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Workers' compensation and consumption smoothing☆

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ABSTRACT

This paper investigates the consumption-smoothing benefits of state workers' compensation (WC) programs. These programs are among the largest and most controversial forms of social insurance, with the putative purpose of supporting families affected by unexpected income shocks due to workplace injuries and illnesses. Using Health and Retirement Study (HRS) data for a sample of workers who have experienced a work-related, work-limiting disability, I find that a 10% increase in WC benefit generosity offsets the drop in household consumption upon injury by 3 to 5%. Moreover, my estimates imply that if benefits were very low, the drop in consumption upon injury would be in the range of 30%. A model adapted from the literature on optimal social insurance yields a formula for the optimal level of WC benefits, which depends on empirical estimates of the consumption-smoothing parameter. My calculations suggest that current WC benefit levels are somewhat higher than optimal.

1. Introduction

State workers' compensation (WC) programs are among the largest forms of social insurance, with a primary goal of providing income support to families facing unanticipated hardship when a worker becomes injured or ill on the job. Throughout the 1990s and early 2000s, WC was larger than unemployment insurance (UI), AFDC/TANF, Supplemental Security Income (SSI), and Food Stamps in terms of total expenditures (U.S. House of Representatives Committee on Ways and Means, 2004). A long literature estimates the incentive effects of variation in WC benefits on outcomes like the frequency of injuries, number of claims, and duration of claims.[1] However, existing research proffers remarkably little evidence on the *benefits* of WC or its impacts on the well-being of injured workers and their families.[2]

This paper investigates the consumption-smoothing effect of WC cash benefits for households who incur a workplace injury (or illness). In doing so, I seek to answer two questions: first, at current benefit levels, to what extent do WC benefits help households to smooth consumption over the loss of earned income resulting from a job-related injury? Second, what is the optimal level of WC benefits that balances the trade-off between the value of smoother consumption for these households and the costly distortionary effects on individual labor supply behavior?

To address the first question, I use data from the Health and Retirement Study (HRS) to estimate the impact of WC benefit generosity on changes in household consumption for individuals who suffer a work-related injury or illness. My results indicate a significant consumption-smoothing role for WC: I find that a 10% increase in cash benefit levels offsets the drop in household consumption upon injury by 3 to 5%. I also show that the consumption-smoothing benefits of WC are larger for households with limited pre-injury assets, and that the results are robust to several extensions. Moreover, my estimates indicate that if WC benefits were very low, equal to the 10th percentile of their current distribution, the implied drop in household consumption upon a work-related injury would be approximately 30%.

The economic significance of these consumption-smoothing benefits can only be determined when they are weighed against the costs associated with incentive effects of WC on individual labor supply decisions. Accordingly, a second goal of the paper is to examine the inherent trade-off between the benefits and costs of increased WC generosity. I adopt from the public finance literature a model for optimal social insurance, developed by Baily (1978) and Chetty (2006) in a framework of unemployment risk. Adapted to the case in which workers face risk of on-the-job injury, the model provides an explicit formula for the optimal level of WC benefits, which depends directly upon empirical estimates of the consumption smoothing provided by WC. I find that the optimal level of wage-replacement for WC is *lower* than current values for plausible levels of risk aversion and for a range of estimates of the distortionary effects of WC generosity on individual behavior.

☆ The primary data used in this paper are based on restricted access Health and Retirement Study geocode data. Interested users should contact hrsquest@isr.umich.edu for more information. I am grateful to John Karl Scholz and two anonymous referees for constructive feedback and guidance, and to Bruce Meyer, Frank Neuhauser, Les Boden, Melissa McInerney, Chris Taber, Dennis Sullivan, and many others for helpful comments. I especially thank Michael Nolte at the Michigan Center on the Demography of Aging (MiCDA) for patient assistance with restricted access HRS data.

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[1] See, e.g., Chelius (1982), Butler and Worrall (1985), Ruser (1985, 1991), Krueger (1990, 1991), Meyer et al. (1995), Hirsch et al. (1997), Neuhauser and Raphael (2004), and Bronchetti et al. (2011).

[2] There is some research on the replacement of earnings losses experienced by injured workers (e.g., Biddle (1998), Reville and Schoeni (2001), or Boden and Galizzi (1999, 2003)).

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A key contribution of this study is to provide new evidence on the *benefits* of WC for workers injured on the job by examining their household consumption expenditures. A set of recent papers has examined the adequacy of WC benefits in replacing earnings losses associated with a work-related injury or illness.[3] However, studies of earnings losses yield an incomplete understanding of the impact of a workplace injury or illness on household well-being. A need for additional research on the economic consequences of workplace injuries and illnesses has been suggested by Reville et al. (2001), who specifically call for evaluations of the adequacy of WC using measures other than earnings or income losses.

Household consumption may provide a more appropriate and direct measure of household material well-being for injured workers. Standard models of utility maximization are based on consumption rather than income, and with concave utility, households prefer to smooth consumption over temporary income losses from a job-related disability. To the extent that a household is able to do so, current period consumption will provide a more complete picture of its material well-being than will current period income (Cutler and Katz, 1992). Meyer and Sullivan (2003) show that for households with fewer resources, consumption is measured more accurately than income in survey data and is more closely linked to material hardship. They conclude that policy makers should examine consumption data when determining benefit levels and evaluating transfer programs.

This study also complements related research from outside the literature on work-related injuries and illnesses. Stephens (2001) uses data from the Panel Study of Income Dynamics (PSID) to examine the long-run consumption effects of disability (not necessarily work-related) and finds a significant long-run reduction in household food consumption. The long-term change in consumption is not as large as the disabled individual's earnings loss, suggesting a degree of consumption smoothing. Meyer and Mok (2008) show large and persistent impacts of disability on food and housing consumption, especially for households with a chronic/severely disabled head. They find that social insurance only partially reduces the consumption drop at disability.

For workers experiencing job displacement in the PSID, Gruber (1997) finds significant consumption-smoothing effects of UI benefits. However, it is not clear ex ante whether WC should provide more or less consumption smoothing than UI. Without moral hazard effects, on-the-job injuries are likely more unexpected than unemployment and can result in longer time out of work, so injured workers may be less able to smooth consumption through self-insurance. But if many work injuries are planned or anticipated, individuals may be more prepared to smooth consumption than displaced workers. Kantor and Fishback (1997) show that the introduction of WC caused a significant reduction in precautionary savings by working-class families, a finding that suggests WC may have important consumption-smoothing effects. But the extent to which WC provides consumption smoothing for injured workers remains an empirical question, to which this study provides an answer.

The paper proceeds as follows: Section 2 provides a brief background on WC benefits in the United States. Section 3 discusses the Health and Retirement Study (HRS) data used in the paper, focusing on the information provided by the HRS on work-related disabilities and household consumption expenditures. Section 4 describes the key empirical methods used to estimate the consumption-smoothing benefits of WC, and Section 5 presents the main empirical results. Section 6 performs an exercise to determine the optimal level of WC benefits, using empirical estimates from my own work as well as those in previous research. Section 7 concludes and discusses implications for policy and future research.

[3] See, e.g., Biddle (1998), Boden and Galizzi (1999, 2003), and Reville and Schoeni (2001).

2. State WC programs and variation in WC benefits

WC is the main form of indemnity for workers in the U.S. who are injured or become ill on the job. By law, firms are required to obtain WC insurance to provide a state-mandated amount of cash benefits, medical care, and rehabilitation services to injured workers. Over 90% of the wage and salaried workforce is covered, and workers become eligible to receive WC as soon as they enter covered employment. In 2008, $57.6 billion were paid out in WC benefits (including medical costs), and employer costs for WC amounted to $78.9 billion (Sengupta et al., 2010).

When a worker files a claim for a work-related illness or injury, WC provides immediate coverage of all medical and rehabilitation costs and provides cash benefits after a state-determined waiting period (3 to 7 days).[4] Fig. 1 demonstrates the share of overall WC program costs accounted for by cash benefits and by coverage of medical costs. Although medical costs account for a growing share of overall WC outlays and have equaled cash benefits in recent years, cash benefits exceed medical costs for the time period studied here. This paper focuses solely on the consumption-smoothing role of WC cash benefits.

Over 70% of all WC claims for cash benefits are for 'temporary total disability' (TTD) benefits, which are paid to individuals who are unable to work for a finite period of time. If an injury persists beyond the date at which maximum medical improvement has been achieved, it is reclassified as a permanent disability.

There is substantial cross-state and within-state variation in the generosity of WC cash benefit levels. An injured worker's weekly TTD benefit is set equal to a fraction (the replacement rate, typically 66.7%) of the worker's pre-injury gross weekly wage, subject to the minimum and maximum benefit amounts in his state and year.[5] Some states adjust benefits to reflect the worker's marital status and number of dependents. The maximum binds for 20% of the injured workers in my primary HRS sample. For this group, the nominal replacement rate (i.e., the ratio of weekly TTD benefits to weekly pre-injury gross wages) is less than two thirds. However, the exemption of WC benefits from income and payroll taxation implies a more generous after-tax replacement rate.

