Indemnity Benefit Duration, Maximum Weekly Benefits, and Claim Attributes

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Abstract

Motivation. Pricing legislative changes is an integral part of NCCI ratemaking. An increase in the maximum weekly indemnity benefit for temporary total disability claims increases indemnity payments for given injury durations, but, at the same time, these injury durations may increase as well (among claimants affected by the benefit change), thus giving rise to an additional cost effect.

Method. The study makes use of a research framework developed by Krueger [13] (and subsequently employed in several studies) on the effect of changes in the maximum weekly benefit on injury duration. This research framework is a natural experiment, where the treatment effect is measured as the difference in the "post-reform minus pre-reform" differences between treatment and control groups. Two partial linear regression models (generalized additive regression and quantile regression) are used to validate the measured treatment effect. Further, quantile regression is applied to quantify the effect on injury duration of claim attributes such as age and gender.

Results. Using data sets provided by the Oregon Department of Consumer and Business Services and the New Mexico Workers' Compensation Administration, it is shown that an increase in the maximum weekly benefit of temporary total disability claims leads to a lengthening of the average benefit duration in the group of affected claimants. This increase in the utilization of indemnity benefits contributes to about 30 percent of the total cost impact of the reform.

Availability. Computing and bootstrapping the difference in the "post-reform minus pre-reform" differences between treatment and control groups is explained in detail and is straightforward to execute. The generalized additive model was implemented using the R package *mgcv*, which was developed by Simon Wood (http://cran.r-project.org/web/packages/mgcv/index.html). The partial linear quantile regression model was implemented using the R package *quantreg*, which was created by Roger Koenker (http://cran.r-project.org/web/packages/quantreg/index.html).

Keywords. Generalized Additive Model, Indemnity Utilization, Injury Duration, Legislative Reform, Quantile Regression.

1. INTRODUCTION

Pricing legislative reforms in workers compensation is an integral component of NCCI ratemaking. A possible manifestation of a legislative reform is an increase in the maximum weekly benefit for temporary total disability (TTD) claims, as has been observed in several U.S. states over the past decades. In a pioneering study, Krueger [13] quantified the impact of such a benefit change for Minnesota. The experimental research framework developed by this author was subsequently applied to analyzing increases in the maximum weekly benefit of TTD claims in Kentucky and Michigan (in 1980 and 1982, respectively; see Meyer, Viscusi, and Durbin [14], and Connecticut (1987; see Gardner [4]); further, Curington [3] employed this approach when quantifying the impact on Permanent Partial Disability (PPD) claims of legislative changes that occurred in New York between 1965 and 1978. In all instances, the researchers established evidence of an increase in utilization in response to an increase in benefits for the time of absence from work. At the same time, Curington [3] shows that an increase in PPD benefits that apply after the claimant returns to work (while benefits during work absence remain unaltered) shortens the time away from work among severely impaired claimants.

What follows is a study on the effects on injury duration of an increase in the maximum weekly benefit for TTD claims in Oregon and New Mexico. In Oregon, effective January 1, 2002, the maximum weekly benefit rose from 100 to 133 percent of the state average weekly wage. It is shown that this hike in the maximum weekly benefit increased total indemnity payments on TTD claims by 3.82 percent; 31 percent of this increase (or, equivalently, 1.17 percentage points) were due to a utilization increase (as caused by an expansion of the injury duration of TTD claimants whose weekly benefits increased due to the hike in the weekly maximum). In New Mexico, effective January 1, 2000, the weekly maximum benefit increased from 85 to 100 percent of the state average weekly wage. The accompanying increase in total indemnity payments on TTD claims amounted to 4.50 percent, 29 percent of which (or, equivalently, 1.30 percentage points) was due to a utilization increase. The duration/benefit elasticity (defined as the percentage change in benefit duration, divided by the percentage change in the maximum weekly benefit) equals 0.53 for Oregon and 0.43 for New Mexico. Because Oregon and New Mexico display similar elasticities and similar proportions of the cost effect of the utilization increase, only the Oregon findings are going to be discussed in detail. Further, the Oregon data are available in greater number and detail, thus allowing a more comprehensive statistical analysis.

For Oregon, the measured treatment effect is validated using a generalized additive regression model (GAM). Further, to get a more differentiated picture of the increase in benefit duration than a regression on the mean can offer, a partial linear quantile regression model is estimated. This quantile regression approach shows that the increase in injury duration in response to the legislative reform is mostly confined to short durations.

Finally, a partial linear quantile regression model is used to study the effect on benefit duration of age and gender. It is shown that the median injury duration is about log-linear in age within the age bracket 20 through 60; within this bracket, on average, benefit duration increases for every year of age by 1.0 percent for Oregon and 0.72 percent for New Mexico. Further, for Oregon, it is shown that among TTD claims with long durations, the durations of female claimants exceed those of male claimants by about 20 percent.

The generalized additive model was implemented using the R package *mgcv*, developed by Simon Wood of the University of Bath (England); the package is available for download at http://cran.r-project.org/web/packages/mgcv/index.html. The partial linear quantile regression model was implemented using the R package *quantreg*, developed by Roger Koenker from the University of Illinois at Urbana-Champaign; this package is available at http://cran.r-project.org/web/packages/quantreg/index.html. The statistical software platform R is a GNU project of the Free Software Foundation and is administered by the Technical University of Vienna, Austria.

