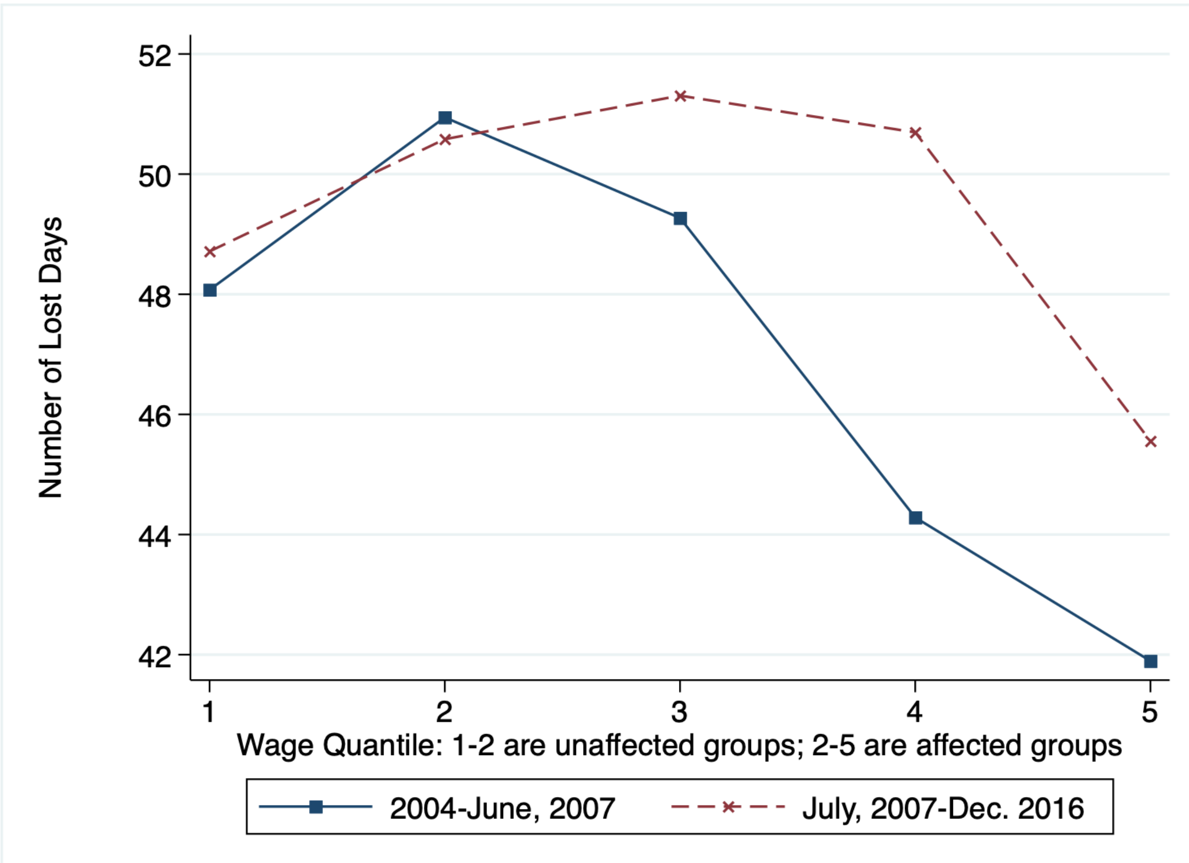
Figure 2: Kernel density of number of claims across wages



The vertical line refers to the workers earning $600 per week in that year.

is the policy change. Workers around the fourth wage quantile had the largest difference in days off work relative to the pre-reform period. Both trends decline for workers with higher wages, possibly because the wage effect dominates the return-to-work decision and the effect of increased benefits is the smallest for top wage earners. In the result section, I quantify the estimates using regressions and investigate heterogeneous effects on workers within different wage ranges.

Figure 3: Number of lost days during pre- and post-reform



CHAPTER 5

EMPIRICAL METHODS

5.1 Isolating Exogenous Variation in Wage Replacement Rate

The wage replacement rate is defined as the ratio of the cash benefit to the pre-injury wage. As described above, the wage replacement rate equals two-thirds for the workers who are unaffected by the changes in the maximum benefit level, and equals the ratio of the maximum benefit to the wage for workers who are affected by the changes in the maximum benefit level. The identifying variation I use comes from the changes in the wage replacement rate caused by the annual increase in the maximum benefit level. Since the benefit schedule is made public on July 1 of every year and is based on the average earnings at the state level for the previous calendar year,[1] the variation is credibly exogenous and is not influenced by individual companies or employees. Moreover, using the wage replacement rate as the treatment variable can effectively capture the intensity of the treatmentthat is, the percentage point change in the wage replacement rate caused by increases in the maximum benefit level.

Figure 4 displays variation in the wage replacement rate I use in this study. The data are inflation adjusted using the Consumer Price Index and are expressed in 2018 dollars. Prior to

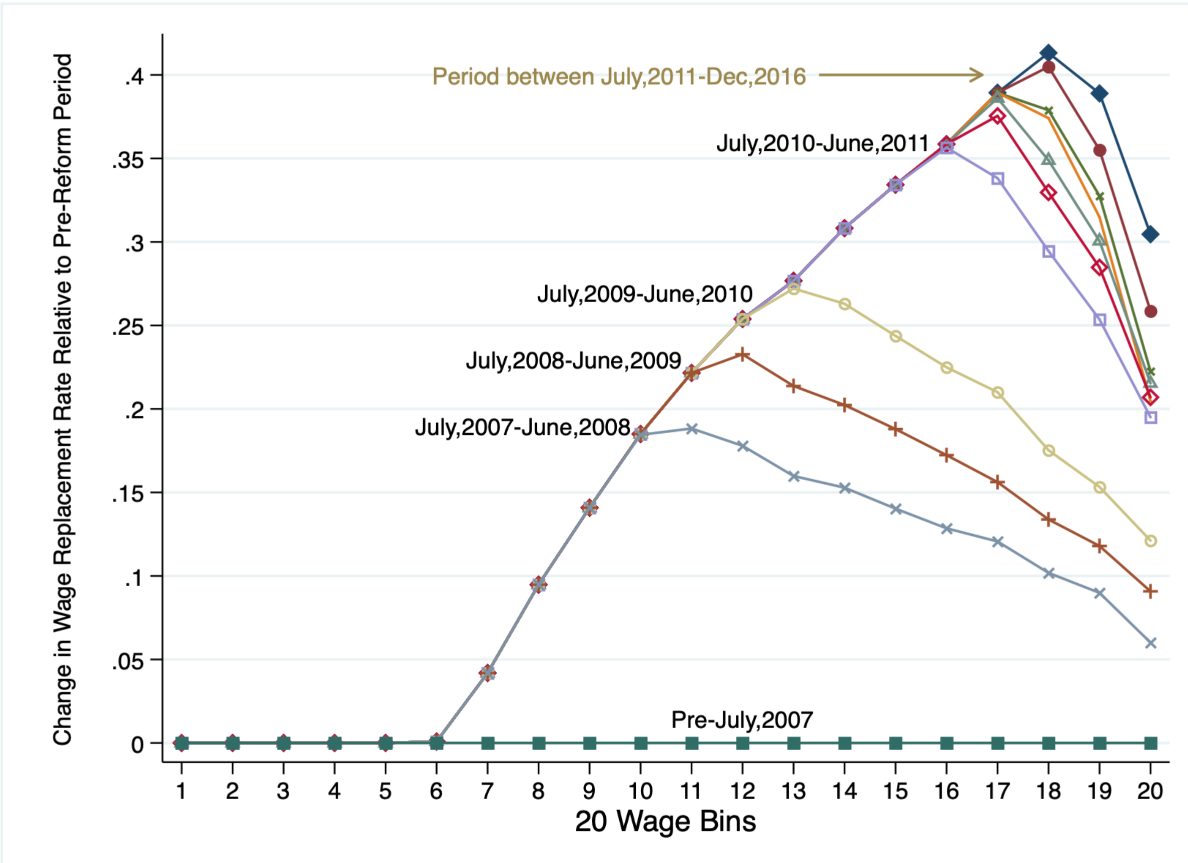
[1] The maximum benefit levels were set arbitrarily through 2009 and has equaled two-thirds of the states average weekly wage for the previous calendar year since 2009.

the 2007 reform, the maximum benefit level did not change and no workers experienced changes in the wage replacement rate. In July 2007, the maximum benefit level increased from \$321 to \$413, leading workers who earn \$482 or more to have higher wage replacement rates. For example, relative to the pre-reform years, the wage replacement rates increased by roughly 14 percentage points for the workers who earn between \$550 and \$600 (the ninth bin) and by 19 percentage points for those who earn between \$650 and \$700 (the 11th bin). The maximum benefit level increased from \$413 to \$471 in July 2008, which further increases the wage replacement rates by 23 percentage points for the workers who earn between \$650 and \$700. Similar changes happened to the wage replacement rate through 2016 due to the annual increases in the maximum benefit level. Therefore, the variation in wage replacement is solely the result of the policy change, and thus, it is exogenous. Note that the changes in the wage replacement rates are smaller on the higher end of wage distribution because the higher a workers wage, the lower his or her wage replacement rate.

The following formula further illustrates the wage replacement rate rule stipulated by the New York workers' compensation law:

$$wage\ replacement\ rate = \begin{cases} \frac{2}{3}, & \text{if } benefit_{min} \leq \frac{2}{3} \times wage \leq benefit_{max}; \\ \frac{benefit_{max}}{wage}, & \text{if } \frac{2}{3} \times wage > benefit_{max}. \end{cases}$$

Figure 4: Variation in wage replacement rate (in 2018 dollars)



The wage replacement rate equals two-thirds if a workers pre-injury wage falls below the wage that is subject to the maximum benefit level and above the wage that is subject to the minimum benefit level; otherwise, it equals the ratio of the maximum benefit to the pre-injury weekly wage. For example, the maximum weekly benefit level in 2008 was set at $471. A worker with a pre-injury weekly wage of $600 would receive two-thirds of the wage, $400, as the benefit amount if injured, and thus the wage replacement rate equals two-thirds. On the other hand, a worker with a pre-injury weekly wage of $800 would receive 59 percent of the wage, $471, as the benefit amount because two-thirds of his or her weekly wage is more than the maximum benefit stipulated by the law. The wage replacement rate in this case equals 0.59.