The top panel of Table 1 illustrates the cross-state variation in WC benefit generosity for a representative set of states in 2008. The most notable difference in benefit generosity across states is in the maximum weekly benefit amounts. For instance, while Illinois has a maximum weekly benefit of $1164, in the same year, injured workers in New York receive a maximum of $500 per week. Likewise, replacement rates are higher in Illinois than in New York. Only 4% of injured workers in Illinois earn wages high enough to receive the maximum, while the maximum binds for 32% of injured workers in New York.

The lower panel of Table 1 demonstrates one key source of within-state variation in WC benefits, namely, changes in maximum benefit levels over time. Numbers in bold reflect increases in the maximum of more than 10% relative to the previous period, while highlighted numbers reflect increases of more than 20% over the previous HRS wave. While increases in the maximum benefit level are often pegged to changes in the state's average weekly wage, large, discrete increases in the maximum are clearly quite common. Between 2002 and 2004, for example, California raised its maximum WC benefit from $490 to $728, an increase of almost 50%.

Many of this paper's key results rely on within-state variation in WC benefits to identify the effects of WC on household consumption. Table 1 indicates that significant changes in maximum and minimum WC benefit levels are frequent, but nonlinearities in benefit formulas

[4] A worker is later compensated for the days of the waiting period if his injury persists beyond the length of the state-determined retroactive period, usually a few weeks.

[5] The pre-injury weekly wage is typically calculated as the individual's average pretax wage over the 52 weeks prior to injury.

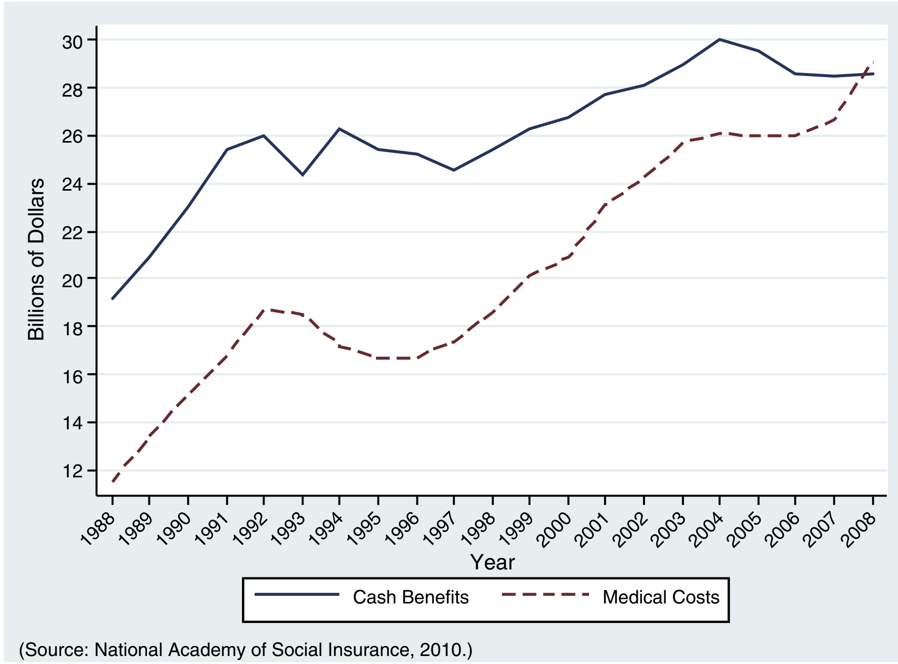

Fig. 1. WC medical and cash benefits, 1988–2008.

and individual variation in wages and family structure provide additional sources of within-state variation in benefit entitlements. Fig. 2 plots WC benefit entitlements (calculated based on a worker's pre-injury average weekly wage and the WC laws in his state-year) for injured workers in the HRS by state of residence. I return to a discussion of the additional sources of within-state identifying variation in WC benefits in Section 4.

3. Data

The HRS is the only nationally representative data set that provides information on household consumption and permits identification of injuries related to work without conditioning on WC receipt.[6] The HRS has collected longitudinal data on individuals nearing (or of) retirement age biennially since 1992.[7] Along with extensive information on demographics, employment, health, sources of income, and program participation, the HRS contains several questions that allow me to identify individuals with work-related injuries and illnesses, who are potential WC recipients. The ability to identify these injured workers without conditioning on receipt of WC benefits is important, since the decision to take up WC is endogenous with respect to changes in household consumption upon injury.

First, I limit the sample based on the question in the survey that asks, "Do you have any impairment or health problem that limits the kind or amount of work that you can do?" Because I examine changes in consumption when a worker becomes ill or injured, the sample includes only those who report a work-related disability in period t, but did not report a work-limiting health problem in period $t-1$.[8] To attribute an injury/illness to the workplace, I include only those respondents who answered in the affirmative the question that asks whether the impairment "was in any way caused by the nature of [the respondent's] work."[9] This definition of on-the-job injuries includes impairments like carpal tunnel syndrome, which would not have been caused by a specific workplace incident. Additionally, inclusion in the sample is conditional on employment in period $t-1$ because employment determines WC eligibility and because the primary effect of a workplace injury on household material well-being is through lost earnings of the injured worker.

Information on household food expenditures is available in the HRS for all waves except Wave 4.[10] Three measures of household food consumption are reported: 1.) food consumption at home (not including food stamps), 2.) food consumption away from home (including "take-out" or food "ordered in"), and 3.) the value of food stamps used by the household.[11] These three types of food expenditures are converted into 2002 dollars using the corresponding component of the CPI-U in the interview month; food consumption is measured as the sum of the real components.

Although food expenditure information is a limited measure of household consumption, it has been used in a number of papers on household consumption behavior.[12] A benefit of using food

[6] The National Longitudinal Survey of Youth (NLSY) and the Survey of Income and Program Participation (SIPP) also allow for identification of work-related injuries/illnesses without conditioning on WC; however, neither of these surveys contain information on household consumption. The Panel Study of Income Dynamics (PSID) contains household consumption data for prime-aged workers but does not permit identification of injured workers except through reports of WC receipt.

[7] Because HRS surveys occur every two years, my sample of workers becoming injured between survey waves may contain a disproportionate number of permanent or persistent injuries and illnesses relative to what we would observe if the data were collected more frequently. However, the percentage of injured workers in my sample who still report a work-limiting, work-related injury/illness in the following wave (i.e., two years after the first report of injury) is only 25%, which is lower than we might expect for this sample of older workers.

[8] I include observations for which this is the *first* reported work-limiting disability in the HRS.

[9] The questionnaire also inquires whether "the impairment or health problem… was the result of an accident or injury," and whether the accident took place at work, home or elsewhere. An alternative would be to include only those whose health problem resulted from a workplace accident.

[10] Therefore, consumption changes are missing for Wave 3 to Wave 4 (1996 to 1998) and Wave 4 to Wave 5 (1998 to 2000). While measures of housing consumption are available for these years, I use only the years for which I can measure changes in both types of consumption.

[11] In the HRS, the value of food stamps is not to be included in the reported value of spending of food consumed at home. If the respondent has reported receiving any food stamps, the question regarding spending on food consumed at home reads, "In addition to what you bought with food stamps, about how much do you… spend on food that you use at home in an average week?"

[12] See Gruber (1997, 2000), Stephens (2003), Haider and Stephens (2003), and Meyer and Mok (2008).

Table 1
Legislated workers' compensation (TTD) benefit generosity and changes in maximum weekly benefits, 1994–2008.

	Workers' compensation TTD benefit parameters, 2008					Measures of WC generosity for injured workers in HRS (1994-2008)		
	Replacement rate	Max benefit	Min benefit	Waiting period	Retroactive period	Nominal rep. rate	After-tax rep. rate	% Receiving max
California	66.67	881.66	132.25	3 days	14 days	0.650	0.824	0.311
Colorado	66.67	753.41	–	3 days	14 days	0.552	0.631	0.471
Illinois	66.67	1164.37	200.00	3 days	14 days	0.675	0.836	0.043
Indiana	66.67	588.00	50.00	7 days	21 days	0.668	0.824	0.211
Iowa	80	1311.00	–	3 days	14 days			
Massachusetts	60	1000.43	200.09	5 days	21 days	0.609	0.778	0.105
Michigan	80	739.00	205.01	7 days	14 days			
Minnesota	66.67	750.00	130.00	3 days	10 days	0.678	0.861	0.063
Mississippi	66.67	398.93	25.00	5 days	14 days	0.635	0.732	0.190
New Hampshire	60	1153.50	230.70	3 days	14 days	0.656	0.786	0.000
New Jersey	70	711.00	190.00	7 days	7 days	0.651	0.790	0.214
New Mexico	66.67	595.67	36.00	7 days	28 days	0.623	0.743	0.333
New York	66.67	500.00	40.00	7 days	14 days	0.650	0.788	0.324
Oregon	66.67	961.88	50.00	3 days	14 days	0.667	0.768	0.000
Pennsylvania	66.67	779.00	389.50	7 days	14 days	0.821	1.070	0.095
Tennessee	66.67	682.00	102.30	7 days	14 days	0.637	0.670	0.167
Washington	60	900.88	43.19	3 days	14 days	0.608	0.726	0.222