1.1 Research Context

Studies on the impact of benefit changes on TTD claim durations can be divided into cross-sectional and event studies. In cross-sectional time series and pooled time series cross-sectional studies, differences in legislative provisions across states are modeled in attempts to gauge the impact of these differences on claimant behavior; examples of such studies are Butler and Worrall [2] and Worrall, Butler, Borba, and Durbin [16], and, for PPD claims, Johnson and Ondrich [8]; see also Brooks [1] and, most recently, Guo and Burton [6]. Krueger [13] expresses skepticism about the ability of cross-sectional studies to discern the influence of specific legislative provisions on claimant behavior—this is because of the multitude of cross-sectional variations at any given point in time. As an alternative to the cross-sectional research framework, Krueger [13] suggests using event studies. Instead of focusing on variations across states at a given point in time, event studies home in on variation over time in a given state—the event is defined by the legislative change. In order to isolate the impact of this event, a time window surrounding the reform has to be specified; also, the framework is available only if both a treatment group (claimants affected by the legislative change) and a control group (unaffected claimants) can be identified. If this condition is met, the time window creates a quasi-experimental setting in which the legislative reform can be studied as a natural experiment.

1.2 Objective

The objective of this study is twofold. First, the treatment effect is quantified, both in terms of its expected value and its probability distribution. This treatment effect is broken down into (1) an increase in payments due to the hike in the maximum weekly benefit at given durations and (2) an increase in payments due to lengthened injury durations of the claimants affected by the benefit change. The measured treatment effect is validated using generalized additive and quantile regression approaches. Second, a partial linear quantile regression model is applied to quantify for the post-reform period the effect on benefit duration of claim attributes such as age and gender.

1.3 Outline

What follows is a presentation of the experimental research framework proposed by Krueger [13]. Section 3 offers a description of the data, which is followed in Section 4 by a presentation of the findings for the treatment effect. Section 5 presents estimates of the treatment effect that are arrived at by means of generalized additive and, alternatively, quantile regression models. The quantile regression model of the effect on benefit duration of age and gender are displayed in Section 6. Section 7 concludes.

2. BACKGROUND AND METHODS

In a seminal study on the effects of an increase in the maximum weekly benefit for TTD claims in Minnesota in 1986, Krueger [13] suggested an experimental research framework where the impact of the benefit change on injury duration is measured as a treatment effect. The author identifies as the treatment group the claimants whose benefits were constrained by the legal weekly maximum both before and after the legislative reform—this group of claimants experiences an increase in weekly benefits equal to the stipulated increase in the maximum weekly benefit. As the control group, Krueger [14][13] chooses claimants whose benefits were unconstrained by the weekly maximum both before and after the reform; thus, the weekly benefits of the control group were unaltered by the reform. The treatment effect, which is defined as the increase in injury duration for the treatment group that is causal to the benefit change, is measured as the difference between the differences in post-reform and pre-reform durations of the treatment and the control groups. Conceptually, the difference between post-reform and pre-reform durations equals the treatment effect plus any change common to all claims; an example of such common effects may be changes in injury duration due to variations in economic activity (possibly related to the business cycle) or due to structural economic change (which may manifest itself in a time trend). In order to eliminate such common effects from the treatment group's difference between post-reform and pre-reform durations, the corresponding difference in duration for the control group is subtracted. The resulting difference in differences delivers the treatment effect.

Chart 1 illustrates the TTD benefit schedule for Oregon during the time window surrounding the benefit change; the legislative reform became effective on January 1, 2002. Up to a pre-injury weekly wage of $55.56, the weekly benefit equaled 90 percent of that weekly wage. For claimants with a pre-injury weekly wage in excess of $55.56 but not more than $75, the average weekly benefit equaled $50. Claimants with a pre-injury weekly wage in excess of $75 collected the maximum weekly benefit or two-thirds of the pre-injury weekly wage, whichever is lower; the reform raised the maximum weekly benefit from 100 percent of the official state average weekly wage (which was $645 at the time) to 133 percent. In Oregon, the official state average weekly wage becomes effective on July 1.

The increase in the maximum weekly benefit was not retroactive. This means that for a claimant who sustained an injury before January 1, 2002, the applicable maximum weekly benefit equals 100 percent of the state average weekly wage for the duration of the claim; increases in benefits are confined to the annual increase in the official state average weekly wage.

The treatment (T) group comprises all claimants whose benefits were constrained by the legal maximum both before and after the reform; that is, all claimants that had a pre-injury weekly wage of more than 1.5 times 133 percent of the state average weekly wage. The control (C) group consists of all claimants whose benefits were not altered by the reform (that is, whose pre-injury weekly wage was less than 150 percent of the state average weekly wage) and, at the same time, had a pre-injury weekly wage of more than $75. The treatment effect, which gauges for the treatment group the change in injury duration that is causal to the benefit change, is defined as "mean injury duration in post-reform treatment group minus mean injury duration in pre-reform treatment group" minus "mean injury duration in post-reform control group minus mean injury duration in pre-reform control group."