5.2 Generalized Difference-in-Differences Framework

I adopt a generalized DID framework to estimate the impact of increases in maximum weekly benefit level on return to work. The regression form I use is:

$$Y_{ict} = \alpha + \rho WRR_{ict} + \lambda_t + \gamma_c + \eta_{ict} + \beta X_{ict} + \gamma_c \times \lambda_t + \epsilon_{ict} \tag{5.1}$$

where i denotes the individual claim; c denotes the company; and t denotes the year. ρ is the coefficient on the wage replacement rate and is the coefficient of interest. λs are the coefficients on the year fixed effect which control for the trends that are common to all years. γs are the coefficients on the company fixed effect that allow for the comparison within a company. ηs are the coefficients on the wage bin fixed effect that enable me to compare workers with similar earning ability. I control for wage bins instead of using a continuous wage variable because the wage bin fixed effect flexibly allows measuring the effect of wages on return to work. A continuous wage variable would forcibly linearize the relationship between wages and return to work, which is less realistic. Xs are the covariates at the injury level, the employment level, and the claimant level, which includes body parts injured, cause of injury, whether working in New York City or rural area, employment status, NAICS code, days of service, and the claimants gender, age, number of dependents, and marital status. To address the concern that workers at the companies that offer higher wages may behave differently over time than workers at the lower-wage companies, I include a company by year fixed effect. I argue that since the reform is exogenous to employers and employees, adding predetermined covariates should not affect the estimate substantially. The results section validates this argument. Since the disturbance ϵ may be correlated within company, I cluster the standard errors at the company level.

CHAPTER 6

RESULTS

6.1 Main Results

This section discusses the effect of the change in wage replacement rate on the number of lost days. Panel A in Table III presents the results from Equation 5.1. Column 1 through column 5 display results as progressively more covariates are added. Column 1 is the basic specification, which includes company, time, and wage fixed effects; column 2 through column 5 show results as injury characteristics, employment characteristics, claimant characteristics, and company by year fixed effect are respectively included. The estimates and standard errors become stable once all fixed effects are included. This outcome makes sense because the changes in the wage replacement rate are mostly correlated with companies, timing, and wages, and are not related to predetermined characteristics at injury, employment, and claimant level. The inclusion of the company by time fixed effect barely changes the result, meaning that workers in different companies do not act systematically different over time. Since the changes in the wage replacement rate are not related to the observed characteristics, the changes in the wage replacement rate are likely not correlated with the unobservables. From column 1 to column 5 the coefficients on the wage replacement rate range from 34 to 36 and are statistically significant at the 1 percent level. Column 5 includes a full set of covariates and is the preferred specification. The coefficient on the wage replacement rate is 34.4, which means that an increase in the wage

TABLE III: EFFECT OF INCREASES IN MAXIMUM WEEKLY BENEFIT ON NUMBER OF LOST DAYS

	(1)	(2)	(3)	(4)	(5)
Panel A[b]: Wage Replacement Rate	35.95	35.78	35.37	34.17	34.43
	(9.90)[a]	(9.98)	(10.00)	(10.18)	(10.36)
Panel B[c]: Wage Replacement Rate	0.79	0.80	0.78	0.76	0.78
	(0.31)	(0.31)	(0.31)	(0.31)	(0.31)
Company FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Wage Bin FE	Yes	Yes	Yes	Yes	Yes
Injury Characteristics[d]	No	Yes	Yes	Yes	Yes
Employment Characteristics[e]	No	No	Yes	Yes	Yes
Individual Characteristics[f]	No	No	No	Yes	Yes
Company × Year FE	No	No	No	No	Yes
Observations	16139	16139	16139	16139	16139
Mean of Dep. Var.	48.32	48.32	48.32	48.32	48.32

[a]Standard errors in parentheses, clustered at the company level.
[b]Panel A is estimated using a level model.
[c]Panel B is estimated using a inverse hyperbolic sine model.
[d]Defined as injured body parts and the cause of injury.
[e]Defined as employment status, Standard Industrial Classification, average pre-injury weekly wage, length of service.
[f]Defined as gender, age, number of dependents, marital status.

replacement rate from zero to 100 percent leads to an additional 34.4 days off work. Since the wage replacement rate can only be as large as two-thirds, the days increased can only be as many as 23 days. To put the number on a more reasonable scale, a 10 percentage point increase in the wage replacement rate leads to an additional 3.4 days off work. Given that the average number of lost days is 48.32 days, an additional 3.4 days is a 7 percent increase.

Since the length of absence can be as long as a year, to account for skewness of the distribution, panel B in Table III presents the results from Equation 5.1 with its outcome in inverse hyperbolic sine form. Similar to panel A, the coefficient on the wage replacement rate becomes stable once it is conditioned on the fixed effects. It ranges from 0.76 to 0.79, and values are statistically significant at around the 1 percent level. Again, taking column 5 as an example, a one percentage point increase in the wage replacement rate leads to a 1.17 percent increase in the number of days off work, or a 10 percentage point increase in the wage replacement rate leads to an 11.7 percent increase in days off work.

Previous studies have estimated duration-benefit elasticities rather than duration-wage replacement rate elasticities. To make my result comparable to earlier reports, I convert my estimate to a duration-benefit elasticity and yield an estimate of 0.53.[1] Given that the elasticities in the literature range from 0 to 1.67 (6) (28) (7) (8) (9) (10) (11) (12), my estimate is at the lower end of the spectrum.

6.2 Heterogeneous Effects

Figure 3 indicates that it is possible that high-wage earners respond to the increases in benefits differently than the low- to middle range wage earners. This section investigates whether there are heterogeneous effects on workers with different wages. I split the treatment group

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[1] To accomplish the conversion, I perform the following calculations. The mean of the wage replacement rate and the mean of the pre-injury weekly wage are 0.45 and $773 for the treatment group prior to the reform, making the average benefit amount $348. A one percentage point increase in the wage replacement rate from 0.45 to 0.46 equals a $7.73, or a 2.22 percent increase in the average benefit. Therefore, a 2.22 percent increase in the average benefit leads to a 1.17 percent increase in days off work. The duration-benefit elasticity is thus 0.53.

TABLE IV: EFFECT OF INCREASES IN MAXIMUM WEEKLY BENEFIT ON NUMBER OF LOST DAYS HETEROGENEOUS EFFECTS: PREFERRED SPECIFICATION

	Lower Wage[a]	Middle-Range Wage	Higher Wage
Wage Replacement Rate	28.20	44.97	20.18
	(34.23)[b]	(25.57)	(23.12)
Observations	3823	3823	3822
Mean of Dep. Var.	49.38	48.88	44.72

[a]The base group in this analysis are the workers who experienced no change in their wage replacement rate.
[b]Standard errors in parentheses, clustered at the company level.

into three subgroups based on their wage distribution. The comparison group is composed of workers who experienced no changes in their wage replacement rate. To estimate the effect of benefits on return to work separately in each subgroup, I perform the same DID analysis using Equation 5.1 three times. Each time the model includes the same comparison group and a different treatment subgroup. The results are displayed in Table IV. Compared with the comparison group, relatively lower-wage earners incur 2.8 days more off work as a response to a 10 percentage point increase in benefits, as shown in column 1. Column 2 shows that the middle range wage earners incur 4.5 days more, and the estimate is statistically significant at the 5 percent level. Column 3 shows that the higher-wage earners incur about 2 days more. The point estimates are consistent with Figure 3 and make sense because the middle range wage earners enjoy more increases in their benefits proportion wise.

6.3 Robustness

I conduct four different robustness checks to address three concerns in this section. First, to obtain an unbiased estimate from Equation 5.1, I assume that the workers within the same wage bin have homogeneous responses to the changes in their wage replacement rates. One concern may be that the bins are not tight enough, so workers within the same wage bin may respond differently, particularly those on the right tail of the distribution. Therefore, I perform the same DID analysis on two different specifications. I first include an interaction term between the wage bin fixed effect and the weekly wage variable in the regression to purge the variation in the wage replacement rate within the same wage bin. I then include a continuous wage variable in the regression to control wages directly. The level model and inverse hyperbolic sine model results are shown in the first four columns in Table V. The coefficients on the wage replacement rate in the model with the interaction term do not differ much from the main results, indicating no obvious heterogeneous responses to the wage replacement rate change among workers within the same wage bin. The coefficients from the model with a continuous wage variable are slightly different. One potential reason is that controlling a continuous wage variable forcefully linearizes the effect of wage on returning to work, which is not realistic, as I show in Table IV.

Twenty-four percent of claimants have missing pre-injury weekly wage in my original dataset.[1] Since wage is a critical variable for my analysis, I impute the missing wage values using workers whose pre-injury weekly wages are available.[2] To check the robustness of the results, I drop the observations with the imputed wages, and the results are shown in the fifth and sixth columns in Table V. Compare with the preferred specification in Table III, the point estimates increase from 34.4 to 35.7 for the level model and from 0.78 to 0.81 for the inverse hyperbolic sine model. The estimates become larger after excluding imputed values because the imputed values are subject to measurement error that biases the estimates towards zero. Therefore, the estimates are robust to the sample including imputed values. If anything, they provide a lower bound of the impact of increases in benefits on return to work.

Lastly, since the maximum benefit level only had incremental increases in the later years of the study period, the larger increases in the earlier years can be expected to contribute to the majority of the effect observed. To confirm this expectation, I exclude the observations after 2012 and the results are in the seventh and eighth columns in Table V. Indeed, the exclusion of the observations in the later years does not dramatically change the estimates.

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[1] The missing status is not correlated with the claimants' demographic characteristics.

[2] Refer to Table XIII for the detailed information.

TABLE V: EFFECT OF INCREASES IN MAXIMUM WEEKLY BENEFIT ON NUMBER OF LOST DAYS: ROBUSTNESS CHECKS (PREFERRED SPECIFICATION)

	Interaction		Continuous		No Missing		Pre-2012	
	Level	IHS[a]	Level	IHS	Level	IHS	Level	IHS
Wage Replacement Rate	34.76	0.77	31.79	0.60	35.73	0.81	30.04	0.66
	(10.33)[b]	(0.32)	(9.95)	(0.32)	(9.45)	(0.30)	(10.18)	(0.33)
Wage Bin FE	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Wage Bin FE × Wage	Yes	Yes	No	No	No	No	No	No
Continuous Wage Variable	No	No	Yes	Yes	No	No	No	No
Other FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16139	16139	16139	16139	14352	14352	12407	12407
Mean of Dep. Var. (un-transformed)	48.32	48.32	48.32	48.32	48.02	48.02	49.58	49.58

[a]Inverse Hyperbolic Sine model.
[b]Standard errors in parentheses, clustered at the company level.