	Changes in maximum weekly WC benefits for a representative set of states, 1994-2008								
	1994	1996	1998	2000	2002	2004	2006	2008	Avg. change
California	366	336	**448**	490	490	**728**	**840**	882	12.9%
Colorado	432	451	468	**559**	**646**	659	697	753	8.5%
Illinois	713	761	815	**900**	990	1012	1052	**1164**	7.5%
Indiana	**394**	428	448	**762**	548	588	588	588	10.3%
Iowa	797	846	873	**996**	1069	1133	1226	1311	7.6%
Massachusetts	566	586	**666**	**750**	**891**	884	959	1000	8.8%
Michigan	475	**524**	553	**611**	644	671	706	739	6.7%
Minnesota	**508**	**615**	615	615	**750**	750	750	750	7.2%
Mississippi	244	265	280	303	323	341	351	**399**	7.3%
New Hampshire	**710**	714	**794**	**888**	**998**	1038	1124	1154	7.9%
New Jersey	**460**	480	516	**568**	591	650	691	711	7.2%
New Mexico	333	353	376	**480**	480	**549**	563	596	8.9%
New York	**400**	400	400	400	400	400	400	**500**	4.9%
Oregon	493	509	**577**	601	**858**	**885**	948	962	11.3%
Pennsylvania	493	509	**561**	611	662	690	716	779	7.0%
Tennessee	**356**	**415**	**492**	541	562	618	663	682	11.3%
Washington	**517**	**583**	**703**	758	538	**885**	901	901	12.1%
States raising max more than 10 %	13	9	15	21	17	5	4	10	
States lowering max or raising max < infl.	9	30	10	13	12	14	28	29	
States raising min more than 10 %	16	8	17	15	16	8	12	10	
States lowering min or raising min < infl.	25	38	24	27	24	31	33	38	

Notes: WC 'temporary total disability' (TTD) benefits are paid weekly. Iowa and Michigan pay WC benefits as percentage of "spendable" (or after-tax) earnings. Highlighted numbers reflect increase in maximum weekly WC benefit of more than 20% relative to previous year's maximum. Numbers in bold reflect increase in maximum benefit of more than 10% relative to last year.

expenditures to represent household consumption is that food is a non-durable good and should be closely tied to changes in household utility. A concern is that food is a necessary good; however, estimates of the income elasticity of food range from 0.6 to 0.7, implying that food consumption is responsive to changes in income (Stephens, 2003).

Measuring housing consumption is more difficult. One possibility is to compute housing consumption as the rent or mortgage payments paid toward the respondent's primary residence, as in Gruber (2000). While I use this approach for renters, it may not be appropriate for a sample of older homeowners, many of whom likely no longer make mortgage payments. Indeed, over 70% of injured workers in my sample own their homes in year $t-1$, but only half of owners report paying any mortgage payments. Instead, I use a simple measure of the flow value of housing services for homeowners, calculated as 6% of the reported market value of the home, as in Skinner (1987).[13] Throughout, I examine changes in food and housing consumption separately, and I emphasize the results for food consumption and an imputed measure of total household consumption.[14]

To measure the effects of WC on total household consumption, I rely on an imputation procedure developed in the literature. Skinner (1987) uses Consumer Expenditure Survey (CEX) data to regress total consumption on food at home, food away from home, the market value of

[13] This figure is divided by twelve to be consistent with monthly rent payments for renters. Both measures are converted into 2002 dollars using the appropriate component of the CPI-U.

[14] All HRS questions on consumption expenditures appear to refer to the point of interview. For example, households are asked how much they spend on food at home and food away from home in a "typical week." This timing is consistent with the information on disability status as well as with the information used to construct respondents' pre-injury weekly wages.

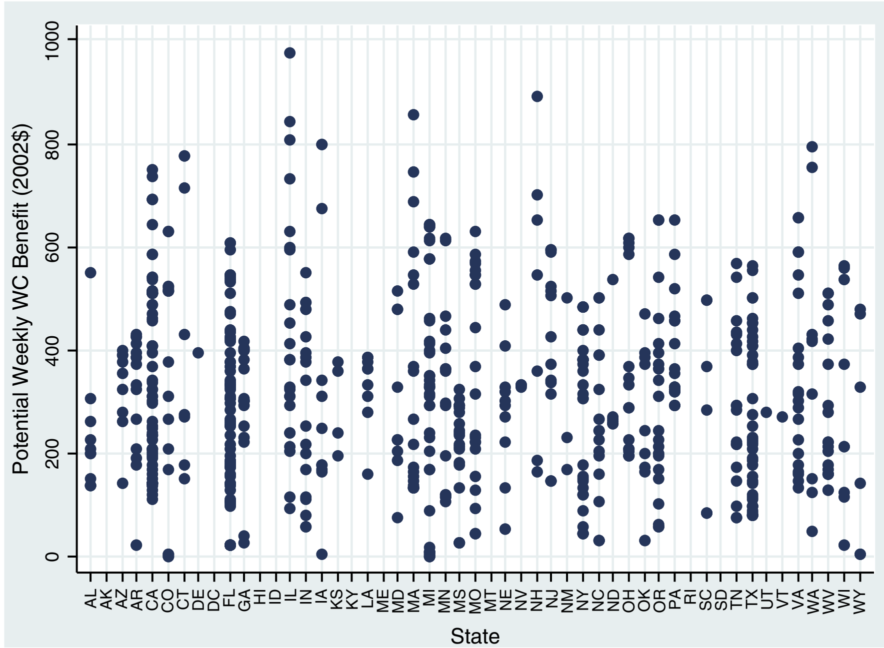

Fig. 2. Variation in WC benefit entitlements for injured workers in the HRS, by state.

the home if the respondent is a homeowner, and rent. The estimated coefficients from this regression are then applied to impute total consumption in the PSID. Fisher and Johnson (2006) revisit the approach in Skinner (1987) and re-estimate his original regressions using updated CEX data from 1999. I impute total household consumption for injured workers by applying the estimated regression coefficients from Fisher and Johnson (2006) to HRS data on the same expenditure categories used in Skinner's original regressions (i.e., food away from home, food at home, market value of the home for homeowners, and rent).[15]

Table 2 reports mean characteristics for the sample of workers with work-related injuries and illnesses as well as for those workers who never experience a job-related injury/illness, those who never experience any work-limiting disability, and those who are displaced between period $t-1$ and t. On average, when compared to the other samples, injured workers are more likely to be male and have less education and are slightly less likely to be non-white. Not surprisingly, workers reporting job-related injuries or illnesses have lower average weekly wages (and are thus eligible for lower weekly WC benefits). Injured workers also have lower average household consumption expenditures in year $t-1$ and somewhat higher rates of participation in other public benefit programs in the year of injury.

Notably, the fraction of injured workers in the sample who report having received WC benefits in the last calendar year is only 13%, a take-up rate that is low relative to other estimates in the literature. In a study of WC claiming behavior using administrative data on injured workers in Michigan, Biddle and Roberts (2003) document that only about 39% of these workers ever file for WC cash benefits. One explanation for an even lower participation rate in my sample is under-reporting of WC income in surveys like the HRS. Meyer et al. (2009) compare self-reports of transfer income received in several public-use micro data surveys to national administrative reports of benefit outlays and find that only about 40 to 50% of WC income is reported in the SIPP and CPS.[16]

Another potential explanation for the low rate of benefit receipt concerns the use of self-reported measures of disability status to identify potential WC recipients. Self-reports of work-limiting disability may not be accurate if individuals in my sample exaggerate the degree of their health problems, perhaps to justify reduced labor supply or increased participation in other programs. Benitez-Silva et al. (2004) use HRS data to study bias in self-reported disability measures similar to the one in this paper and find that respondents do not systematically misreport their health or disability status in anonymous non-governmental surveys like the HRS.

4. Empirical methods

I estimate the consumption-smoothing effects of WC benefits for workers becoming injured (or ill) at work, using models of the form:

$$\Delta C_{ist} = \alpha + \beta_1 BEN_{ist} + \beta_2 X_{it} + \tau_t + \gamma_s + \beta_3 \varphi_{st} + u_{ist} \quad (1)$$

where ΔC_{ist} is the change in (log) household consumption for individual i when he becomes injured (in state s and year t), X_{it} is a vector of personal characteristics that may affect the size of the consumption change upon injury, τ_t is a set of time effects, γ_s is a set of state effects, φ_{st} is a set of state-year economic controls, and BEN_{ist} is the (log) WC benefit for which the individual is eligible. A positive coefficient on the benefit variable represents a consumption-smoothing effect of WC.[17]

Several measures of consumption serve as dependent variables: the change in household food expenditures, the change in housing consumption, the change in their sum, and the change in (imputed) total household consumption. The consumption change measures are top- and bottom-coded at the 99th and 1st percentiles of their distributions, respectively.

The key independent variable of interest is clearly the benefit variable. For each individual in year t, I calculate a potential weekly benefit based on his gross weekly wage in year $t-1$, the replacement

[15] I also imputed consumption using the coefficients from Skinner (1987); the results are very similar in magnitude and significance to those presented. Results are available upon request.

[16] If most to all under-reporting of WC income comes from recipients not reporting participation in WC, rather than understating the *amount* of WC income received (conditional on reporting positive WC income), we can use this fraction to "scale up" the take-up rate for my sample. We multiply the take-up rate of 13% by the fraction's inverse (2 to 2.5) to estimate a true take-up rate in the range of 25 to 35%.

[17] I provide estimates from alternative specifications of this model in Table A2 in the online appendix.

Table 2
HRS sample characteristics by job injury and disability status (unweighted sample means; standard deviations in parentheses).