Chart 1: TTD Benefit Schedule on the Day the Legislative Reform Took Effect, Oregon

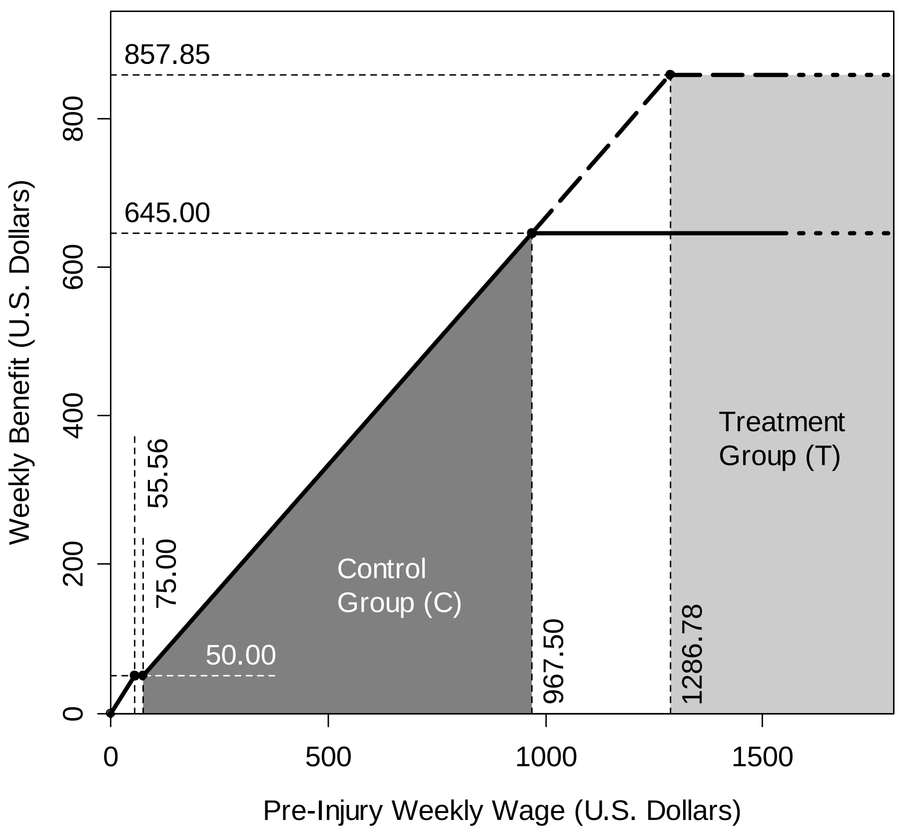
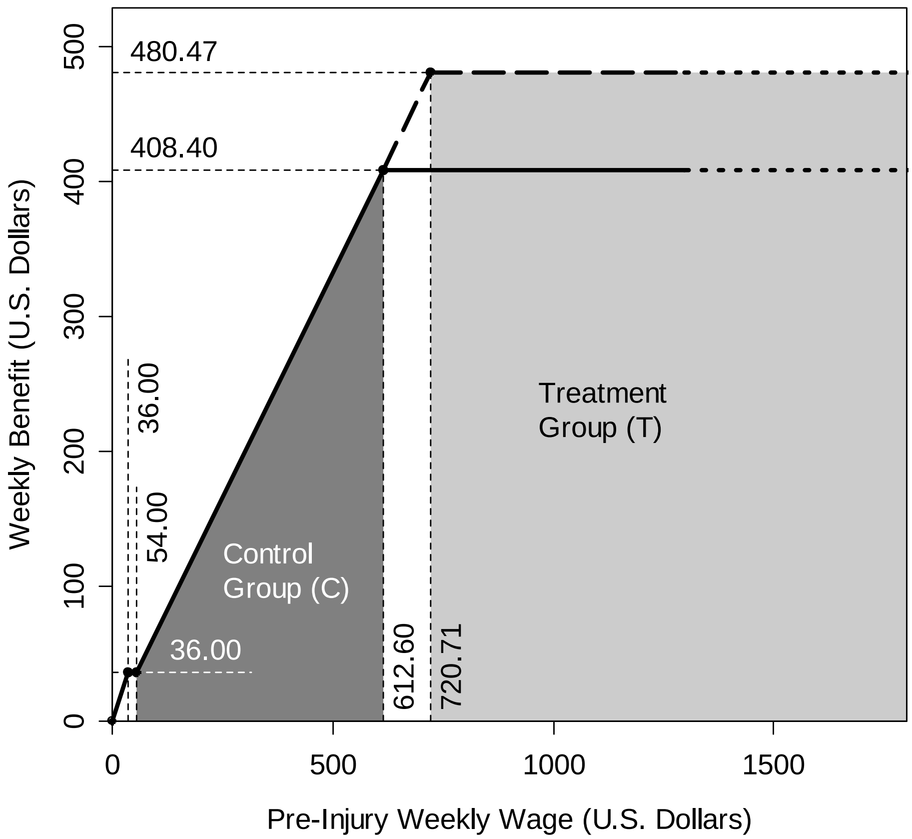


Chart 2 exhibits the TTD benefit schedule for New Mexico that was effective on the day of the legislative reform, which was January 1, 2000. On the same day, the official state average weekly wage experienced its annual adjustment. According to this schedule, up to a pre-injury weekly wage of $36, the weekly benefit equals 100 percent of that weekly wage. For claimants with a pre-injury weekly wage in excess of $36 but not more than $54, the average weekly benefit equals $36. Claimants with a pre-injury weekly wage in excess of $54 collect the minimum of the maximum weekly benefit and two-thirds of the pre-injury weekly wage. The reform raised the maximum weekly benefit from 85 percent of the state average weekly wage to 100 percent; this change in benefit level implied a maximum weekly benefit of $480.47 on the day the reform took effect, up from the $408.40 that would have applied otherwise. Similar to Oregon, the increase in the maximum weekly benefit in New Mexico was not retroactive.