6.4 Falsification and Permutation Tests

To exclude the possibility that the detected effect of higher benefits on longer time off work is due to randomness, I conduct falsification and permutation tests and present the results in this section. I conduct four falsification tests. The first three are the same DID analysis on observations from three states near New York: Virginia, Maryland, and Massachusetts. Since these states did not go through major workers' compensation reforms or make any changes to their maximum benefit level during the study period, I do not expect to find any significant effects using the same variation in the wage replacement rate. The fourth falsification test involves performing the same DID analysis on the period before the 2007 reform. Similarly, I do not expect to detect any significant effect because no change occurred in the maximum benefit level during the pre-reform period.[1] Table VI displays the results from the falsification

[1]Note that there was still variation in wage replacement rate during the pre-reform period.

TABLE VI: EFFECT OF INCREASES IN MAXIMUM WEEKLY BENEFIT ON NUMBER OF LOST DAYS: FALSIFICATION TESTS (PREFERRED SPECIFICATION)

	Virginia		Maryland		Massachusetts		Pre-Reform	
	Level	IHS[a]	Level	IHS	Level	IHS	Level	IHS
Wage Replacement Rate	-12.32	0.01	-0.59	0.08	-12.13	-0.18	35.35	-0.55
	(14.52)[b]	(0.40)	(12.84)	(0.37)	(12.21)	(0.24)	(87.35)	(2.15)
Observations	6809	6809	9047	9047	12804	12804	5129	5129
Mean of Dep. Var. (un-transformed)	51.68	51.68	39.89	39.89	55.98	55.98	47.41	47.41

[a]Inverse Hyperbolic Sine model.
[b]Standard errors in parentheses, clustered at the company level.

tests. The point estimates are not statistically significant from zero, which is consistent with my expectation.

The permutation test serves the same purpose: to examine how likely obtaining the coefficient on the wage replacement rate observed from the regression is due to randomness. Figure 5 represents the distribution of the coefficient on the wage replacement rate after resampling the observed data 5000 times. The vertical line marks the actual coefficient generated from the regression. The actual coefficient looks quite extreme relative to the sampling distribution, which indicates that getting the observed coefficient on the wage replacement rate by chance is extremely unlikely.

Figure 5: Permutation test on coefficient on wage replacement rate

6.5 Subgroup Analysis

The results above show the average effect of the benefits on time off work among workers overall, but the effect may differ across industry, gender, and types of injury. Table VII presents the results from the subgroup analysis. Among the industries, many of the point estimates are not statistically significant, possibly due to having too few observations. With regard to the point estimates, the increases in benefits have a particularly large impact on workers employed in wholesale trade, health care, administrative support industries.

Two studies have found that workers take more days off if they have physically demanding jobs (34) (37), such as those in the wholesale trade and administrative management industries in my sample. Some studies also have focused on workers in the manufacturing industry and concluded that increases in workers' compensation benefits either lead to higher numbers of cases in general (46) or cases involving lost days (47), but such increases have a smaller effect on large experience-rated companies (42) (43). The point estimate for manufacturing industry in my analysis is positive yet not statistically significant from zero. Given that the sample consists of self-insured companies, the finding is consistent with (42) (43).

Moreover, I stratify the analysis by gender and types of injury. Increases in benefits have a larger impact on women than on men. Past studies have documented that women tend to return to work more slowly than men possibly due to childcare and housekeeping responsibilities (36) (48). Workers with soft tissue injuries such as sprain injury were slightly more

TABLE VII: SUBGROUP ANALYSIS ON NUMBER OF LOST DAYS: PREFERRED SPECIFICATION

	By Industry										By Gender		By Cause	
	Transport	Retail	Mrg.	Wholesale	Accom.	Info.	Hlthcare	Finance	Admin.	Constrn.	Male	Female	Sprain	Other
Dependent Variable:	Number of Lost Days													
Wage Replacement Rate	3.27	-22.56	29.38	80.94	47.35	31.46	65.43	25.96	76.09	36.52	27.72	38.24	35.52	32.57
	(16.59)[a]	(23.37)	(22.15)	(17.33)	(30.28)	(10.53)	(29.84)	(39.59)	(94.78)	(65.28)	(12.62)	(14.28)	(12.69)	(12.06)
Observations	3817	2910	2212	2050	1068	1048	754	387	343	250	10826	5313	6409	9730
Mean of Dep. Var.	50.68	48.11	51.40	42.10	47.68	47.33	49.00	50.62	56.65	48.56	46.35	52.34	51.88	45.98

[a]Standard errors in parentheses, clustered at the company level.

responsive to the policy change than workers with non-sprain injury, which makes sense since soft tissue injuries may require longer time to recover than other types of injuries.

CHAPTER 7

ASSESSING POSSIBILITIES OF SAMPLE SELECTION AND ENDOGENOUS WAGE SETTING

7.1 Endogenous Sample Selection

I do not observe employees who are not injured in my sample. This omission would be problematic if the workers who incurred injuries were changing systematically over time, which would cause sample selection. For example, if increases in benefits have induced workers to file more claims, the severity of injury may go down and fewer lost days would be incurred. Estimates conditional on injuries would be biased towards zero. Therefore, I conduct a series of tests to investigate whether the injured population changes systematically over time.

7.1.1 Systematical Changes to Injured Population

First, workers with higher wages may respond to increased benefits by taking fewer precautions in performing tasks and consequently incur more injuries, so I investigate whether the increases in maximum benefit level lead to more claims filed at the company by wage bin level. I look at both the number of TTD claims and the number of all types of claims overall. Second, increased benefits may induce workers to file claims involving hard-to-diagnose injuries. I examine whether the increases in maximum benefit level change the types of injury involved, with a particular focus on laceration/contusion versus strain injuries. Changes in laceration injuries may imply a real change in the working environment, while changes in strain injuries may indicate that workers are gaming the system. Third, I test whether employers are more likely to deny a claim in response to a higher benefit and potentially a larger number of claims. Finally, although I do not have information on workers who do not get injured, I observe workers who file claims that only involve medical spending or partial disability benefits. I examine whether the types of claims filed have changed systematically since the benefit level increased. Even though this is a different extensive margin, the results have important implication on whether the injured population are changing systematically.

Overall, the increases in the maximum benefit level do not have significant impacts on the outcomes mentioned above. The results are displayed in Table VIII. Specifically, increases in benefits did not make workers with higher wages file more claims, as seen for TTD claims and for all types of claims (columns 1 and 2). Similarly, increases in the maximum benefit level had minimal impacts on the types of injury involved. Neither the likelihood of having a strain injury nor the likelihood of having a laceration/contusion changed significantly due to the increases in benefits (columns 3 and 4). Moreover, employers were not more likely to deny a claim (column 5). Finally, on the extensive margin, workers were not more likely to file TTD claims as opposed to claims for medical expense only (column 6) or TTD claims as opposed to TPD claims (column 7). Therefore, the injured population does not seem to have been changing systematically over time in response to the increases in the maximum benefit level.

TABLE VIII: EFFECT OF INCREASES IN MAXIMUM WEEKLY BENEFIT ON TYPES OF CLAIMS: PREFERRED SPECIFICATION

	# of TTD	# of All	Pr(Strain)	Pr(Cut)	Pr(Deny)	Pr(TTD vs MO)	Pr(TTD vs TPD)
Wage Replacement Rate	0.18	0.06	0.01	-0.02	-0.03	-0.05	-0.07
	(0.47)[a]	(0.34)	(0.07)	(0.04)	(0.05)	(0.13)	(0.12)
Observations	1545	2598	16139	16139	19026	109784	29027
Mean of Dep. Var. (un-transformed)	10.45	48.27	0.56	0.16	0.04	0.15	0.56

[a]Standard errors in parentheses, clustered at the company level.

Several studies have researched the effect of benefit change on claim frequency and injury type. A few found that an increased benefit led to a higher frequency of claims filed (49) (46) (47) (50) or that a reduced benefit lowered the frequency of claims (41). If workers were induced to file more claims, they were more likely to report injuries that were hard to diagnose (15) (46) (51). Only a couple of studies show that the workers did not respond to increased benefits by filing more claims (6) (8). The discrepancy between the literature and my findings may arise from my studys focus on self-insured employers, which have stronger incentives than fully-insured companies to counteract workers behavior and keep workers' compensation cost under control (42) (43).

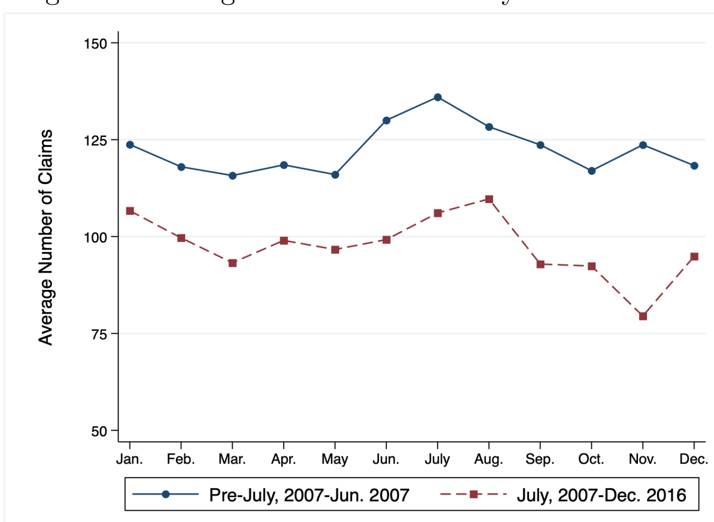
7.1.2 System Manipulation

The analysis above shows that workers are not more likely to file claims in response to a benefit increase in general. But it does not preclude the possibility that workers game the system by filing claims *immediately* after the benefit increases. If workers deliberately delay reporting injuries until the benefit increases, they may be able to take more time off work. In this case, my estimate would be biased upward. To explore this possibility, I first compare the average number of claims filed each month during the pre-reform period with that during the post-reform period. Then I home in on the number of claims filed in June and July during the post-reform period. Lastly, I look at the number of lost days for injuries that occurred in June and July during the post-reform period. An excessive number of claims filed or lost days incurred immediately after July 1 during the post-reform period would be a sign of system manipulation.

Figure 6 displays the average number of claims at the month level. Post-reform years have fewer claims on average than pre-reform years, which indicates improvement in working environment as a secular trend. The trends go up in May and drop after August for both pre- and post-reform years. Summer is possibly the peak season for workplace injuries due to high outdoor temperatures (52). Therefore, the figure demonstrates more of a seasonal effect rather than evidence that workers are gaming the system. Figure 7 plots the average number of claims filed 30 days before and after July 1, the date when new benefit schedule began during the post-reform period. A big dip happens around July 4, possibly due to the July 4 holiday.