	Injured at work		Never injured at work		Never disabled		Displaced workers	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Demographics								
Age	58.9	(5.8)	59.4	(6.5)	59.3	(6.5)	58.0	(5.8)
Male	0.571	(0.496)	0.452	(0.497)	0.453	(0.498)	0.446	(0.498)
Married	0.735	(0.442)	0.751	(0.432)	0.757	(0.429)	0.685	(0.465)
Less than HS	0.343	(0.475)	0.206	(0.405)	0.201	(0.401)	0.286	(0.452)
High school grad	0.504	(0.501)	0.505	(0.500)	0.504	(0.500)	0.477	(0.500)
At least some college	0.153	(0.360)	0.289	(0.453)	0.295	(0.456)	0.237	(0.425)
White	0.847	(0.360)	0.840	(0.366)	0.839	(0.368)	0.817	(0.387)
Black	0.110	(0.313)	0.132	(0.339)	0.132	(0.339)	0.150	(0.358)
Hispanic and other	0.043	(0.203)	0.028	(0.165)	0.029	(0.168)	0.033	(0.179)
Household size	2.645	(1.390)	2.535	(1.220)	2.543	(1.223)	2.733	(1.370)
WC eligibility								
Average weekly wage, $t-1$	412.07	(323.48)	593.92	(689.60)	588.28	(914.70)	533.91	(521.05)
Potential weekly WC benefit	304.00	(201.15)						
Receive WC	0.13	(0.34)	0.01	(0.12)	0.01	(0.11)	0.02	(0.16)
WC benefits received	578.65	(2373.80)	26.90	(468.01)	21.83	(423.70)	45.09	(657.57)
Other program participation in period t								
Receive UI	0.061	(0.241)	0.035	(0.183)	0.035	(0.184)	0.167	(0.373)
Receive SSI	0.016	(0.126)	0.008	(0.008)	0.007	(0.082)	0.010	(0.101)
Receive Welfare	0.005	(0.073)	0.003	(0.003)	0.002	(0.044)	0.002	(0.045)
Household consumption in period $t-1$								
Annual food consumption	6709	(4460)	6747	(3332)	6709	(3352)	6730	(3875)
Annual housing consumption	6288	(4598)	6608	(5953)	6788	(6114)	6534	(6518)
Annual food + housing consumption	11820	(7365)	16503	(8539)	13755	(8703)	13264	(8563)
Imputed annual consumption (Sk-FJ)	23604	(14943)	30943	(21616)	31606	(22292)	25937	(16588)
Number of observations	372		20,991		18,864		486	

Notes: All dollar values are expressed in 2002 dollars using the appropriate component of the CPI-U. All samples are conditional on employment in $t-1$ and include only observations with complete, non-missing consumption data. Injured workers are those who report a work related, work limiting disability in period *t*, conditional on no work-limiting disability in $t-1$. “Never injured at work” includes observations of those who never experience a work-limiting disability related to their work. “Never disabled” includes those who never experience any work limiting disability. “Displaced workers” are those who report in year *t* that they are “unemployed and looking for work” or “temporarily laid off, on sick or other leave” but do not report a work-limiting disability in year *t*.

rate, and the maximum and minimum benefit amounts in his state during year *t*. Potential benefits are adjusted for marital status and dependents in states and years where such allowances apply.[18] I use ‘temporary total disability’ (TTD) schedules in each state and year to compute the benefit variable because all WC claims are initially filed as temporary cases and because TTD cases comprise more than 70% of WC cases in any given year (Meyer, 2002). To be consistent with the measurement of household consumption changes, weekly WC benefits are converted to 2002 dollars using the CPI-U for the year of injury.

The use of a “potential benefit” as the key independent variable, rather than the actual amount of WC benefits received, is crucial. First, using benefit entitlements instead of actual benefits received avoids problems associated with noisy reporting of WC income.

Perhaps more importantly, take-up of WC and the amount of WC benefits received are endogenously determined with respect to the change in consumption upon injury. Biddle and Roberts (2003) document that up to 60% of workplace injuries never result in a claim for WC cash benefits, and as discussed above, the participation rate for my sample of injured workers in the HRS is quite low. To the extent that WC filing behavior and the amount of benefits received are correlated with the consumption change resulting from the injury, estimates of Eq. (1) using actual benefits received cannot be used to predict the effects of proposed changes in WC laws. The argument of this paper is that the policy variable of most interest is the consumption-smoothing effect of legislated changes in WC benefits, since policy makers can control legislated benefits but cannot directly control WC take-up. This is the parameter estimated by β_1.[19]

Because the potential WC benefit variable is a function of pre-injury wages, I control for the separate influence of pre-injury earnings on changes in household consumption by including in each regression the individual's (log) after-tax weekly wage in period $t-1$. Controlling for after-tax weekly wages is important because WC benefits are exempt from income taxation. Marginal tax rates are constructed using the NBER's TAXSIM model and information about each respondent's age, income, deductions, and dependents.[20]

I estimate four different specifications of Eq. (1). The parsimonious model includes controls for age, sex, marital status, race, and education of the injured worker, as well as controls for family size (levels and changes), which will affect the consumption needs of the household. In model 2, I include state fixed effects in order to capture time-invariant state omitted variables, such as differences in the cost of living or industrial composition across states, which are likely to be correlated with both legislated WC benefits and consumption

[18] Information on state WC laws is from the U.S. Chamber of Commerce, Analysis of Workers' Compensation Laws (1994–2008).

[19] While β_1 is often referred to as a “reduced-form” effect, here it is accurately characterized as an estimate of the average intention-to-treat (AIT) effect (see Manski (1996) or Angrist et al. (1996)). The AIT measures the effect of the treatment on eligible subjects, regardless of whether they participate in the program. The AIT is an especially relevant policy parameter when policy makers have little influence on take-up. On the other hand, an estimate of the consumption-smoothing effect of WC for those who receive WC benefits (i.e., the average effect of the treatment on the treated, or ATT) may be of interest for social welfare and cost–benefit calculations. Absent spillover effects, one can calculate the ATT by dividing the AIT by the share of injured workers who participate in WC. I return to this matter below.

[20] The input variables used to compute these marginal tax rates are values from $t-1$, so the simulated tax rates should not be confounded by WC receipt or reduced labor income in *t*.

Table 3
Consumption-smoothing benefits of WC benefits for injured workers (results from reduced-form regressions of Eq. (1); standard errors in parentheses).

Variable	Model 1				Model 2				Model 3				Model 4			
	Food	Housing	Food + housing	Total cons. (Sk-FJ)	Food	Housing	Food + housing	Total cons. (Sk-FJ)	Food	Housing	Food + housing	Total cons. (Sk-FJ)	Food	Housing	Food + housing	Total cons. (Sk-FJ)
Log potential WC benefit	0.204^{*}	0.098	0.190	0.250^{**}	0.283^{*}	0.156	0.272^{**}	0.332^{**}	0.322^{**}	0.079	0.284^{**}	0.340^{**}	0.515^{***}	0.180	0.393^{***}	0.507^{***}
	(0.118)	(0.137)	(0.128)	(0.111)	(0.142)	(0.190)	(0.133)	(0.124)	(0.142)	(0.160)	(0.134)	(0.128)	(0.153)	(0.177)	(0.107)	(0.151)
Household size $t-1$	−0.002	0.035	−0.009	−0.014	0.001	0.050	−0.012	−0.006	0.002	0.054^{*}	−0.005	−0.002	−0.004	0.052	−0.011	−0.007
	(0.030)	(0.025)	(0.020)	(0.024)	(0.028)	(0.031)	(0.022)	(0.025)	(0.029)	(0.030)	(0.021)	(0.024)	(0.026)	(0.031)	(0.020)	(0.024)
Change in hh size	0.110^{***}	0.066^{**}	0.114^{***}	0.140^{***}	0.137^{***}	0.095^{**}	0.141^{***}	0.173^{***}	0.147^{***}	0.088^{**}	0.147^{***}	0.177^{***}	0.150^{***}	0.089^{**}	0.148^{***}	0.180^{***}
	(0.029)	(0.028)	(0.036)	(0.045)	(0.031)	(0.035)	(0.037)	(0.054)	(0.031)	(0.034)	(0.039)	(0.053)	(0.029)	(0.033)	(0.038)	(0.050)
State–year housing price index									-0.002^{***}	0.002^{**}	−0.001	−0.001	-0.003^{***}	0.002^{**}	−0.001	−0.001
									(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
State–year unemp. rate									−0.022	−0.050	−0.074	−0.054	−0.016	−0.048	−0.068	−0.049
									(0.041)	(0.044)	(0.056)	(0.053)	(0.040)	(0.042)	(0.053)	(0.052)
Log after-tax wage in $t-1$	-0.223^{*}	−0.070	−0.209	-0.268^{**}	-0.280^{**}	−0.121	-0.261^{*}	-0.319^{**}	-0.312^{**}	−0.061	-0.274^{**}	-0.328^{**}				
	(0.110)	(0.127)	(0.127)	(0.113)	(0.129)	(0.176)	(0.131)	(0.120)	(0.130)	(0.149)	(0.133)	(0.123)				
Implied% Δ in C	−21.6%	−6.7%	−16.2%	−25.5%	−28.7%	−12.1%	−23.5%	−32.4%	−31.9%	−4.8%	−24.2%	−32.9%	−47.1%	−13.4%	−33.0%	−46.1%
Implied Δ in annual C	−1309	−423	−1913	−6013	−1736	−762	−2785	−7644	−1935	−305	−2857	−7768	−2855	−843	−3900	−10878
Demographic vars.?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects?	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Earnings spline?	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
R-squared	0.070	0.095	0.126	0.113	0.209	0.248	0.270	0.233	0.228	0.291	0.283	0.237	0.255	0.307	0.294	0.252

Notes: All regressions include 372 observations (except for the housing regressions, which include only those 280 observations with non-zero housing consumption), and a full set of year effects. Values are converted into 2002 dollars using the appropriate component of the CPI-U. Consumption data, WC benefits, and wages all measured weekly. Demographic controls include age, education, race, and gender. Individuals in states with fewer than 4 observations are excluded. Regressions are weighted by HRS sampling weights, and standard errors (in parentheses) are corrected for clustering at the state level.