Chart 2: TTD Benefit Schedule on the Day the Legislative Reform Took Effect, New Mexico



3. THE DATA

Claim records were supplied upon request by the Oregon Department of Consumer and Business Services and the New Mexico Workers' Compensation Administration. The next section offers a description of the Oregon data with a focus on data cleansing and descriptive statistics. This is followed by a brief section on the New Mexico data set.

3.1 The Oregon Data

The Oregon data set comprises all records pertaining to claims that collect lost-time benefits with injury dates between (and inclusive of) January 1, 1999 and December 31, 2004. This way, the data set provides for a 36-month pre-reform window that is followed by a 36-month post-reform window. The total number of records of award type TTD/TPD (which comprise TTD and Temporary Partial Disability records) equals 98,311 (thus corresponding to 62.52 percent of the total 157,246 lost-time claims records).

Due to reopening (with or without new condition), 731 claim records (or 0.46 percent of the original 157,246 records) were removed from the data. Further, seven TTD/TPD records with injury durations of more than three years were removed due to data quality concerns; six of these claims (of which four are pre-reform) belonged to the control group, whereas the remaining single (pre-reform) claim belonged to the group located between control and treatment groups. (Although Oregon has no statutory limit on the duration of TTD/TPD claims, correspondence with the data provider indicated that claims of this award type, when showing durations of several years, may be of impaired data quality.) In conclusion, all claims in the data set may be considered closed, which implies that there is no problem of right-censoring in the statistical analysis.

Further, for the purpose of data cleansing, we excluded claim records indicative of a claim disposition agreement (CDA); for such claims, there is no breakdown into indemnity and medical costs available. Of claims with multiple closures, we retain only the record with the most recent closure date. We exclude claims where the injury date equals the closure date; such claims may initially have been accepted as nondisabling (medical only), but aggravation later in the life of the claim initiated a TTD claim record.

Benefit and injury durations were measured in weeks of calendar time. The benefit duration was computed as the ratio of total time-loss days for which the claimant received TTD or TPD benefits and the pre-injury number of days the claimant worked during a week. For the purpose of obtaining the injury duration, the benefit duration was adjusted for a waiting period of three days (which comes with a retroactive period of 14 days). This means that for every claim the benefit duration of which is less than two weeks, the injury duration exceeds the benefit duration by three-sevenths of a week.

The data set lumps TTD and TPD claims into a single award type. In order to eliminate TPD claims (and ensure data quality for TTD claims), we judgmentally excluded records where the observed weekly TTD paid falls short of 85 percent of the indicated weekly benefit. The indicated weekly benefit was computed from the reported pre-injury weekly wage based on the applicable benefit schedule.

Finally, to ensure data quality and exclude claims with lump-sum payments, we judgmentally excluded records where the observed weekly TTD paid exceeds 115 percent of the indicated weekly benefit. The final number of TTD claims for the six-year window equals 53,681.

Chart 3 displays a histogram of the pre-injury weekly wage (with a bin size of $100). For the purpose of this histogram, all observations of the pre-injury weekly wage are inflation-adjusted based on the rate of inflation embedded in the official state average weekly wage effective at the time of the reform. Inflation-adjusted, the minimum pre-injury weekly wage is $3.96; the maximum equals $7,469.46; the median and mean values equal $454.02 and $516.20, respectively. Clearly, the distribution of the pre-injury weekly wage is strongly skewed to the right.

Chart 4 is a combination of the histogram in Chart 3 and the benefit schedule displayed in Chart 1. The frequency distribution in Chart 4 has a residual bin for a pre-injury weekly wage of $1,500 or higher. Chart 4 indicates that only a small proportion of the claims are in the treatment group (pre-reform: 350 claims or 0.65 percent; post-reform: 284 claims or 0.53 percent). The control group, on the other hand, is heavily populated (pre-reform: 27,375 or 51.00 percent; post-reform: 22,442 or 41.81 percent). When control and treatment groups are taken together, they add up to 50,451 claims (which amount to 93.98 percent of the total 53,681 TTD claims). The group of claimants located between the control and treatment groups comprises 3.09 percent of claims pre-reform and 2.35 percent post-reform.

Chart 5 exhibits the age distribution of the claimants in single-year age bins. For the purpose of this chart, 166 claims with zero values for the age of the claimant were removed, thus leaving the data set with 53,515 observations. The minimum age in years is 13; the maximum equals 96; the median and mean values equal 38 and 38.1, respectively. Chart 6 displays the relative frequency distribution of gender by age; in this chart, too, 166 claims with zero values for the age of the claimant were removed. Of the 53,515 claimants, 68.9 percent are male.