Otherwise, the number of claims fluctuates across days, with a mean around 3.5, and it does not seem that workers file more claims right after the increase in maximum benefit level. Figure 8 examines the trends in the average number of lost days from June to July in the post-reform period. It mirrors the number of claims in Figure 7: a dip occurs around July 4, and the number fluctuates across other days, with a mean of 150 days. Therefore, I find no evidence of workers manipulating the system,[1] and sample selection is less of a concern.

Figure 6: Average number of claims by incident month



[1] This is in the same spirit as the method of regression discontinuity. Since there are no discontinuities in the number of lost days, that method is not chosen for this analysis.

Figure 7: Average number of claims by incident date: July 1-July 31

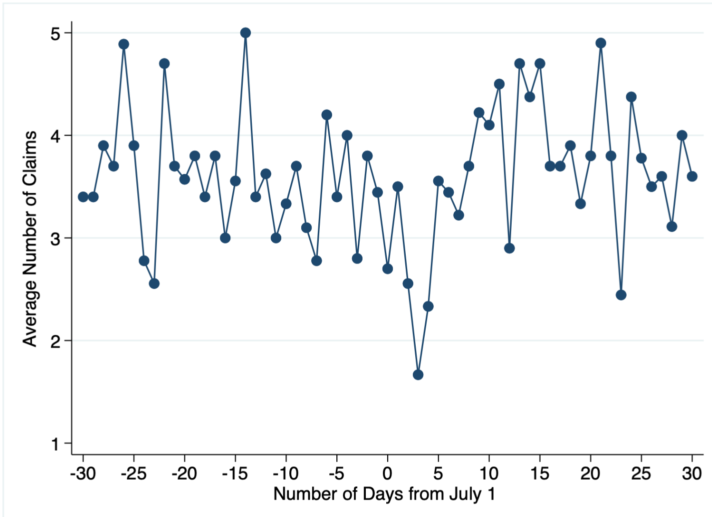
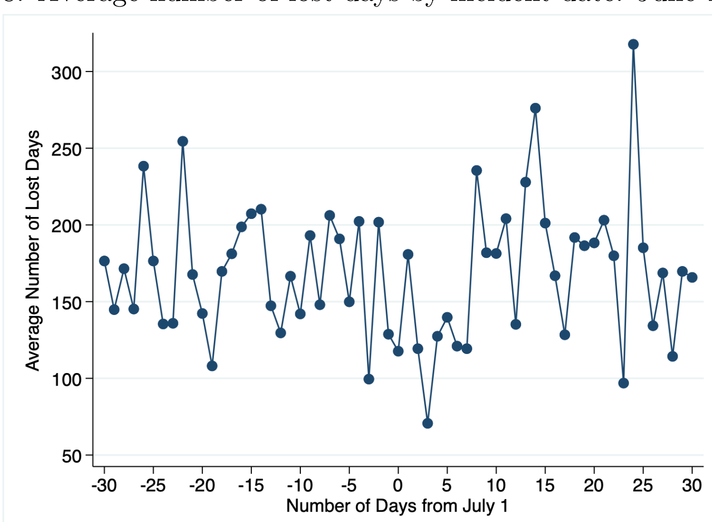


Figure 8: Average number of lost days by incident date: June 1-July 31



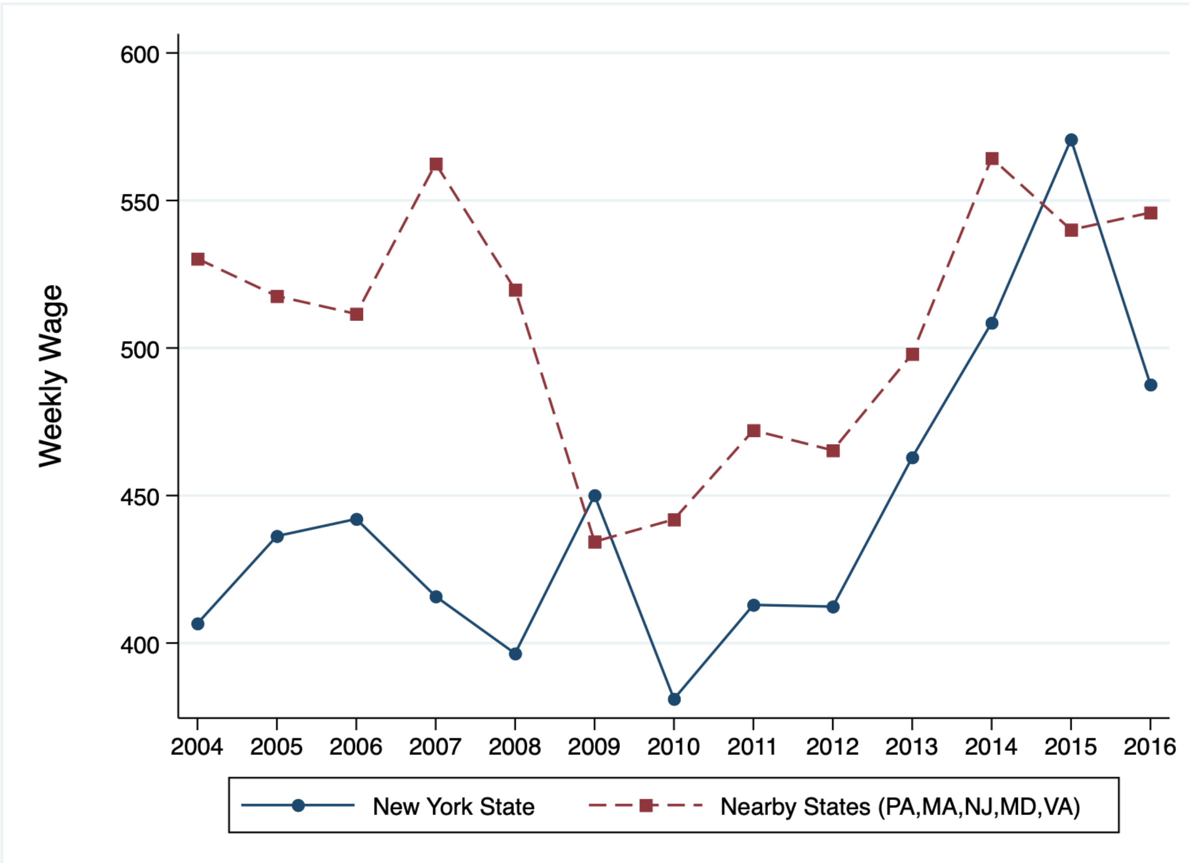
7.2 Endogeneity of Wages

Studies have argued that employers are able to load the additional costs of workers' compensation benefits onto workers by reducing wages (53) (54) (55). The analysis above has shown that high-wage workers tend to stay off work longer after their wage replacement rates are increased. Therefore, if only workers earning lower wages tend to remain employed, my estimates would be biased towards zero. Although the data do not allow me to test for wage reduction directly, I can perform a descriptive analysis to investigate differential hiring and differential firing practices among employers, which have implications for whether employers manipulate wages to reduce their workers' compensation expenses.

7.2.1 Differential Hiring

To investigate whether employers practice differential hiring, I graph trends in weekly wages throughout my study period. One challenge is that the wages in the data were those reported at the time of injury, rather than at the time of hiring. I therefore focus only on workers who were hired and got injured in the same year, and I use the wages reported as proxies for the wages at the time of hiring. I perform the same calculation for five nearby states that did not have major workers' compensation reform that related to their benefits-Pennsylvania, Massachusetts, New Jersey, Maryland, and Virginiato characterize the secular trend. The wage trends for these states are displayed in Figure 9. The weekly wage in New York is lower than in nearby states for the majority of the years. Although the trends are not parallel, no drops in weekly wage are discernible in New York after 2007, suggesting that employers did not exhibit differential

Figure 9: Weekly wage trends (in 2018 dollars)



hiring behavior after the reform.

7.2.2 Differential Firing

Table IX compares the summary statistics on workers whose employment was terminated versus those without termination. Workers with terminated employment are relatively younger, earn a lower wage rate, and have more lost days. No drastic changes occur in claimant age,

TABLE IX: SUMMARY STATISTICS ON EMPLOYMENT TERMINATION

	No Termination		Termination	
	Pre-reform	Post-reform	Pre-reform	Post-reform
Claimant age	40.10	40.97	37.93	34.77
	(11.23)	(11.69)	(12.08)	(11.92)
Weekly wage	594.0	802.1	462.1	567.6
	(332.1)	(467.5)	(461.4)	(417.9)
Number of lost days	47.16	48.21	61.36	64.11
	(60.71)	(54.75)	(57.17)	(62.91)
Number of observations	5037	10638	92	372

wage, or time off work from the pre-reform to the post-reform period in either group.

To summarize, I do not find strong evidence that employers practice differential hiring or firing to reduce workers' compensation expenses. A reasonable explanation is that workers' compensation costs make up only a tiny portion of total compensation that employers have to pay for employees: 1.4 percent compared to 8.5 percent for employer-sponsored health insurance and 7 percent for paid leave (56). Increases in workers' compensation benefits do not entice employers to avoid paying a higher cost because it would be at the expense of losing good employees and/or hiring employees with less skills.

CHAPTER 8

USE OF MEDICAL SERVICES AND HEALTH OUTCOMES

Kaestner and Carroll (57) show that the medical component of benefits should also be taken into consideration when estimating the effect of cash benefits in workers' compensation. Previous studies have shown that a longer time off work is associated with higher medical spending (19) (20) (21). But the reverse causality is always a concern since more severe injuries tend to incur more medical spending and also incur more days off work. The variation in wage replacement rate used in this study allows me to evaluate the causal impacts of increased cash benefits and extra days off work on medical care utilization and health outcomes. Specifically, the impact of increased cash benefits is estimated by equation Equation 5.1, replacing the number of lost days with the medical outcomes. The impact of extra days off work is obtained by Two-Stage-Least-Squares using equation Equation 5.1 as the first stage, with variation in wage replacement rate serving as the excluded instrument.

A couple of concerns about the validity of exclusion restriction are worth mentioning. First, workers may use more medical services because they have more cash in hand (i.e., income effect) rather than more free time (i.e., substitution effect). Second, if the severity of injury changes over time, the use of medical service will also change regardless of alterations in the cash benefits. But I argue that these concerns are not warranted. First, workers do not pay for medical services under workers' compensation, so increased cash benefits does not change their behavior toward obtaining medical services in any way except through additional leisure time. Second, the analysis above (Table VIII) shows no changes in the types of injuries; therefore, there are no reasons to believe that the use of medical services is changing in response to changes in injuries.