* $p<0.1$.
** $p<0.05$.
*** $p<0.01$.

expenditures. Once state fixed effects are included, identification of the model comes from changes in state WC laws over time, nonlinearities in benefit formulas, and individual benefit variation within states. Next, in model 3 I address the concern that WC benefit generosity may be correlated with consumption opportunities in a particular state and year by including state-year unemployment rates and a state-year housing price index (constructed from the Freddie Mac Conventional Mortgage Home Price Index).

Finally, recall that the level of WC benefits for which an individual is eligible is a direct function of his average weekly wage in the previous (i.e., pre-injury) period. Bronchetti and McInerney (2012) show that the empirical relationship between WC receipt and cash benefit levels depends crucially on the extent to which one controls for the influence of past wages. Similarly, conditioning more flexibly on past wages may also be important for unbiased estimation of the relationship between WC benefits and changes in household consumption upon injury. Model 4 flexibly controls for the influence of past wages with a 4-piece linear spline in pre-injury weekly wages.

5. Results

5.1. Consumption-smoothing effects of WC

Results from regressions of the reduced-form models given by Eq. (1) are presented in Table 3. For each model, the first two columns report results of the regressions which use as dependent variables the change in household food consumption and the change in housing consumption; the third column reports results for the change in their sum, and the final column presents the change in (imputed) total household consumption. Model 1 is a simple regression, wherein consumption changes are regressed upon the individual's (log) pre-injury weekly wage, his/her (log) potential weekly WC benefit, a vector of personal characteristics, and a set of year dummies. Model 2 adds state fixed effects, model 3 adds state-year economic controls, and model 4 includes a linear spline in past weekly earnings.

Irrespective of the model or dependent variable, the estimated coefficient on the WC benefit variable is positive, representing a consumption-smoothing effect of WC. For the simple model without state fixed effects, the estimate is statistically different from zero for food consumption and for the imputed measure of total consumption. The estimate of 0.250 indicates that a 10% increase in WC benefit eligibility is associated with a 2.50% smaller drop in total household consumption upon incurring a job-related disability. This smoothing effect seems to be driven mostly by a positive impact of WC benefits on the change in food consumption.

Adding state fixed effects in model 2 leads to a larger and more significant consumption-smoothing effect of WC for all measures of consumption expenditures. For a 10% increase in the potential WC benefit entitlement, the drop in food consumption is offset by 2.83%, the change in food plus housing consumption by 2.72%, and the change in total consumption by 3.32%. The estimated effect for housing consumption is also larger in magnitude, although the coefficient still is not statistically significant.[21]

Including state-year economic controls in model 3 increases the parameters of interest slightly, with the exception of reducing the estimated effect on housing consumption. The negative coefficient on the state–year unemployment rate suggests larger consumption drops for injured workers in state-years with higher unemployment.

When I flexibly condition on past wages with a 4-piece linear earnings spline in model 4, the estimated consumption-smoothing effects of WC benefits are larger. A 10% increase in benefit eligibility now offsets the loss in food consumption by 5.15%, the decrease in food plus housing consumption by 3.93%, and the decline in total household consumption by 5.07%.

A back-of-the-envelope calculation estimates the effect of WC recipiency on household consumption (i.e., the average effect of the treatment on the treated, or ATT) by dividing the estimates in Table 3 by the share of injured workers who participate in WC. Using the Biddle and Roberts (2003) finding that approximately 40% of eligible workers claim WC, my estimates suggest much larger consumption-smoothing effects of WC for the subpopulation of injured workers who receive WC. The estimates in model 3, for example, suggest that a 10% increase in benefits offsets the drop in total household consumption of WC recipients by about 8.5%.[22]

Table 3 also displays the predicted changes in annual consumption if WC benefits were very low, equal to the 10th percentile of their current distribution in an individual's state.[23] Under model 3, which includes state fixed effects and state–year economic controls, the predicted drop in food consumption is \$1935 (32%), and the drop in total household consumption is \$7800 (33%). The results from model 4 suggest even larger drops in household consumption at low benefits: The predicted drop in total annual consumption is now over 40%. Of course, the implied declines in consumption represent more than a loss in material well-being for the injured worker; they also indicate a sizeable loss of consumption for the other members of his household. Thus, WC appears to be providing meaningful social insurance benefits for injured workers *and* their families.

5.2. Robustness checks and extensions

5.2.1. Consumption-smoothing effects of WC for households with limited assets

The consumption-smoothing provided by WC will depend on the degree to which workers are able to self-insure against lost earnings from a work-related injury. All else equal, the consumption-smoothing benefits of WC should be larger for households without substantial wealth upon which to draw when an injury occurs. Zeldes (1989) shows that borrowing constraints are important determinants of consumption behavior, and Browning and Crossley (2008) find that the consumption-smoothing effects of Canadian unemployment benefits are concentrated among those without liquid assets at the time of job separation.

The top panel of Table 4 displays reduced-form estimates from regressions of Eq. (1), for the subsamples with "net liquid assets" below the median and above the median (\$20,000 in 2002 dollars).[24]

[21] That the inclusion of state fixed effects increases the consumption-smoothing estimates indicates an omitted variables bias in the first model. In other words, WC benefits are more generous in states in which the adverse effect of injury on household consumption is larger. Some possibilities are that the fixed effects are picking up the industrial/occupational composition of the state, the types of injuries that occur in the state, or the share of WC claims that are successful. However, including thirteen industry and nine occupation dummies in model 1 does not change the results noticeably, nor does controlling for the state share of injuries resulting from accidents or the share of injured workers in the state who receive WC. Another possible explanation, given the small sample size, is that a few observations are exerting undue influence on the results, and state fixed effects are picking up the influence of these outliers. But median regressions for the pooled sample (i.e., model 1) yield results very similar to the model 1 estimates in Table **3**.

[22] Note that this is not the same parameter as would usually be estimated by 2SLS (see, e.g., Gruber (2000)). That is, it does not give an estimate of the effect of the *amount of WC benefits received* on household consumption. One could obtain that estimate by regressing the amount of WC benefits received on WC benefit entitlements and then dividing the Table 3 estimates by this coefficient. However, I am unable to do so due to missing data problems as well as the timing of the WC income questions in the HRS.

[23] The 10th-percentile benefit level was calculated using the larger sample of all workers injured in the HRS between 1994 and 2008, not just those with non-missing consumption data.

[24] The HRS provides detailed information on financial resources available to households, including information on the net value of relatively liquid assets, like resalable vehicles, stocks, bonds, IRA accounts, certificates of deposit, checking accounts, and other savings. The survey also contains a measure of other outstanding debt for these households (e.g., credit card balances, medical debts, etc.). I refer to "net liquid assets" as the difference between the summed value of assets listed above and the value of other outstanding debt.

Table 4
Consumption-smoothing benefits of WC — extensions and specifications checks.

Consumption-smoothing benefits of WC for households with low and high assets

Variable	Assets ≤ median[a]		Assets > median[a]	
	Food	Total cons. (Sk-FJ)	Food	Total cons. (Sk-FJ)
Log potential weekly WC benefit	0.438*	0.645*	0.260	0.117
	(0.252)	(0.318)	(0.246)	(0.139)
Log after-tax weekly wage	0.385*	−0.604	−0.236	−0.080
	(0.215)	(0.277)	(0.241)	(0.123)
Implied% Δ in C	−35.6%	−54.8%	−30.0%	−7.9%
Implied Δ in annual C	−2021	−10874	−1935	−2170
Share receiving maximum WC benefit	0.123	0.123	0.258	0.258
N	186	186	186	186

Potential correlation between UI and WC benefits[b]

Variable	Model 3 with control for individual UI entitlement							
	Injured workers[c]				Displaced workers[d]			
	Food	Total cons. (Sk-FJ)	Food	Total cons. (Sk-FJ)	Food	Total cons. (Sk-FJ)	Food	Total cons. (Sk-FJ)
Log potential weekly WC benefit	0.323**	0337**	0.348**	0.308**	−0.047	−0.009	−0.174	−0.143
	(0.143)	(0.132)	(0.154)	(0.137)	(0.233)	(0.200)	(0.254)	(0.226)
Log potential weekly UI benefit			−0.036	0.041			0.294***	0.297**
			(0.076)	(0.078)			(0.101)	(0.107)
Implied% Δ in C	−32.5%	−33.0%	−34.5%	−30.6%	−2.6%	−5.7%	5.7%	2.9%
Implied Δ in annual C	−1975	−7865	−2091	−7237	−154	−1486	343	756
N	364	364	364	364	486	486	486	486

Probit for sample selection

	HRS sample[e]		CPS sample[e]	
	Coef.	Marg. effect	Coef.	Marg. effect
Log potential weekly WC benefit	0.0729	0.0033	0.1042	0.0023
	(0.0828)	(0.0038)	(0.0799)	(0.0018)
N	12,962		39,629	

Notes: Regressions include the same controls as model 3 in Table 3. Values are converted into 2002 dollars using the appropriate component of the CPI-U. Consumption data are measured weekly to be consistent with WC benefits. Standard errors are corrected for clustering at the state level.