Chart 3: Histogram of Pre-Injury Weekly Wage (Wage Level at Time of Reform), Oregon

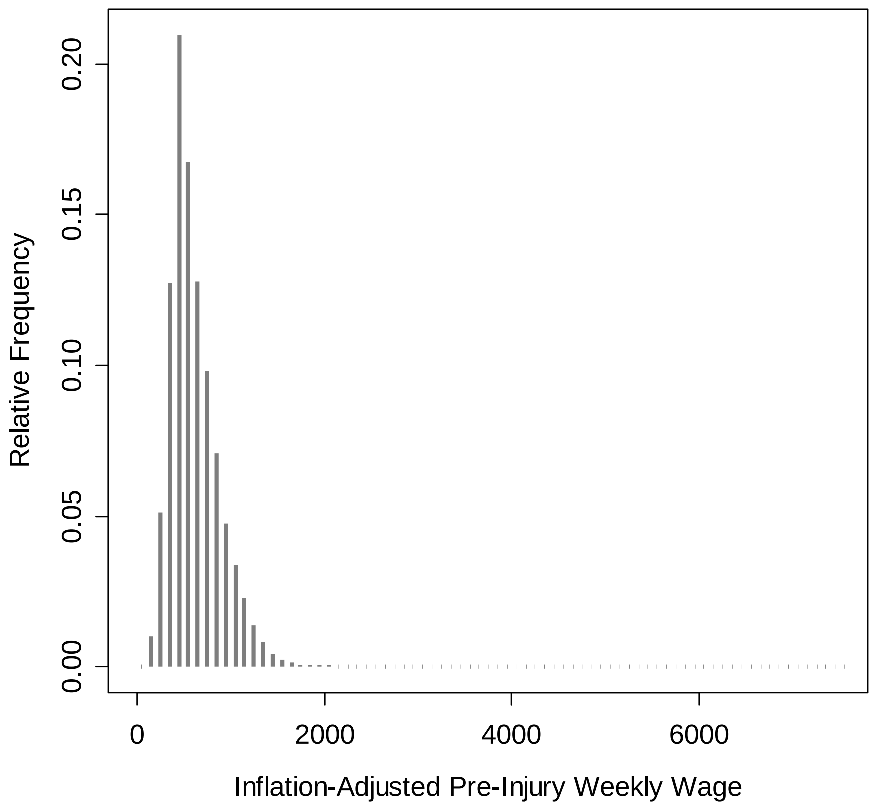


Chart 4: Population of Treatment and Control Groups, Oregon

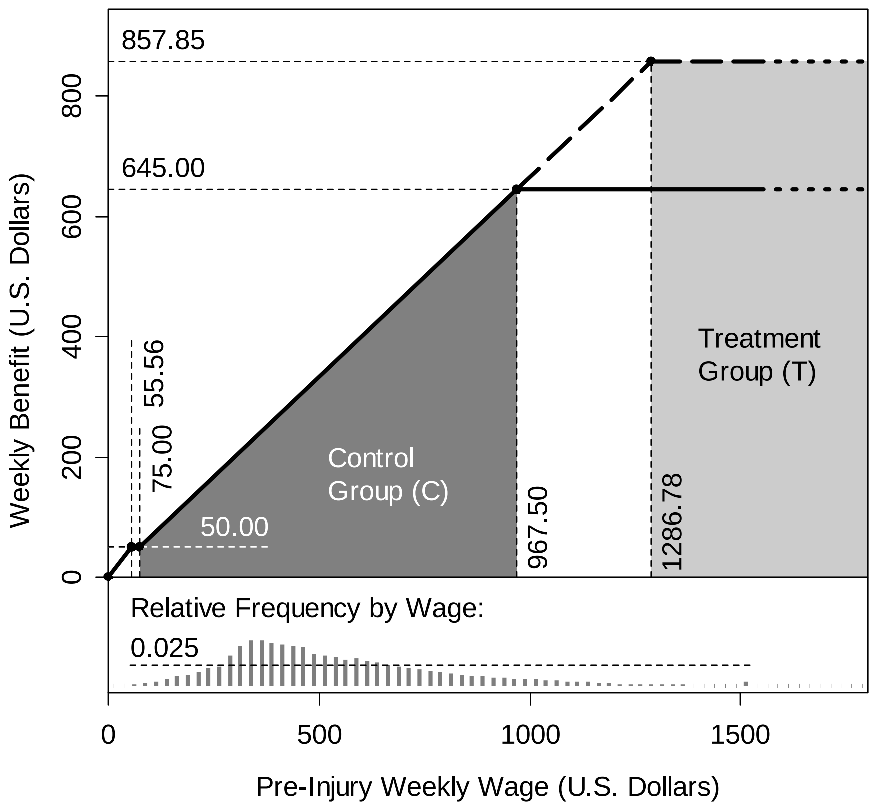


Chart 5: Histogram of Age of Claimant, Oregon

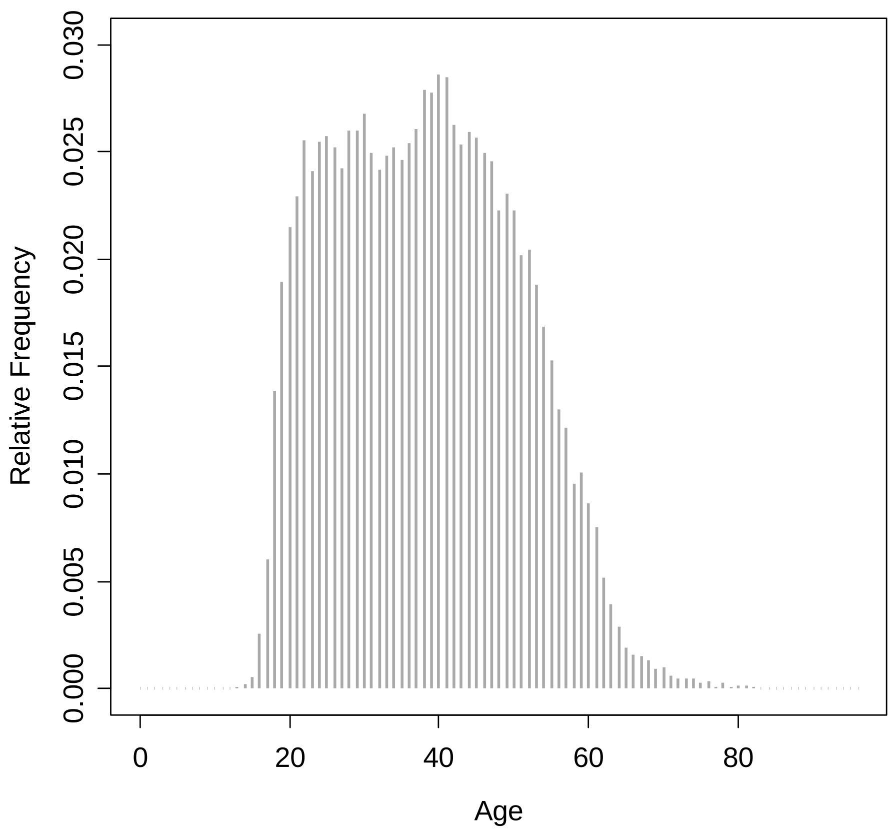
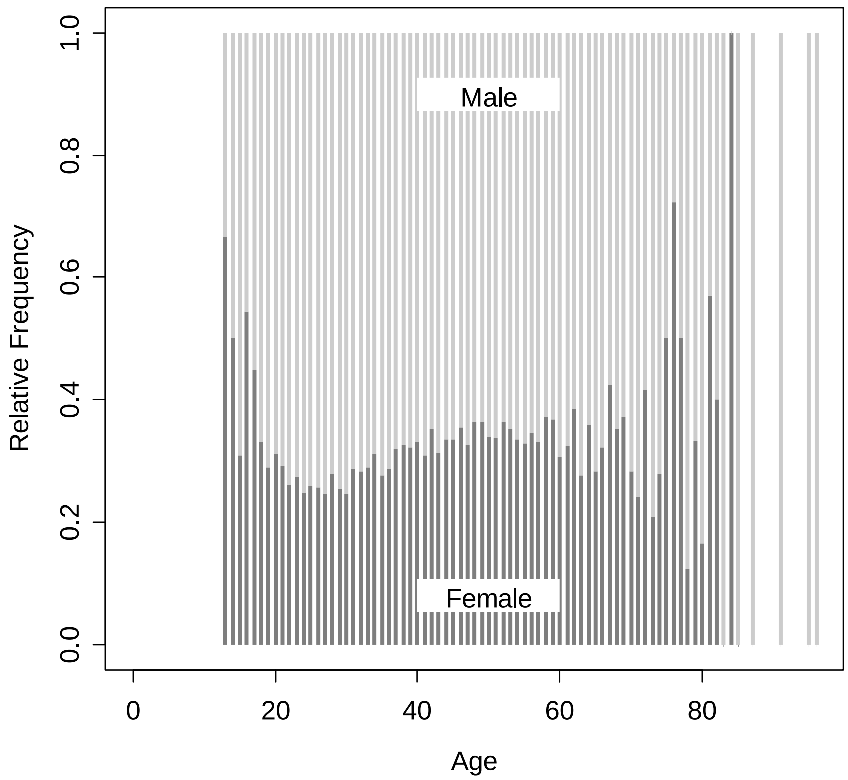


Chart 6: Relative Frequency of Gender by Age, Oregon



3.2 The New Mexico Data

The New Mexico data set comprises all claims that collect lost-time benefits with injury dates between (and inclusive of) January 1, 1997, and December 31, 2002. Just like Oregon, the data cover a 36-month pre-reform window, followed by a 36-month post-reform window.