8.1 Number of Physical Therapy and Chiropractic Sessions

I focus on a combination of physical therapy (PT) and chiropractic sessions as a medical services outcome for two reasons. First, workers often resort to PT and chiropractic treatment to facilitate the recovery process, particularly if they have soft tissue injuries, which are the most frequent type of injury among work-related injuries (58). Second, PT and chiropractic sessions do not have missing values in my sample. The first column from panel A and panel B in Table X display the effects of increases in cash benefits and extra lost days on the number of PT and chiropractic sessions. Since not every claim incurred PT and chiropractic sessions, and the number of these sessions is highly right-skewed,[1] I perform the analysis in inverse hyperbolic sine form. The estimates are positive but not statistically significant from zero, indicating that workers did not actively seek more PT or chiropractic sessions as a result of increased cash benefits and delayed return to work.

[1] The average number of PT and chiropractic sessions per claim is 18. Six percent of claims incur more than 100 sessions per claim.

TABLE X: EFFECT ON MEDICAL SERVICES USE AND HEALTH OUTCOMES: PREFERRED SPECIFICATION

	# of PT	Pr(Opioid)	# of MME	Med $$	Pr(Hosp)	Pr(Srg)	Pr(Re-injury)
Panel A: Wage Replacement Rate	0.06	0.04	0.19	0.21	0.00	-0.03	-1.14
	(0.34)[a]	(0.13)	(0.76)	(0.30)	(0.06)	(0.03)	(0.64)
Panel B: Number of Lost Days	0.002	0.002	0.010	0.006	0.000	-0.001	-0.029
	(0.010)	(0.005)	(0.038)	(0.008)	(0.002)	(0.001)	(0.016)
Observations	16139	6186[b]	6094	16139	16139	16139	16139
Mean of Dep. Var. (un-transformed)	17.97	0.11	11.67	2954.45	.08	0.03	9.65

[a]Standard errors in parentheses, clustered at the company level.
[b]Opioid information is only available after 2010

8.2 Opioid Consumption

Opioid use is prevalent among workers' compensation claimants for pain relief. Studies have estimated the impact of opioid use and dosing on claim outcomes and health outcomes among workers' compensation claimants in different states (59) (60) (61) (62) (63). Understanding this impact is of great policy relevance because the use of prescription opioids and the associated overdoses and deaths have always been on the political radar. Therefore, I look at whether workers are more likely to consume opioids that are categorized as controlled substances. I also assess whether workers have an increased risk of opioid overdose.

The sample for estimating opioid consumption is restricted to 2011 and onward because 30 percent of opioid consumption data is missing in the sample prior to 2011. Opioids are categorized into classes II, III, IV, and V. I focus on class II opioid because it is defined as a controlled substance that has a high potential for abuse. The second column from panel A and panel B in Table X show the likelihood of consuming a class II opioid. Similar to the first column, the point estimates are positive, although workers are not statistically more likely to consume controlled substance in response to increased benefits and delayed return to work.[1]

A higher dosage of an opioid increases the risk of overdose and death (64). To estimate whether workers experience an increased risk of opioid overdose, I calculate the average morphine milligram equivalents (MME) that workers take per day.[2] The third column from panel A and panel B in Table X display the results. A 10 percentage point increase in the wage replacement rate leads to a 21 percent increase in daily MME, and one extra day staying off work increases daily MME consumed by 1 percent. However, the point estimates are not statistically different from zero.

8.3 Medical Spending

I assess how the overall medical spending changes since self-insured employers ultimately have to bear the entire medical cost. The results are shown in the fourth column from panel A

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[1] A regression on any opioid shows that increased benefits does not have a significant impact on the likelihood of consuming any opioid. Class III, IV, and V opioid have lower potential for abuse relative to class II opioid and thus is not a focus of this study.

[2] MME is calculated as: Strength per Unit $\times$ (Number of Units/ Days Supply) $\times$ MME conversion factor. Strength per Unit and MME conversion factor are determined by the NDC code and are published by the Centers for Disease Control and Prevention. One challenge about calculating the MME is that I do not directly observe the daily opioid supply, which is required for the calculation. I therefore obtain the package size (e.g., 100 tablets in one bottle) associated with each NDC from the NDC database file downloaded from the Food and Drug Administration website. I use the package size as a proxy for the total number of units and divide it by the total days of intake, which is directly observable in my data, to calculate the daily intake of opioids.

and panel B in Table X. Similar to other medical outcomes, the point estimates are positive but not statistically significant. A 10 percentage point increase in the wage replacement rate leads to a 23.8 percent increase in medical spending, and one extra day off work increases medical spending by 0.6 percent.

8.4 Health Outcomes During Time Off Work

I use workers undergoing hospitalization or surgery as an indicator for suboptimal health outcomes, controlling for injury, employment, and individual characteristics. Suboptimal health outcome is defined as a worker needing hospitalization or surgery during time off work while another worker with similar injury, employment, and demographic characteristics not needing such treatment. The fifth and sixth columns from panel A and panel B in Table X display the results for the likelihood of being hospitalized or undergoing surgery. The increases in wage replacement rates reduce the likelihood of hospitalization and surgery, but the estimates are not statistically significant. Delayed return to work has virtually no effect or at most a minimal impact on whether a worker is hospitalized or goes through surgery. Therefore, while workers are on temporary disability leave, they did not seem to use the extra time off work to obtain more medical care, nor did the health outcomes change.

8.5 Health Outcomes Upon Return to Work

This section investigates whether workers experience re-injuries after returning to work following time off for previous injuries. Re-injury is an indicator for inferior health outcome in the sense that workers had not fully recuperated from prior injuries and consequently were prone to getting re-injured. While the data contain no unique employee identifier that could be used to study all the claims of a single employee over a given period, I develop a fuzzy matching algorithm that allows me to identify the likely incidence of the same individual being observed across multiple injury claims. In particular, I identify unique individuals based on the following fields: employer, start date, gender, and age (in years at date of incident). I also make sure that the wages across the incidences for potentially the same individual do not change by more than 30 percent annualized. Using these largely time-invariant characteristics, I identify instances of the same individual having multiple injury incidents over time. Specifically, 90.35 percent of cases were singleton incidents, 9 percent of individuals had two injury incidents, and the remaining 0.9 percent of individuals had three or more incidents over the period.[1]

The later I observe a worker experiencing an injury in the study period, the less time is available for the same person to have another injury. Because of the censoring nature of the observations, I use a duration model to estimate the effect of increases in wage replacement rate on the hazard rate of a worker experiencing re-injury. An uncensored observation is a re-injury case I identify using the fuzzy matching method described above, and the associated duration

[1] A test for the quality of matching is to leave out one variable that could be matched on, and then see how well the matches predict the left-out variable. To perform the test, I leave out the variable *gender* to identify re-injury cases. The matching without gender finds 99.38% of singleton cases identified using a full set of matching covariates; 98.31% of two-injury cases identified using a full set of matching covariates; and 83.19% of cases with three or more injuries identified using a full set of matching covariates. Although the matching quality is lower for the cases with three or more injuries, it has decent quality overall given that most individuals had only one or two injuries.

is calculated as the days between a worker returning to work after an injury and the occurrence of the next injury. A censored observation is an individual with no re-injuries throughout the study period, and its associated duration is defined as the days between the worker returning to work and the date on which the workers company exits the study.[1]

Within the sample, 0.9 percent of workers had three or more injuries over the study period. With multiple failures occurring for the same subject, event times are likely to be correlated within subject, violating the assumption of independence of failure times required in the standard survival analysis. Therefore, I adopt a conditional risk set model proposed by Prentice (65), which extends the Cox Proportional Hazard model by incorporating ordered failure times and the existence of event dependence. Ordered failure times refers to the fact that a worker cannot experience a second injury without having had a first injury, and the existence of event dependence means that the hazard rate of getting injured again varies across injuries within a worker.

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[1]Since I do not observe the date on which an individual leaves his or her company, I use the date that the company exits the study as a proxy. Since each companys exit date is not explicitly recorded in the data, I take the following two steps to construct the exit date. First, I observe the date on which a claim is closed and the claims affiliated company. I identify the latest date on which a claim is closed and assume that it is the last claim resolved by its affiliated company in the study period. Second, since the administrator collects data on a quarterly basis, I set the last date of a quarter during which the last claim is closed as the exit date of the company. For example, if June 1, 2014, is the last date I observe on which a claim with company 1807 is closed, I assume that it is the last claim resolved within company 1807 and company 1807 exited the study on June 30, 2014.

In a conditional risk set model, the hazard function is expressed as follows:

$$h\{t|N(t), Z(t)\} = h_{0s}(t)e^{\{z(t)\beta_s\}} \tag{8.1}$$

where $z(u) = \{z_1(u), ..., z_p(u)\}$ is a vector of covariates available at time $u \geq 0$;

$Z(t) = \{z(u) : u \leq t\}$ is the corresponding covariate process up to time t;

$N(t) = \{n(u) : u \leq t\}$, where $n(u)$ is the number of injuries for an individual prior to time u;

$h_{0s}(t) \geq 0$ $(s = 1, 2, ...)$ are baseline intensity functions, which can be completely arbitrary;

s is the stratification variable, which refers to the sth time of injury within an individual; and

β_s is a column vector of stratum-specific regression coefficients.

I estimate the effect of the wage replacement rate on the hazard rate of re-injury occurrence using equation 3. To estimate the effect of extra time off work on the hazard rate of re-injury occurrence, I first predict the days off work using the wage replacement rate as the excluded instrument and other exogenous variables in the first stage, then plug the predicted days off work into the second stage as shown in equation 4.

$$h_{ict} = \beta_0 + \rho WRR_{ict} + \lambda_t + \gamma_c + \eta_{ict} + \beta X_{ict} + \gamma_c \times \lambda_t + \epsilon_{ict} \tag{8.2}$$

$$h_{ict} = \alpha + \theta \widehat{lost\ days}_{ict} + \lambda_t + \gamma_c + \eta_{ict} + \beta X_{ict} + \gamma_c \times \lambda_t + \epsilon_{ict} \tag{8.3}$$

The seventh column from panel A and panel B in Table X present the results from the conditional risk set model. A 10 percentage point increase in the wage replacement rate decreases the hazard rate of getting re-injured by 6.8 percent, and the estimate is statistically significant at the 5 percent level; an extra day off work decreases this rate by 2.9 percent. Given that on average 9.35 percent of individuals suffered re-injuries, the effects are substantial. For employers, the additional workers' compensation costs brought by increased benefits and longer time off work are offset by the expenses avoided through reduction in repeat injuries. Specifically, a 10 percentage point increase in the wage replacement rate ($77) leads to an additional 3.4 days off work and a 6.8 percent decrease in the likelihood of repeat injuries. The re-injury cases on average incur $6730 medical and cash benefits in total in the sample. Therefore, employers pay $38 additional costs in the front to avoid $\$6730 \times 0.068 = \$458$ down the road.