[a] The median level of liquid household assets is $20,000 (in 2002 dollars).

[b] The correlation between max UI benefits and max WC benefits in 2008 was 0.42.

[c] The UI benefit calculation program does not compute benefits for a few small states, which results in a slightly smaller sample of injured workers than in Table 3.

[d] Displaced workers are employed in period $t-1$ but report they are "unemployed and looking for work" or "temporarily laid off, (on) sick or other leave" in period t. I exclude those with a new work-limiting disability or health problem in period t.

[e] Probit models contain the same controls as in model 4 of Table 3. Dependent variable in HRS is an indicator for becoming injured between $t-1$ and t; in CPS it is an indicator for beginning participation in WC between $t-1$ and t. Both samples condition on employment in $t-1$. For comparability, both samples cover 1992–2002.

* $p<0.10$.
** $p<0.05$.
*** $p<0.01$.

Indeed, the results indicate a larger effect of WC benefits for households with low pre-injury assets. A 10% increase in potential WC benefits offsets the drop in household food expenditures by 4.4% for those with assets below the median and offsets the drop in total consumption by 6.5%. For those with assets above the median, the same increase in benefits offsets the drop in food consumption by only 2.6% and raises the change in total consumption by only 1.2%. While I emphasize the results for food and total consumption here, this finding – of larger consumption-smoothing benefits of WC for low-asset households – is also upheld for the other measures of household consumption presented in Table 3.

In the pooled regressions (Table 3), the coefficient on lagged weekly earnings is negative and statistically significant, representing a violation of the Euler equation. Zeldes (1989) shows that if borrowing constraints are important in explaining departures from perfect consumption smoothing by households, the Euler equation will be violated for groups facing binding liquidity constraints but satisfied for those with greater wealth. Indeed, when I split my sample of injured workers into those with low pre-injury assets and those with higher pre-injury wealth (Table 4), the coefficient on pre-injury wages is statistically significant for the low-asset group but is not statistically different from zero for those with liquid assets higher than the median. This result supports the view that liquidity constraints influence the consumption of many households affected by workplace injuries.

5.2.2. Correlation with unemployment insurance and other state programs

If legislated WC benefits are highly correlated with the generosity of other state-level programs, using WC benefit entitlements (rather than WC receipt) as the key independent variable may be problematic. For example, injured workers could be receiving both WC and UI benefits (or worse, just UI), and my regressions may be attributing some of the consumption-smoothing effects of other state-level programs to WC. Indeed, Table 2 indicates that injured workers are more likely to receive transfer income from UI, welfare, and SSI than the non-injured HRS samples.

A few checks help to alleviate this concern. First, the correlation between benefit levels for different state-level programs is not as high as one might expect. For example, the correlation between states' maximum weekly UI benefits and maximum WC benefits in 2008 is 0.43. Similarly, the correlation between states' TANF benefits (for a 3-person family) and WC maximum benefits is 0.45, while the correlation between the generosity of state-level SSI and WC programs is 0.25.

In the middle panel of Table 4, I expand my key regressions to include a control for the individual's weekly UI benefit entitlement, based on state–year UI laws and information from the HRS about his earnings, employment, and dependents. For the sample of injured workers, this addition has no noticeable effect on the WC consumption-smoothing estimates, and the coefficient on the (log) UI benefit is not statistically significant.

A related check is to run my consumption-smoothing regressions for a sample that should *not* demonstrate a consumption response to WC. One would expect the coefficient on the WC benefit variable for this comparison group to be close to zero if the estimates above in Table 3 reflect consumption-smoothing effects of WC. Workers experiencing job displacement between $t-1$ and t are an appropriate comparison group. While they should be ineligible for WC benefits, they have similar characteristics to workers injured on the job and on average, having falling consumption between $t-1$ and t (see Table 2). The regression results for displaced workers are also displayed in the second panel of Table 4. The estimated WC effect is not statistically significant, but the coefficient on the (log) weekly UI benefit is strongly positive and of similar magnitude to my main results for WC.

5.2.3. Sensitivity of results to selection bias

Estimates of β_1 may be biased if increased generosity of WC benefits causes more workers to experience a workplace injury (e.g., through reduced effort devoted to workplace safety, as in Krueger, 1990), and if those marginal workers who are induced by a change in benefits to become injured have systematically different consumption preferences that are not controlled for in my model.

The literature on incentive effects in WC provides mixed evidence on the size of this effect. Several papers find a positive relationship between WC benefits and non-fatal injury rates or WC participation.[25] The estimated elasticities from these studies, which differ widely in terms of data and methodologies, range from non-significant to 0.7. Bronchetti and McInerney (2012) find zero effect of WC benefits on WC receipt after controlling flexibly for the confounding influence of wages on both benefits and WC claiming. But none of these papers directly examines the responsiveness of injury rates to WC benefits for the years of interest or for older workers like those in my sample.

Therefore, the bottom panel of Table 4 presents estimates from a simple probit model of the effect of WC benefit levels on the likelihood of becoming injured/ill on the job for a sample of HRS respondents. I also estimate a similar probit for a larger sample of workers ages 45–65 in the Current Population Survey (CPS). Here the dependent variable is an indicator for *receiving WC* in year t, conditional on not receiving WC in year $t-1$.

The HRS estimates indicate that a *doubling* of current WC benefit levels would raise the probability of a work-related injury by 0.229 percentage points, and the corresponding probit coefficient on the benefit variable is not statistically different from zero.[26] Similarly, the results for the CPS sample indicate no significant effect of WC benefits on the likelihood of participation in the program (and a doubling of WC benefits only increases the probability of WC receipt by 0.156 percentage points). Taken together, these results suggest that sample selection is not likely to be an important source of bias to my estimates.[27]

6. Optimal WC benefits

Estimates of the consumption-smoothing effects of WC should be of concern to policy makers because they reflect the benefits of a social insurance program designed to support workers facing economic hardship brought on by a workplace injury or illness. However, their substantive meaning can only be determined by weighing them against the distortionary effects of WC on individual behavior. The public finance literature provides a starting point for analyzing the social welfare implications of varying the generosity of WC benefits. A classic paper by Baily (1978) derives a formula for optimal UI benefits that involves three empirically estimable parameters: the change in household consumption upon unemployment (as a function of UI benefits), the coefficient of relative risk aversion, and the elasticity of unemployment duration with respect to benefits. In short, the formula balances the costs of work disincentives from increased benefits with the welfare gains from smoother consumption.

Chetty (2006) shows that Baily's result depends on an assumption that third and higher-order terms of the utility function are ignorable (i.e., individuals have no precautionary savings motives), and he provides a formula for optimal level of UI benefits when this assumption is relaxed. Chetty also demonstrates that a Baily-type expression for optimal benefits holds in a more general dynamic framework in which workers face a persistent risk of unemployment, and is robust to the inclusion of leisure value of unemployment, borrowing constraints, private insurance decisions, and other extensions of Baily's model.

6.1. Applying the model for optimal benefits

The models can be adapted to the case of work-related injuries and illnesses. To emphasize the intuition of the resulting formula for optimal WC benefits, I apply a simple and illustrative model motivated by Chetty (2006).

In this one-period model, a worker faces risk of on-the-job injury only at the beginning of the period, and then lives until the end of the period. He arrives at the beginning of the period having accumulated wealth equal to W_0.With probability p, he incurs an on-the-job injury, making him temporarily unable to work, and then receives WC benefits, b, for the duration of time he spends away from work.[28] With probability $(1-p)$, he incurs no injury and continues to work at his job that pays wage w, with no further risk of job loss or injury, for the remainder of his life. I assume that the probability of injury (and thus, of benefit receipt), p, is exogenous with respect to the level of WC benefits.[29]

In the employed and uninjured state, he pays a lump-sum tax of τ, which finances WC. In reality, if a worker is injured on the job, there is an exogenous component to the duration of his injury in the time necessary for him to recuperate; however, beyond that time, he may extend the duration of time out of work by devoting less effort to rehabilitation or exaggerating the seriousness of his injury. For now, assume that the duration of time out of work due to an injury can be fully determined by the worker.[30] Let $D(b)$, denoted D

[25] See, e.g., Chelius (1982) and Ruser (1985, 1991) on injury rates and Krueger (1990), Hirsch et al. (1997), and Neuhauser and Raphael (2004) on WC claims.