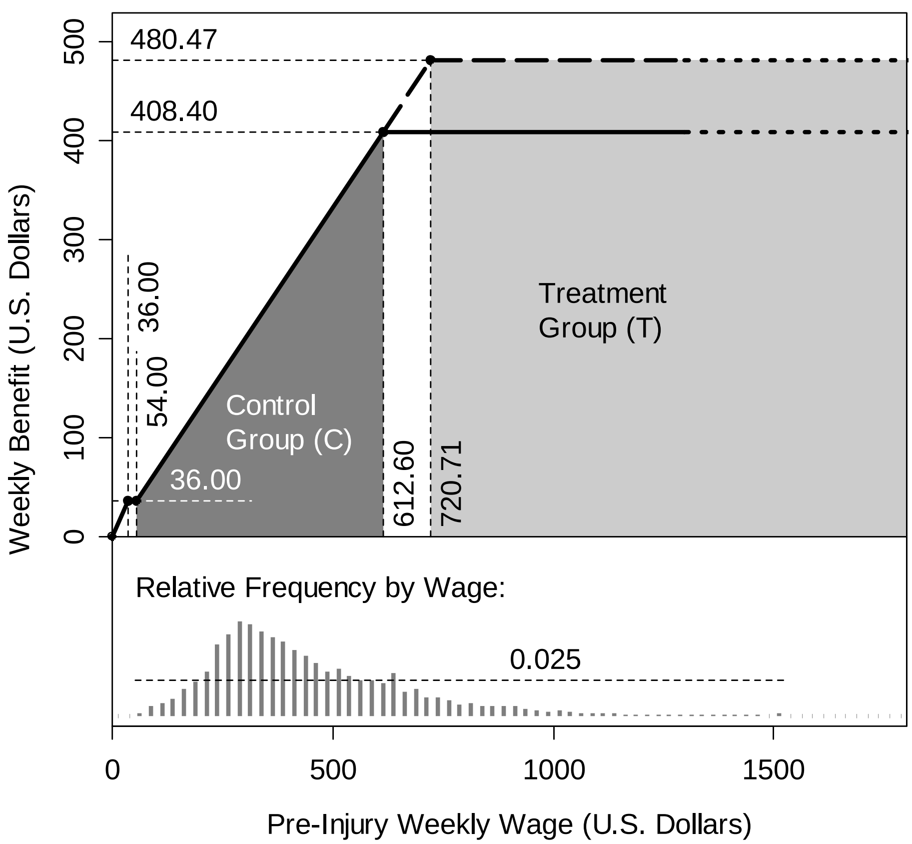
The data for New Mexico were provided at the level of the claim (unlike the Oregon data, which consisted of claim records and necessitated aggregation where there was more than one record per claim). The lost-time claims in this data set are identified by positive payments in the categories TTD, TPD, PPD, PTD, "Death," or "Lump sum;" this way, 36,997 claims were identified as collecting lost-time benefits. Of these lost-time claims, there are 2,866 claims (or 7.75 percent) that were categorized as "R" ("Reopened") or "X" ("Reopened/Closed").

For the purpose of identifying the set of TTD claims in the population of lost-time claims and with the intent of cleansing these identified claims, we implemented four rules of exclusion (in the order stated). First, we excluded claims with positive payment entries for TPD, PPD, PTD, "Death" or "Lump sum," as well as claims with nonpositive payment entries for TTD. Second, we excluded claims with nonpositive entries for TOTAL WEEKS OF LOST TIME and TOTAL DAYS OF LOST TIME. Third, we excluded claims the "Claim Status" of which is not "O" ("Open"), or "C" ("Closed"); this rule excluded claims that were categorized as "R" ("Reopened") or "X" ("Reopened/Closed"). Fourth, to ensure data quality, we judgmentally excluded claims where the reported TTD duration falls short of 90 percent or exceeds 110 percent of the ratio of TTD PAID and the indicated TTD weekly benefit.

An inspection of the claims shows that all of them can be assumed as closed; such does not necessarily apply to reopened claims, which had been eliminated during the data-cleansing process.

Chart 7 displays the benefit schedule of New Mexico with a histogram that illustrates the wage distribution. As with Oregon, the wage data have been inflation-adjusted to the date the reform took effect, and the histogram has a residual bin for a pre-injury weekly wage of $1,500 or higher. Compared to Oregon, the proportion of claims in the treatment group is larger (pre-reform: 565 claims or 3.82 percent; post-reform: 831 claims or 5.62 percent), but the control group is again the most heavily populated category (pre-reform: 5,935 or 40.16 percent; post-reform: 6,339 or 42.89 percent). Taken together, control and treatment groups comprise 13,670 claims (or, equivalently, 92.50 percent of the total 14,778 TTD claims). The group of claimants located between the control and treatment groups comprises 3.21 percent of claims pre-reform and 3.86 percent post-reform.

Chart 7: Population of Treatment and Control Groups, New Mexico



4. QUANTIFYING THE TREATMENT EFFECT

In what follows, the treatment effect is calculated for benefit duration (measured in calendar time, as mentioned) and, alternatively, for the amount of benefit payments. As discussed, the benefit duration differs from the injury duration by the waiting period (as applicable). Unless stated otherwise, all findings in this section apply to Oregon.

The treatment effect in benefit duration is computed as the difference between two differences or, when measured in relative (percentage) terms, as the ratio of two ratios. The first difference pertains to the treatment group and equals the mean of the post-reform benefit duration less the mean of the pre-reform benefit duration. The second difference is the corresponding difference in such means for the control group. Calculated in this way, the treatment effect equals 0.76 weeks or, when the treatment effect is calculated in ratios instead of differences, 17.49 percent. In other words, there is an average increase in the benefit duration among claimants of the treatment group of 0.76 weeks (or, equivalently, 17.49 percent), and this increase can be considered causal to the increase in the maximum weekly benefit. The computation of the treatment effect in weeks and relative terms is detailed in the following two subsections.