The possibility exists that employers fire workers that are injury prone. Since I do not observe individuals who leave the company *after* returning to work, my estimate is likely subject to the sample selection. If the injury-prone workers tend to leave the company, theoretically, the direction of bias could go either way. One hand, without considering "termination" as a competing risk, I would consistently underestimate the re-injury rate and the sample I observe would be healthier than otherwise. It would be more difficult to find an effect of benefits on re-injury reduction and model would provide a lower bound of the estimate (66). On the other hand, if workers left the company after multiple repeat injuries, I would attribute the effect of observing no re-injuries to increased benefits. The model would provide an overstatement of the estimate. In reality, states have laws that explicitly prohibit employers from firing an injured workers for filing workers' compensation claims (67). At the federal level, the Occupational Safety and Health Act imposes penalties on employers for retaliating employees who are out on workers' compensation (68). Therefore, the reinforcement of state and federal laws help mitigate the sample selection concern.

To summarize, there is no strong evidence showing that workers utilize more medical care as a response to increased benefits and longer disability duration. While on the disability leave, injured workers have the same likelihood of being hospitalized or having surgery as in the period before the policy change. However, a higher benefit and more time off work reduce the likelihood of repeat injuries upon return to work. Given that almost 60 percent of injuries are soft tissue injuries, medical treatments yield no additional improvement at a certain point and injured workers can only recover through longer rest and less physical exertion.

CHAPTER 9

THE WELFARE EFFECT AND OPTIMAL WAGE REPLACEMENT RATE

The analyses above have shown that workers responded to increases in benefits by staying off work longer. Although workers did not utilize more health care during disability leave, they incurred fewer repeat injuries upon return to work. The results imply that an increase in benefits is beneficial to workers' well-being. This section investigates how much exactly the increase is needed. Specifically, I provide evidence as to where the optimal wage replacement rate should be by estimating the welfare effect brought by the current wage replacement rate level in New York.

9.1 Liquidity Effect and Moral Hazard Effect

To estimate the welfare effect, I model the liquidity effect and moral hazard effect first. The model I use is a variation from that of Chetty (18) by incorporating the reduction in re-injuries as part of the liquidity effect.

The value function for a worker who stays on disability leave at the beginning of period t, receives benefits b_t, and remains disabled at period $t+1$, conditional on beginning the period with assets A_t, is

$$U_t(A_t) = \max u(A_t - A_{t-1} + b_t) + U_{t+1}(A_{t+1}) \tag{9.1}$$

The value function for a worker who returns to work at the beginning of period t and earns wage w_t, conditional on beginning the period with assets A_t, is

$$V_t(A_t) = \max v(A_t - A_{t-1} + w_t) + J_{t+1}(A_{t+1}) \tag{9.2}$$

where

$$J_t(A_t) = \max\ (1 - p_t)V_t(A_t) + p_t U_t(A_t) - \psi(p_t) \tag{9.3}$$

is the value of returning to work at period t with assets A_t. Upon returning to work, a worker faces probability p_t of getting re-injured and becoming disabled again. p is a function of assets and number of days off work, that is, $p_t = p_t(A_t, L_t(A_t, b_t, w_t))$. The cost associated with transitioning from health to illness is defined as $\psi(\cdot)$.[1]

[1] In Chetty's model for unemployment insurance benefits, the cost is born by people who are actively searching for a job when unemployed. In this model, the cost is born by workers who incur reinjuries at work.

When deciding whether to return to work, a worker chooses p_t to maximize expected utility at the beginning of period t, given by equation 7. The first-order condition with respect to p_t yields

$$\psi'(p_t) = -V_t(A_t) + U_t(A_t) \tag{9.4}$$

Equation 8 shows that a worker chooses p when the marginal cost of re-injury equals the difference between the optimized values of returning to work and staying off work.

Taking equations 6 to 8 together, first consider the effect of a \$1.00 increase in the weekly benefits b on a workers decision to return to work:

$$\frac{\partial L_t}{\partial b_t} = \frac{u'}{\psi''(p_t)\frac{\partial p_t}{\partial L_t}} \tag{9.5}$$

An increase in benefits raises the marginal benefit of being off work to the extent that it prolongs the leave of absence through which the probability of getting re-injured is lowered.

Second, consider the effects of a \$1.00 increase in assets A:

$$\frac{\partial p_t}{\partial A_t} + \frac{\partial p_t}{\partial L_t}\frac{\partial L_t}{\partial A_t} = \frac{-v' + u'}{\psi''(p_t)} \tag{9.6}$$

The marginal effect of an increase in cash on hand is expressed as the difference in marginal utilities between staying off work and returning to work. An increase in cash raises the value of staying off work relative to returning to work.

Last, consider the effects of a \$1.00 increase in the wage w:

$$\frac{\partial L_t}{\partial w_t} = \frac{-\nu'}{\psi''(p_t)\frac{\partial p_t}{\partial L_t}} \tag{9.7}$$

A raise in wage rate makes work more attractive, so workers are more likely to return to work. Combining (10) and (11), we get

$$\frac{\partial L_t}{\partial b_t} = \frac{\partial L_t}{\partial A_t} + \frac{\frac{\partial p_t}{\partial A_t}}{\frac{\partial p_t}{\partial L_t}} - \frac{\partial L_t}{\partial w_t} \tag{9.8}$$

Equation 12 shows that a higher benefit level increases lost work days through two channels. The first channel is the liquidity effect $\frac{\partial L_t}{\partial A_t} + \frac{\frac{\partial p_t}{\partial A_t}}{\frac{\partial p_t}{\partial L_t}}$, meaning that a higher benefit increases the cash on hand that allows workers to smooth the consumption while being disabled. The second channel is the moral hazard effect $\frac{\partial L_t}{\partial w_t}$, meaning that a higher benefit effectively lowers a workers wage and disincentivizes the worker to go back to work. This result is consistent with Chetty (18). The innovation is that I decompose the liquidity effect into two separate components: Workers have less pressure to rush back to work $\frac{\partial L_t}{\partial A_t}$, and they achieve a better health status by having fewer re-injuries upon returning to work $\frac{\frac{\partial p_t}{\partial A_t}}{\frac{\partial p_t}{\partial L_t}}$.

9.2 Optimal Benefit Formula

Following Chetty (18), I show that the welfare gain from increasing the benefit level can be calculated using the following formula:

$$\frac{\partial W}{\partial b} = \frac{1-\sigma}{\sigma}\frac{D_B}{D}\left[\frac{\epsilon_{D_L^b}}{\epsilon_{D_B^b} - \epsilon_{D_L^b}} - \frac{\epsilon_{D_B^b}}{\sigma}\right] \tag{9.9}$$

where $\frac{\partial W}{\partial b}$ is the marginal welfare gain, which can be interpreted as the ratio of the welfare gain from raising benefits to the welfare gain from increasing the wage rate by \$1;

σ is the proportion of workers without re-injuries;

D_B is the workers' compensation benefit duration;

D is the duration of absence from work due to work-related injuries;

$\epsilon_{D_B^b}$ is the total benefit-duration elasticity;

$\epsilon_{D_L^b}$ measures the liquidity effect; and

$\epsilon_{D_B^b} - \epsilon_{D_L^b}$ measures the moral hazard effect.

The key parameter is the ratio of liquidity to moral hazard effects $\frac{\epsilon_{D_L^b}}{\epsilon_{D_B^b} - \epsilon_{D_L^b}}$. Chetty (18) shows that $\frac{\epsilon_{D_L^b}}{\epsilon_{D_B^b} - \epsilon_{D_L^b}}$ is a sufficient statistic to calculate the optimal benefit level without additional assumptions about consumption or utility. Intuitively, this shows that if the benefit brings out a large liquidity effect, $\frac{\epsilon_{D_L^b}}{\epsilon_{D_B^b} - \epsilon_{D_L^b}} - \frac{\epsilon_{D_B^b}}{\sigma}$ is positive, which makes $\frac{\partial W}{\partial b}$ positive. This result means that the current benefit level is too low and an increase in benefits would lead to an increase in the overall social welfare. Similarly, if the benefits induce a large moral hazard effect, $\frac{\epsilon_{D_L^b}}{\epsilon_{D_B^b} - \epsilon_{D_L^b}} - \frac{\epsilon_{D_B^b}}{\sigma}$ becomes negative, which makes $\frac{\partial W}{\partial b}$ negative. This outcome suggests that the current benefit level is too high and a reduction in benefits would lead to an increase in the overall social welfare. When $\frac{\partial W}{\partial b}$ equals zero, the benefit level is at its optimum.

9.3 Estimation of the Liquidity Effect

As defined above, liquidity effect means that an injured worker chooses to stay off work longer because more benefits increase the cash on hand and reduce the pressure to return to work quickly. Meanwhile, the moral hazard effect refers to the situation in which an injured worker chooses to delay return to work because more benefits make the private return to work lower. Not being able to earn wages will cause larger fluctuations to consumption and utility for liquidity-constrained than -unconstrained workers, so the liquidity effect is expected to be stronger among the liquidity-constrained workers (18). Unfortunately, the workers' compensation claims data do not contain information on assets that I could use to infer liquidity constraint status. To overcome this problem, I predict assets with an equation estimated using ordinary least squares (OLS) on the Survey of Consumer Finances (SCF) data sponsored by the Federal Reserve Board. The assets in the SCF data include money in checking accounts and retirement plans, CD and savings, mutual fund, and cash minus liabilities. The OLS model used to predict the assets is a linear function of weekly wage, age, and marital status.[1] Note that the predicted average assets per household for the workers' compensation claims data is

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[1] I am not able to observe the location of the household in the publicly available file.

$500,971, which is 28 percent lower than the average assets per household of $692,100 (69). It makes sense for the workers in the workers' compensation claims dataset to have fewer assets than the national average because the individuals who have work-related injuries tend to have relatively lower paying jobs.

Following Chetty (18), I divide the individual workers into two groups. The workers below the median level of the predicted assets ($575,927.5) is the liquidity-constrained group, and the workers above the median is the non-constrained group. To investigate whether the predicted asset measure successfully identifies the workers that are liquidity constrained, I perform the following three tests. First, I estimate whether the workers in the constrained group experience a longer time off work and subsequently a higher reduction in the likelihood of re-injuries as a response to higher benefits relative to the non-constrained group. This approach measures the effect of more benefits relieving the pressure of having to rush back to work, which permits workers to rest longer and achieve a better health status. Second, I create different liquidity-constrained groups using alternative cutoffs and test whether the general pattern in responding to higher benefits between the constrained and non-constrained groups holds. Third, I further examine whether the responses in consuming medical care services and the likelihood of hospitalization and surgery are different between these two groups.