[26] Using the HRS probit results, a doubling of weekly WC benefit levels (or a 0.693 increase in the natural log of the weekly benefit) implies an increase in the probability of WC receipt equal to $0.693\times100\times0.0033=0.229$ percentage-point increase. That is, the probability of being injured on the job between two HRS waves would rise from the current mean of 1.75 to 1.98.

[27] While Meyer et al. (2009) provide convincing evidence that WC income is under-reported in surveys, this should only impact the probit estimates in Table 4 to the extent that under-reporting is systematically related to the WC benefit entitlement. That is, if under-reporting is random with respect to benefit entitlements, then the probit estimates should not be subject to bias from under-reporting. If the two are systematically related, then an adjustment would be appropriate but would be based on empirical estimates of the relationship between under-reporting behavior and WC benefit generosity, which are not available.

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

[29] This assumption is supported by some of the evidence in the literature: Bronchetti and McInerney (2012), for example, find that the reduced-form effect of WC benefit generosity on the number of WC claims is essentially zero when one controls for the confounding influence of past earnings on both benefits and claims decisions. Bartel and Thomas (1985) and Guo and Burton (2010) also find the effect of variation in benefit generosity on the number of WC claims to be statistically insignificant.

[30] Allowing for a stochastic component to injury duration introduces further uncertainty. If the stochastic and deterministic parts of D enter additively, the optimal benefits formula can be written as in Eq. (4), but requires a positive correction factor that augments the consumption drop upon injury.

below, be the fraction of the period the worker spends away from work due to his injury, which is a function of the benefits available to him. By definition, D is weakly positive.

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

Applying the model from Chetty (2006) in this way, the individual takes b and τ as given and chooses consumption if employed, c_e, consumption if injured, c_i, and D, to

$$\max(1-p)U(c_e)+p[U(c_i)+g(D)] \tag{2}$$

subject to a budget constraint in each state[31]:

$$W_0+(w-\tau)-c_e \geq 0$$
$$W_0+bD+w(1-D)-c_i \geq 0.$$

Let $V(b,\tau)$ denote the maximal value of Eq. (2) for a given level of WC benefits, b, and taxes, τ. The social planner's choice of the optimal levels of WC benefits and taxes, (b,τ), is subject to a balanced-budget constraint for the WC system so that $pbD=(1-p)\tau$. As shown in Chetty (2006), the optimality condition ($\frac{dV}{db}(b^*)=0$) can be expressed as

$$U'(c_e)\left[1+\frac{b}{D}\frac{dD}{db}\right]=U'(c_i) \tag{3}$$

which requires that the marginal benefit of raising c_i by $1 (the right hand side) equal the marginal cost of raising τ when employed to cover the $1 increase in b.

6.2. A formula for optimal benefits

The key technique to turn this optimality condition into an approximate formula for the optimal benefit rate involves rearranging and approximating $\frac{U'(c_i)-U'(c_e)}{U'(c_e)}$ by taking a Taylor series expansion around the average worker's utility at the consumption level in the employed state. If third and higher-order terms of $U(\cdot)$ are ignored, the condition for optimal WC benefits can be expressed as:

$$\gamma\frac{c}{c}(b^*)\approx\varepsilon_{D,b} \tag{4}$$

where $\frac{c}{c}=\frac{c_e-c_i}{c_e}$ is the consumption drop due to a work-related injury, $\gamma=-c\frac{U''(c)}{U'(c)}$ is the coefficient of relative risk aversion, and $\varepsilon_{D,b}=\frac{d\log D}{d\log b}$ is the elasticity of expected injury duration with respect to benefits.

This formula is analogous to that derived in Baily (1978) and is intuitively simple. The optimal benefit, b^*, balances the welfare gains of a marginal increase in benefits in terms of smoother consumption for households affected by workplace injury risk, the magnitude of which will depend on the degree of risk aversion, against the social welfare costs of a marginal benefit increase in terms of increased time away from work.

Chetty (2006) finds that ignoring third-order terms of the utility function when taking the Taylor series expansion described above can lead to substantial approximation error when calculating b^*. Relaxing this assumption gives the formula for optimal WC benefits:

$$\gamma\frac{c}{c}(b^*)\left[1+\frac{1}{2}\rho\frac{c}{c}(b^*)\right]\approx\varepsilon_{D,b} \tag{5}$$

where the additional term, $\rho=-c\frac{U'''(c)}{U''(c)}$, is the coefficient of relative prudence.

Moreover, Chetty (2006) demonstrates that this formula can also be applied in a continuous-time, dynamic lifetime utility model in which workers face a persistent risk of becoming injured and is robust to the inclusion of several extensions to Baily's model. In short, the formula for the optimal benefit level applies in a much more general setting than was previously thought; b^* still depends only on the key parameters in (Baily, 1978).

6.3. Calculating optimal WC benefits

The formulas in Eqs. (4) and (5) can be implemented using empirical estimates of their key inputs to calculate the optimal level of WC cash benefits. First, consider the parameter $\varepsilon_{D,b}$, which, in the general case, is the effect of a 1% increase in benefits on the fraction of his life that the agent spends out of work due to work-related injury/illness. If the frequency of workplace injuries is not affected by b, then $\varepsilon_{D,b}$ is equivalent to the elasticity of average injury/claim duration with respect to benefits. In the exercise below, I consider multiple values for $\varepsilon_{D,b}$, incorporating estimates of the duration elasticity from the literature (see Krueger and Meyer (2002)) to compute optimal benefits.[32]

This paper provides the first empirical estimates of the extent of consumption smoothing provided by WC benefits (i.e., the parameter $\frac{\bar{c}}{c}(b)$). In calculating the optimal level of WC benefits, I use two different estimates of the effect of benefits on the change in total household consumption: the reduced-form consumption-smoothing estimate from model 3 (0.340), which includes state fixed effects and state-year economic controls, and the larger estimate of the consumption-smoothing effect from model 4 (0.507).[33]

Table 5 presents the results of optimal benefit calculations. In either panel, the first column considers a "base case," in which the elasticity of time out of work with respect to benefits equals 0.3, which is consistent with the estimated effect of benefit variation on the duration of claims from Meyer et al. (1995). Applying my estimate of the impact of benefit generosity on total household consumption changes from model 3 to the Baily formula in Eq. (4), I find that the optimal benefit–wage ratio ranges from 0.143 (at a very low levels of risk aversion) to 0.619 at the highest level of risk aversion considered ($\gamma=5.0$).

[31] The utility function, $U(\cdot)$, is assumed to be strictly concave and state-independent, implying that an individual values a given level of c equally, regardless of whether he is employed or away from work due to injury. An additional implicit assumption is that the utility functions of workers who become injured take the same form as for workers who never become injured. Finally, note that to guarantee an interior solution $g(D)$ must be sufficiently concave (or $g'(D)$ must be sufficiently high at low levels of D).

[32] Note also that the parameter $\varepsilon_{D,b}$ involves the total derivative of $D(\cdot)$ with respect to b, which would include any effects of b on other behaviors that feed back into the choice of D. Fortunately, reduced-form studies like those reviewed in Krueger and Meyer (2002) identify this parameter. The same applies for the parameter $\frac{\bar{c}}{c}(b)$ and the reduced-form estimates in this paper.

[33] To be clear, it is important to note that in applying the optimal benefit formulas, $\frac{\bar{c}}{c}(b)\approx-\log C$, where $\Delta\log C$ is a function of the *replacement rate* of benefits to pre-injury wages. Instead, my estimates from model 3, for example, imply that $\log C=-0.372+.340\log(BEN)$. (The reduced-form regression results from model 3 imply that in the absence of WC benefits, the average decline in (log) total household consumption is 37.2%.) Dividing the coefficient on the benefit variable (0.340) by the mean replacement rate for my sample (0.675) allows me to calculate the optimal replacement rate, R, from $\log(C)=-0.372+0.5037R$.

Table 5
Optimal workers' compensation benefit calculations.

Coeff. of relative risk aversion	Optimal benefits from Baily (1978)[a]				Optimal benefits from Chetty (2006)[a]
	Base case ($\varepsilon_{D,b}=0.3$)	Case 2 ($\varepsilon_{D,b}=0.4$)	Case 3 ($\varepsilon_{D,b}=0.7$)	Case 4 ($\varepsilon_{D,b}=1.0$)	Base case ($\varepsilon_{D,b}=0.3$)
(Optimal benefit level calculated using regression results from model 3)					
1.0	0.143	0	0	0	0.259
1.5	0.314	0.209	0	0	0.410
2.0	0.441	0.341	0.004	0	0.488
2.5	0.500	0.421	0.183	0	0.536
3.0	0.540	0.474	0.233	0.077	0.569
3.5	0.568	0.512	0.341	0.171	0.593
4.0	0.590	0.540	0.391	0.242	0.610
4.5	0.606	0.562	0.430	0.297	0.624
5.0	0.619	0.580	0.461	0.314	0.635
(Optimal benefit level calculated using regression results from model 4)					
1.0	0.313	0.180	0.000	0.000	0.391
1.5	0.446	0.357	0.091	0.000	0.492
2.0	0.513	0.446	0.246	0.047	0.544
2.5	0.553	0.499	0.340	0.180	0.577
3.0	0.579	0.535	0.402	0.268	0.599
3.5	0.598	0.560	0.446	0.332	0.614
4.0	0.612	0.579	0.479	0.379	0.626
4.5	0.624	0.594	0.505	0.416	0.636
5.0	0.632	0.606	0.526	0.446	0.643

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

Using my estimate from model 4 and the formula in Eq. (4), the optimal rate of wage replacement is higher for every level of risk aversion, topping out at about 63.2%. The last column of each panel examines the optimal benefit–wage replacement rate for this base case (where $\varepsilon_{D,b}=0.3$), applying instead the more general optimal benefits formula in Eq. (5), from Chetty (2006). For all levels of risk aversion, optimal benefits are more generous under this formula. However, for this relatively small estimate of the labor supply effects of WC, the optimal benefit is generally less than the mean for my sample (0.675), and only approaches the current level for very high levels of risk aversion.