The first and second columns in Table XI display the effect of wage replacement rate on time off work among the constrained and non-constrained groups separately. Columns 3 and 4

TABLE XI: LIQUIDITY EFFECT AMONG CONSTRAINED AND UNCONSTRAINED WORKERS: PREFERRED SPECIFICATION

	Number of Lost Days		Hazard Rate of Re-Injury	
	Constrained[a]	Unconstrained[b]	Constrained	Unconstrained
Wage Replacement Rate	1.29	0.68	-3.19	0.22
	(0.34)[c]	(0.28)	(0.97)	(0.90)
Observations	8070	8069	8070	8069
Mean of Dep. Var.	46.85	49.79	9.48	12.13

[a]Predicted assets of $575,927.5 or lower.
[b]Predicted assets higher than $575,927.5.
[c]Standard errors in parentheses, clustered at the company level.

display the hazard rate of re-injuries. A 10 percentage point increase in the wage replacement payment increased the number of lost days by 27 percent among the constrained workers, while it was 10 percent among the non-constrained group. The effect on delayed return to work translates to a reduction in the hazard rate of repeat injuries by 9.6 percent for the constrained workers, but no statistically significant effect for the non-constrained group.

Table XVI shows the differential effects on medical services use and the likelihood of hospitalization and surgery among the constrained and non-constrained groups. Although most estimates are statistically insignificant, the constrained group incurred economically positive amount of medical services as a result of increased benefit and more days off work, while the effects on the non-constrained workers are negligible.

Table XVII presents the results using alternative cutoffs, which are defined as the 60th, 70th, 80th, and 90th percentiles of the predicted assets. The groups below the percentiles are the liquidity-constrained group, and the ones above are the non-constrained workers. Regardless of how I categorize the constrained group, they incurred more time off work as a response to increased benefits than their non-constrained counterpart, indicating that the results are not sensitive to a specific liquidity threshold. Therefore, all the results above suggest that the predicted asset measure has successfully identified the liquidity-constrained and non-constrained workers.

Another problem with the workers' compensation claims data is that they do not contain lump sum payment information that would allow me to credibly identify each component of the liquidity effect: $\frac{\partial L_t}{\partial A_t}$ and $\frac{\frac{\partial p_t}{\partial A_t}}{\frac{\partial p_t}{\partial L_t}}$ from equation Equation 9.8. To identify these two components, I need to vary a lump sum payment A and observe how time off work L and re-injury rate p change. That said, under certain assumptions, the data allow me to calculate the total liquidity effect, which is the difference in the effect of increased benefits on days off work between the liquidity-constrained and non-constrained groups. The first assumption is that the non-constrained workers respond to increased benefits by staying off work longer purely due to the moral hazard effect, so any observed difference between the constrained and non-constrained workers is attributed to the liquidity effect. The second assumption is that workers experience fewer re-injuries only through extra time off work, so the effect of benefits on time off work captures the overall liquidity effect.

The first and second columns in Table XI show the result of the wage replacement rate on time off work by constraint status. Both estimates are significant and the liquidity-constrained workers have a longer absence from work in response to increased benefits. Specifically, the liquidity effect accounts for $\frac{1.285-0.675}{1.285}$, or 47 percent of the total effect.

9.4 The Welfare Effect and Optimal Benefit Level

To estimate $\frac{\partial W}{\partial b}$ in equation Equation 9.9, I use the following numbers:

$(1-\sigma) = 9.65\%$: the proportion of workers who had re-injuries in the data.

$\frac{D_B}{D} = 1$: the cash benefits stop once workers return to work.[1]

$\epsilon_{D_B^b} = 0.53$: the total elasticity derived from column 5 in Table III.

When the liquidity effect accounts for 47 percent of the total effect in the benefits on time off work: $\frac{\partial W}{\partial b} = \frac{0.0965}{0.9035}[\frac{0.47}{0.53} - \frac{0.53}{0.9035}] = 0.032$

The positive results suggest that the current benefit level is lower than its optimum. Under the condition that the liquidity effect accounts for 47 percent of the total effect observed, a $1 increase in the weekly benefit level would increase a workers utility by the equivalent of a 3.2-cent increase in the weekly wage, or about $1.66 a year. Given that the average number

[1] Workers are not compensated for the first seven days off work in New York. But in my data, the number of lost days is counted from the first compensable day.

of the injuries involving lost workdays yearly in New York during the study period was 770,15 (70), the total welfare gain added up to \$127,845. The insignificant welfare gain and small magnitude of $\frac{\partial W}{\partial b}$ suggest that the current benefit level in New York is almost optimal.

The result is similar to Chetty (18) and Rennane (71). Chetty uses the Survey of Income and Program Participation sample and the Mathematica surveys to estimate the welfare effect brought by the current Unemployment Insurance benefits. The calculation yields a number of 4-cent per week. Rennane calculates the welfare effect using the Oregon workers' compensation administrative data. She finds that the liquidity effect takes up 50-60 percent of the increase in claim duration, and the optimal benefit formula yields a number of 3-cent per week.

CHAPTER 10

DISCUSSION AND CONCLUSION

In this study, I use variation in the wage replacement rate generated from annual increases in the maximum benefit level to estimate the effect of cash benefits on disability duration, medical care utilization, and health outcomes in the workers' compensation setting. Because the maximum benefit level is updated on July 1 of every year and is based on the average performance of the entire state, individual companies or employees cannot manipulate it. The variation in wage replacement rate brought by the changes in the maximum benefit level are believably exogenous.

Using wage replacement rate as the treatment variable has two advantages. First, I focus on the variation in the wage replacement rate brought by 10 annual increases in the maximum benefit level from 2007 to 2016, creating 10 quasi-experiments rather than only one or two as in past studies. Second, the wage replacement rate is a continuous variable, which captures the intensity of the policy effect. Both features enhance the robustness of the study results.

This study found a positive effect of cash benefits on time off work. Specifically, a 10 percent increase in the wage replacement rate led to an additional 3.4 days off work, or a 7 percent increase. A 1 percentage point increase in the wage replacement rate led to a 1.17 percent increase in days off work. The back-of-the-envelope calculation estimates a duration-benefit elasticity of 0.53. Moreover, I find no evidence that workers file more claims or report a different type of injury systematically as a result of increased benefits, indicating that sample selection is not a concern.

Compared to the duration-benefit elasticities estimated from the literature, which range from basically no elasticity (6) (8) to strongly elastic (28), my estimate fits in the lower to middle range. This outcome is not surprising because the sample includes large self-insured companies and their incentive to control the cost is stronger. As the theoretical model predicts, employers respond to benefit expansion by facilitating workers return-to-work process, while employees respond to it by staying off work longer. The result is the net effect from these two opposing actions. Self-insured companies may react more aggressively than fully-insured companies to offset the reaction from workers, minimizing the impact of the benefit expansion on time loss. It is worth mentioning that although companies choose to self insure, these self-insured companies are large corporations that provide employment for the majority of workers. In 2014, about 66 percent of workers were employed by mid- to large-sized companies (72). Therefore, the workers in this study are representative of the current workforce.

Another novel aspect of this paper is its exploration of the potential causal link between cash benefits and medical care utilization. Multiple studies have evaluated the adequacy of workers' compensation cash benefits and concluded that the cash payment does not provide sufficient protection against lost wages (73) (74) (75) (76) (77) (4). Workers tend to rush back to work before they are fully healed to prevent further income loss, so a policy that increases cash benefits may reduce workers financial burden and allow them to acquire needed care before returning to work (10). From this study, I do not find strong evidence that workers use extra time off work to obtain more care. Further, the health outcomes when workers are on workers' compensation disability leave remain unchanged. Upon return to work, however, as a result of increased cash benefits and extra days off work, workers are less likely to experience re-injuries. This finding implies that the damage due to injury can only be mitigated by a worker resting longer, rather than consuming more health care. In fact, 60 percent of re-injures in my sample involve strains and sprains, which require longer rest and less physical exertion to heal.

Lastly, the welfare analysis concludes that the current cash benefits in New York is almost at the optimal level. Under the current benefit schedule, a $1 increase in the weekly benefits level would increase a workers utility by the equivalent of a 3.2-cent increase in the weekly wage. New York has set the maximum benefit level at two-thirds of the state's average wage during the previous calendar year. The study results imply that two-thirds of the state's average wage is a reasonable benefit benchmark for workers' compensation program.

To conclude, the policy that increases workers' compensation cash payments is costly to employers in terms of higher benefits and delayed return to work, but the cost is offset by the savings associated with reduction in re-injuries. Workers benefit from the policy by having longer time off work and subsequently incurring fewer re-injuries after returning to work. New York has been adjusting the benefit levels for more than a decade. The welfare calculation shows that the current benefit level in New York is close to optimal. Given the universal requirement for workers' compensation insurance coverage, this study has important policy implications for other states. Moreover, other public insurance programs must strike a balance between program costs and work incentives. The results from this study provide evidence for this trade-off and show that the long-term health effect should be taken into consideration when designing social programs.

CHAPTER 11

APPENDICES

The steps to construct the initial sample is the same as the steps I took in a paper I published in *Journal of Risk and Uncertainty.* I include the permission statement for author reuse from the publisher in this chapter. The initial sample contains 226,644 workplace injuries occurring from 2004 to 2016 in New York. I exclude individuals above the age of 64 years from the sample because they may substitute Medicare for workers' compensation if injured. There are six types of workers' compensation claims and one type of workers' compensation incident report. I keep the six types of workers' compensation claims and exclude incident reports because they have not advanced to become a claim yet. Together, these exclusions represent 13 percent of the sample.

Twenty-four percent of claimants have missing pre-injury weekly wage. I impute the missing weekly wage value next since weekly wage is a critical variable for my analysis. The wage values are missing at random and are not correlated with other characteristics.[1] I impute the missing weekly wage using workers whose weekly wages are available. Specifically, I identify donors from the sample, i.e., workers with wage information available that share similar characteristics

[1] I regress the missing status on claimants demographic characteristics, and the coefficients on those characteristics are not statistically significant.