The next three columns in each panel calculate optimal benefit levels from Eq. (4) when $\varepsilon_{D,b}$ ranges from 0.4 to 1.0.[34] Larger estimates of $\varepsilon_{D,b}$ are associated with lower optimal rates of wage replacement. For example, with $\varepsilon_{D,b}$ equal to 0.7, the optimal rate of wage-replacement is positive only for higher levels of risk aversion, and even at $\gamma=5.0$, optimal benefits only replace about half of pre-injury after-tax wages.

7. Conclusions

This study provides the first evidence on the adverse effects of work-related injuries and illnesses on household consumption and the extent to which WC benefits help to mitigate those effects. I have shown that WC cash benefits provide significant consumption smoothing to affected households. A 10% increase in benefit generosity is found to offset the drop in household consumption upon injury by about 3 to 5%. Moreover, my results suggest that if WC benefits were at very low (but empirically relevant) levels, the decline in household consumption upon incurring a work-related injury would be approximately 30%.

My findings also indicate larger consumption-smoothing benefits of WC for households with limited pre-injury assets. This finding is consistent with evidence from the literature on consumption-smoothing provided by UI (see, for example, Browning and Crossley, 2008) and complements research on moral hazard and income effects in UI (e.g., Chetty, 2008) and health insurance (Nyman, 2003). These results also suggest that borrowing constraints are an important determinant of consumption behavior for many households impacted by work-related injuries and illnesses (as in Zeldes (1989)).

Despite the finding of a considerable consumption-smoothing role for WC, this paper also demonstrates that current benefit levels are somewhat higher than optimal. Even for the most optimistic of my estimates of the consumption-smoothing effects and small estimates of the distortionary effects of WC on the duration of WC claims, the optimal benefit–wage replacement rate is generally lower than the mean replacement ratio for my sample of injured workers (67.5%). In fact, the optimal rate of wage replacement approaches two thirds only for very high degrees of risk aversion. The model also assumes that variation in benefits does not impact the frequency of workplace injuries; allowing for a positive relationship between benefits and injury rates would yield an even lower optimal benefit. In essence, the distortionary effects of WC on individual labor supply behavior are large enough to outweigh the substantial consumption-smoothing effects of the benefits for injured workers.

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

It is important to recognize that my analysis only studies the optimal rate of wage-replacement for the cash benefits provided by WC. Of course, these programs provide other valuable benefits to injured workers, namely, the coverage of medical and rehabilitation costs associated with the injury. A comprehensive cost–benefit analysis of the entire WC system is outside the scope of this paper, but my results certainly do not imply that coverage of medical costs by WC should be reduced.

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

[34] An elasticity of 0.4 is consistent with larger estimates from Meyer et al. (1995) or from Butler and Worrall (1985). Krueger (1991) estimates a duration elasticity greater than 1.0.

Appendix A

Appendix Table 1
Consumption-smoothing benefits of WC benefits for injured workers in all states (results from reduced-form regressions of Eq. (1); standard errors in parenthesis).

Variable	Model 1				Model 2				Model 3				Model 4			
	Food	Housing	Food + housing	Total cons. (SK-FJ)	Food	Housing	Food + housing	Total cons. (SK-FJ)	Food	Housing	Food + housing	Total cons. (SK-FJ)	Food	Housing	Food + housing	Total cons. (SK-FJ)
Log potential WC benefit	0.172	0.058	0.187	0.248**	0.254*	0.156	0.272**	0.335***	0.291**	0.082	0.280**	0.337***	0.514***	0.190	0.412***	0.529***
	(0.104)	(0.128)	(0.116)	(0.101)	(0.136)	(0.188)	(0.132)	(0.110)	(0.138)	(0.159)	(0.134)	(0.114)	(0.149)	(0.176)	(0.111)	(0.150)
Household size $t-1$	−0.006	0.033	−0.005	−0.009	−0.005	0.049	−0.010	−0.005	−0.003	0.053*	−0.004	−0.002	−0.007	0.052	−0.009	−0.004
	(0.030)	(0.025)	(0.020)	(0.023)	(0.028)	(0.031)	(0.022)	(0.024)	(0.029)	(0.031)	(0.021)	(0.023)	(0.026)	(0.031)	(0.021)	(0.022)
Change in hh size	0.081**	0.062**	0.087**	0.115**	0.131***	0.096***	0.136***	0.171***	0.140***	0.089**	0.141***	0.172***	0.148***	0.090***	0.142***	0.180***
	(0.037)	(0.026)	(0.036)	(0.047)	(0.029)	(0.035)	(0.037)	(0.052)	(0.029)	(0.034)	(0.039)	(0.051)	(0.028)	(0.033)	(0.039)	(0.049)
State–year housing price index									−0.002***	0.002**	−0.001	−0.001	−0.003***	0.002**	−0.001	−0.001
									(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
State–year unemp. rate									−0.022	−0.050	−0.074	−0.054	−0.016	−0.048	−0.068	−0.049
									(0.041)	(0.044)	(0.056)	(0.053)	(0.040)	(0.042)	(0.053)	(0.052)
Log after-tax wage in $t-1$	−0.192*	−0.026	−0.206*	−0.263**	−0.251*	−0.120	−0.259*	−0.320***	−0.280**	−0.061	−0.269*	−0.323***				
	(0.099)	(0.117)	(0.116)	(0.104)	(0.125)	(0.174)	(0.131)	(0.107)	(0.127)	(0.148)	(0.133)	(0.110)				
Implied % Δ in C	−17.2%	−3.2%	−15.1%	−23.5%	−24.6%	−11.4%	−22.2%	−30.8%	−27.5%	−4.6%	−22.5%	−30.8%	−44.5%	−13.5%	−32.7%	−45.4%
Implied Δ in annual C	−1040	−204	−1790	−5563	−1483	−721	−2628	−7276	−1659	−293	−2662	−7277	−2683	−857	−3880	−10724
Demographic vars.?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects?	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Earnings spline?	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
R-squared	0.059	0.089	0.104	0.097	0.234	0.252	0.275	0.243	0.253	0.293	0.283	0.246	0.282	0.310	0.297	0.263

Notes: All regressions include 387 observations (except for the housing regressions, which include only those 292 observations with non-zero housing consumption), and a full set of year effects. Values are converted into 2002 dollars using the appropriate component of the CPI-U. Consumption data, WC benefits, and wages all measured weekly. Demographic controls include age, education, race, and gender. Regressions are weighted by HRS sampling weights, and standard errors (in parentheses) are corrected for clustering at the state level.

* $p<0.1$.

** $p<0.05$.

*** $p<0.01$.

Appendix Table 2
Consumption-smoothing benefits of WC under alternative specifications (results from reduced-form regressions of Eq. (1); standard errors in parentheses).

	(A)	(B)	(C)	(D)
Panel A				
Dependent variable: change in (log) total imputed consumption				
Log potential WC benefit	0.268**	0.250**	0.332**	0.340**
	(0.127)	(0.111)	(0.124)	(0.128)
Log after-tax wage in $t-1$	−0.271**	−0.268**	−0.319**	−0.328**
	(0.132)	(0.113)	(0.120)	(0.123)
Panel B				
Dependent variable: change in (log) total imputed consumption				
Log effective after-tax	0.272*	0.275**	0.314**	0.323**
replacement rate	(0.134)	(0.113)	(0.122)	(0.125)
Panel C				
Dependent variable: change in (log) total imputed consumption				
Level of effective after-tax	0.197	0.192	0.234*	0.238*
replacement rate	(0.122)	(0.119)	(0.125)	(0.126)
Panel D				
Dependent variable: change in the level of total imputed consumption (2002 $)				
Potential WC benefit (2002 $)	0.404***	0.469	0.653*	0.788*
	(0.408)	(0.379)	(0.357)	(0.396)
After-tax weekly wage in $t-1$	−0.109	−0.207	−0.213	−0.322
(2002 $)	(0.333)	(0.337)	(0.317)	(0.364)
Demographic controls?	No	Yes	Yes	Yes
State fixed effects?	No	No	Yes	Yes
State–year economic controls?	No	No	No	Yes
Earnings spline?	No	No	No	No

Notes: All regressions include 372 observations (except for the housing regressions, which include only those 280 observations with non-zero housing consumption), and a full set of year effects. Values are converted into 2002 dollars using the appropriate component of the CPI-U. Consumption data, WC benefits, and wages all measured weekly. Demographic controls include age, education, race, and gender. Individuals in states with fewer than 4 observations are excluded. Regressions are weighted by HRS sampling weights, and standard errors (in parentheses) are corrected for clustering at the state level.

* $p<0.1$.
** $p<0.05$.
*** $p<0.01$.

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