TABLE XII: APPENDIX A. OTHER CHANGES BROUGHT BY THE NEW YORK 2007 WORKERS COMPENSATION REFORM

Benefit Changes
Increased the maximum weekly death benefit:
Increased from $750 to $825 on or after July 1, 2008.
Increased from $825 to $900 on or after July 1, 2009.
Indexed at the state's average weekly wage on or after July, 2010.
Decreased the benefit for permanent partial disability:
Removed the lifetime benefit for permanent partial disability and limited the benefit to 224 to 525 weeks depending on the severity of injury.
Reduced Workers' Compensation Insurance Premium by 20 Percent
Anti-Fraud Provisions
Authorized the workers' compensation board chairperson to issue stop-work orders and shut down a business that is not complying with workers' compensation requirements.
Increased civil penalties and criminal penalties for employers who fail to obtain workers' compensation coverage for workers.
Prohibited employers who fail to comply with workers' compensation requirement from bidding on public work contracts.
Streamline Claim Process
Reduced the long delays in receiving benefits.
Doubled the fine, from $250 to $500, for an employer or insurer who appeals a decision for the purposes of delaying benefit or on frivolous grounds.
Reduced hearings over doctor-ordered diagnostic medical tests.
Established the diagnostic testing networks and restrict the diagnostic medical tests to be done within the networks

[a]The information is retrieved from https://www.cga.ct.gov/2007/rpt/2007-R-0696.htm

with workers with missing wages, and calculate the missing weekly wages based on the donors. Similar characteristics are defined as workers sharing the same industry, same geographic area in New York (New York City vs. outside New York City), same occupation, same gender, and same employment status; their ages differ by five years or less, and their length of time at work differs by three years or less. Not every missing value has a known value to use in its place, so after imputation, observations with missing weekly wages are 7 percent of the sample. I exclude observations with missing weekly wages from the analysis. In the robustness section, I estimate the model without the imputed values and show that the results are only slightly increased.

Moreover, 7.5 percent of claims in my sample incur positive income benefits but have zero lost days of work. New York workers' compensation law regulates that individuals who are disabled and not able to work for more than seven days receive cash benefits (New York Workers Compensation Board, 2018b). Therefore, I suspect that the claims with positive benefits but no lost days are recorded in error. In order to maintain a reasonable sample size, I calculate the number of lost days for these claims, defined as the sum of the days between cash payment from/through dates for lost time payments. I then exclude the claims that incur more than 365 lost days (less than 5 percent of the sample) to avoid a censoring problem and potential measurement error. I further exclude claims that are open, denied, or litigated because these claims are fundamentally different from the closed and accepted claims. I also eliminate claims that involve lump-sum settlements because the claimants in such cases face different incentives than claimants who receive cash benefits on a regular basis. After these steps, the sample size drops down to 135,764, which is 60 percent of the initial sample.

To estimate the impact of benefits on time off work, I restrict the observations to only Temporary Total Disability (TTD) claims because the wage replacement rate is better measured for these claims.[1] Only including TTD claims reduces the sample size by 88 percent because the majority of claims are medical expense-only claims.[2] Finally, I restrict the sample for the main analysis to the claimants whose pre-injury weekly wages are not subject to the minimum weekly benefit amount. Later in the study, I include other types of claims for the tests for whether the injured population is changing systematically.

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[1]The cash payment received by temporary partial disability claimant needs to be modified by the degree of impairment, which is poorly measured in my data set. The cash payment received by permanent disability claimant is calculated in a different way than how temporary disability benefit is calculated, and it is subject to a different schedule set by law.

[2]Claims for medical expense only take 76 percent, Temporary Partial disability claims take 10 percent, Permanent Disability claims take 2 percent, and Death claims take 0.2 percent.

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TABLE XIII: APPENDIX B. SAMPLE RESTRICTION

General Steps		
Steps	Number of Observation	Comments
Step 1: Claims in New York, 2004-2016	226,644	Initial sample
Step 2: Keep age 16-64, and has served in a firm for at most 49 years	207,093	Claimants older than 64 may use Medicare in lieu of workers' compensation
Step 3: Keep six types of claims: Medical only; Temporary total; Temporary partial; Permanent total; Permanent partial; Death	197,226	Exclude incident report since it is not a claim yet.
Step 4: Impute missing pre-injury weekly wage value	182,879	24% of weekly wage are missing. After imputation, 7% are missing.
Step 5: Fix number of lost days recorded in error, and exclude claims with more than 365 lost days.	170,926	Fix 7.5% of the values
Step 6: Keep closed, accepted, and non-litigated claims, with no settlement	135,764	
Step 7: Keep TTD claims	16,598	Treatment variable is better measured for TTD claims. Medical-only claims: 76%; TTD claims: 12%; TPD claims: 10%; PD claims: 2%; Death claims: 0.2%
Step 8: Keep weekly wage not subject to the minimum benefit level	16,139	
Tests for Systematical Changes to TTD Population		
Final sample+ medical-only claims	112,255	
Final sample + TPD claims	29,223	
Final sample + denied claims	19,168	

TABLE XIV: APPENDIX C. SUMMARY STATISTICS ON LOST TIME AND MEDICAL OUTCOME VARIABLES

		Pre-reform		Post-reform	
	All	Control[a]	Treatment[b]	Control	Treatment
Variables	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd
Number of Lost Days	48.32	49.53	46.12	50.25	48.25
	(56.94)	(61.77)	(59.98)	(57.95)	(54.14)
PT and Chiropractic Sessions	17.97	9.022	12.47	17.16	22.46
	(44.08)	(25.09)	(32.14)	(44.76)	(50.32)
Controlled Substances	0.091	0.057	0.06	0.11	0.11
	(0.29)	(0.23)	(0.24)	(0.31)	(0.31)
MME Per Day	12.98	11.66	11.53	14.23	13.43
	(64.75)	(68.12)	(75.86)	(57.46)	(61.54)
Medical Spending	2954.4	2339.6	3059.6	2512.5	3203.8
	(5130.7)	(3676.6)	(4832.6)	(4369.7)	(5713.5)
Hospitalization	0.08	0.14	0.13	0.05	0.05
	(0.27)	(0.34)	(0.33)	(0.22)	(0.22)
Surgery	0.03	0.01	0.03	0.01	0.03
	(0.16)	(0.10)	(0.18)	(0.11)	(0.17)
Number of Observations	16139	1937	3192	2734	8276

[a]Workers with wages between $113 to $450. Mean: $301; Medium: $307.
[b]Workers with wages between $450 to $5425. Mean: $904; Medium: $800.

TABLE XV: APPENDIX D. SUMMARY STATISTICS ON OTHER OUTCOME VARIABLES

Variables	All	Pre-reform Control[a]	Pre-reform Treatment[b]	Post-reform Control	Post-reform Treatment
Nature of Injury	percent	percent	percent	percent	percent
-no physical injury	0.23	0.36	0.06	0.26	0.25
-burn	1.12	1.29	1.32	1.87	0.76
-contusion/laceration	15.60	19.62	13.25	19.94	14.13
-enucleation	0.17	0.10	0.19	0.22	0.17
-infection/inflammation	6.11	5.37	7.90	3.99	6.30
-puncture/fracture	9.15	8.47	9.43	10.61	8.71
-strain/sprain/tear	55.57	51.11	53.51	51.43	58.77
-all other specific injuries	8.33	10.69	10.18	7.35	7.38
-multiple physical injury	2.59	1.86	2.82	2.67	2.65
-not provided/NOC	1.14	1.14	1.35	1.68	0.88
Job Termination	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd
	0.03	0.03	0.01	0.07	0.02
	(0.17)	(0.17)	(0.10)	(0.26)	(0.15)
Number of Observations	16139	1937	3192	2734	8276
Temporary Total/ (Temporary Total+Medical)	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd
	0.15	0.09	0.18	0.10	0.17
	(0.35)	(0.29)	(0.39)	(0.30)	(0.37)
Number of Observations	109784	14068	20970	22862	51884
Temporary Total/ (Temp Total+Temp Partial)	0.56	0.47	0.54	0.49	0.60
	(0.50)	(0.50)	(0.50)	(0.50)	(0.49)
Number of Observations	29027	2774	7020	4699	14534
Denied Claims	0.04	0.04	0.10	0.02	0.01
	(0.20)	(0.21)	(0.31)	(0.13)	(0.11)
Number of Observations	19026	1557	5031	2571	9867

[a] Workers with wages between $113 to $450. Mean: $301; Medium: $307.
[b] Workers with wages between $450 to $5425. Mean: $904; Medium: $800.

TABLE XVI: APPENDIX E. LIQUIDITY EFFECT ON MEDICAL SERVICES USE AND HEALTH OUTCOMES: PREFERRED SPECIFICATION

	# of PT		Pr(Opioid)		# of MME		Med $$		Pr(Hosp)		Pr(Srg)	
	Cnstrn	Uncnstrn	Cnstrn	Uncnstrn	Cnstrn	Uncnstrn	Cnstrn	Uncnstrn	Cnstrn	Uncnstrn	Cnstrn	Uncnstrn
Panel A: Wage Replacement Rate	0.909	-0.036	0.678	-0.025	3.363	-0.471	0.664	-0.237	0.074	-0.057	-0.014	-0.039
	(0.609)[a]	(0.459)	(0.269)	(0.166)	(2.115)	(0.822)	(0.410)	(0.431)	(0.067)	(0.069)	(0.034)	(0.038)
Panel B: Number of Lost Days	0.018	-0.001	0.020	-0.001	0.127	-0.025	0.013	-0.007	0.001	-0.002	-0.000	-0.001
	(0.012)	(0.013)	(0.027)	(0.007)	(0.207)	(0.070)	(0.007)	(0.014)	(0.001)	(0.002)	(0.001)	(0.001)
Observations	8070	8069	2933[b]	3253	2905	3189	8070	8069	8070	8069	8070	8069
Mean of Dep. Var. (un-transformed)	15.17	19.23	.10	.12	10.98	12.64	2517.78	3391.16	.08	.08	.02	.03

[a]Standard errors in parentheses, clustered at the company level.
[b]Opioid information is only available after 2010.

TABLE XVII: APPENDIX F. LIQUIDITY EFFECT ON NUMBER OF LOST DAYS: ALTERNATIVE CUTOFFS (PREFERRED SPECIFICATION)

	60th Percentile		70th Percentile		80th Percentile		90th Percentile	
	Below	Above	Below	Above	Below	Above	Below	Above
Wage Replacement Rate	1.158[a]	0.541	0.972	0.719	0.901	0.703	0.928	-0.433
	(0.320)[b]	(0.326)	(0.330)	(0.363)	(0.319)	(0.426)	(0.297)	(0.615)
Observations	9684	6455	11298	4841	12912	3227	14525	1614
Mean of Dep. Var. (un-transformed)	47.34	49.80	47.51	50.22	47.99	49.66	48.29	48.63

[a]The results are based on a Inverse Hyperbolic Sine model.
[b]Standard errors in parentheses, clustered at the company level.

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