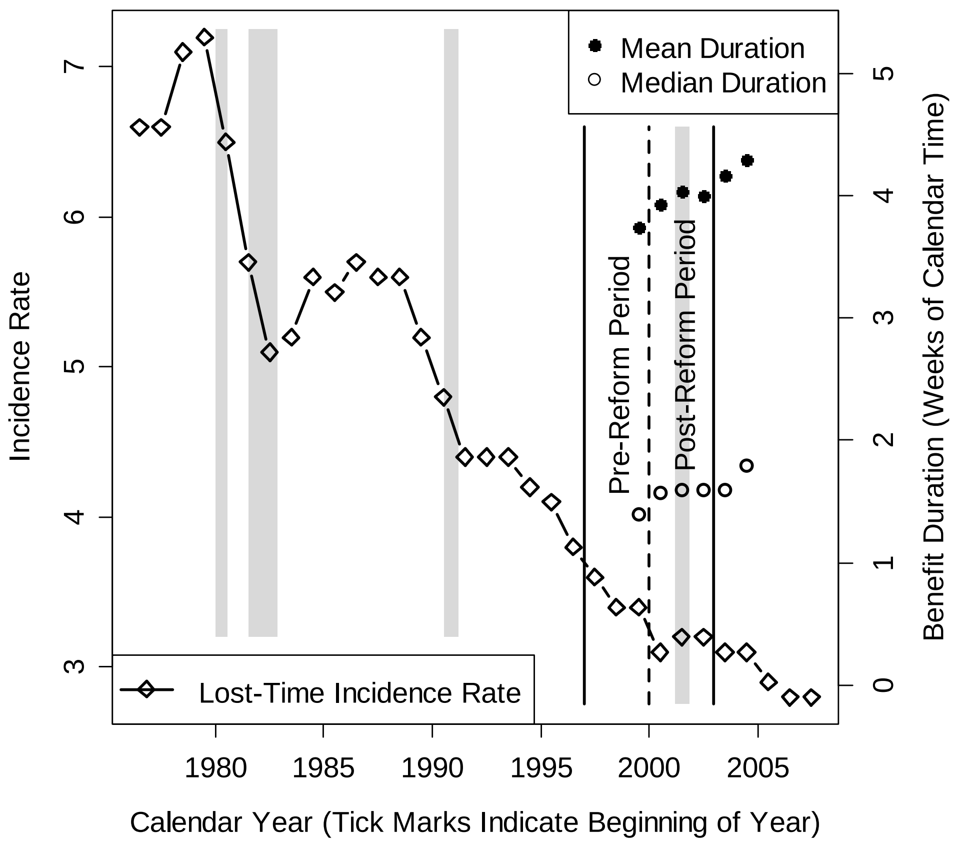
4.1 Treatment Effect in Weeks

To illustrate the importance of employing a control group for the purpose of isolating the treatment effect, Chart 8 displays the behavior of the benefit duration for the pre-reform (1999–2001) and post-reform (2002–2004) time windows; the chart shows the control group only, as the treatment group is affected by the reform. In this chart, economic recessions (as defined by the National Bureau of Economic Research, www.nber.org) are represented by gray bars, which cover the time window between the months that formed the peak and trough of economic activity, respectively; peak and trough are treated as occurring mid-month. Both the mean and the median benefit durations exhibit a positive trend over the six-year time period—this trend is interrupted (median duration) and temporarily reversed (mean duration) during the 2001 recession (peak to trough: February through November).

Studying Chart 8 indicates that it is the economic recovery (as opposed to the economic recession) that (temporarily) disrupts the upward trend in injury duration—the same can be said for the displayed downward trend in frequency, as measured by the Bureau of Labor Statistics lost-time incidence rate (rate of injury and illness cases per 100 full-time workers; cases involving days away from work, job restriction, or transfer). Further research will have to investigate the link between frequency and injury duration, both with regards to their trends and their business cycle behavior.

In order to obtain a probability distribution for the treatment effect, the difference in differences may be bootstrapped, alternatively with and without stratification. In the unstratified bootstrap, 50,451 claims are drawn with replacement from the total of 50,451 claims that comprises (exclusively) the pre- and post-reform periods and the control and treatment groups. Then, the difference in differences (or, alternatively) ratio of ratios is calculated. This procedure is carried out a total of 2,000 times.

Chart 8: Incidence Rate (1976–2007) and Mean and Median Benefit Durations (1999–2004), Oregon



Whereas in the unstratified bootstrap the claims are allocated to their respective group (pre- and post-reform, control and treatment) after drawing, in the stratified bootstrap, the drawing itself is done from the individual groups—the difference in differences (or ratio of ratios) is computed after drawing from each group (with replacement) according to their respective sample populations.

Chart 9 displays the treatment effect in weeks of calendar time—both its mean and its probability distribution are shown. There are two alternative distributions displayed, one being from an unstratified bootstrap and the other from a stratified bootstrap. Chart 10 presents the treatment effect in relative (percentage) terms, again along with bootstrapped probability distributions.

Chart 9: Bootstrapped Change of Benefit Duration in Weeks (of Calendar Time), Oregon

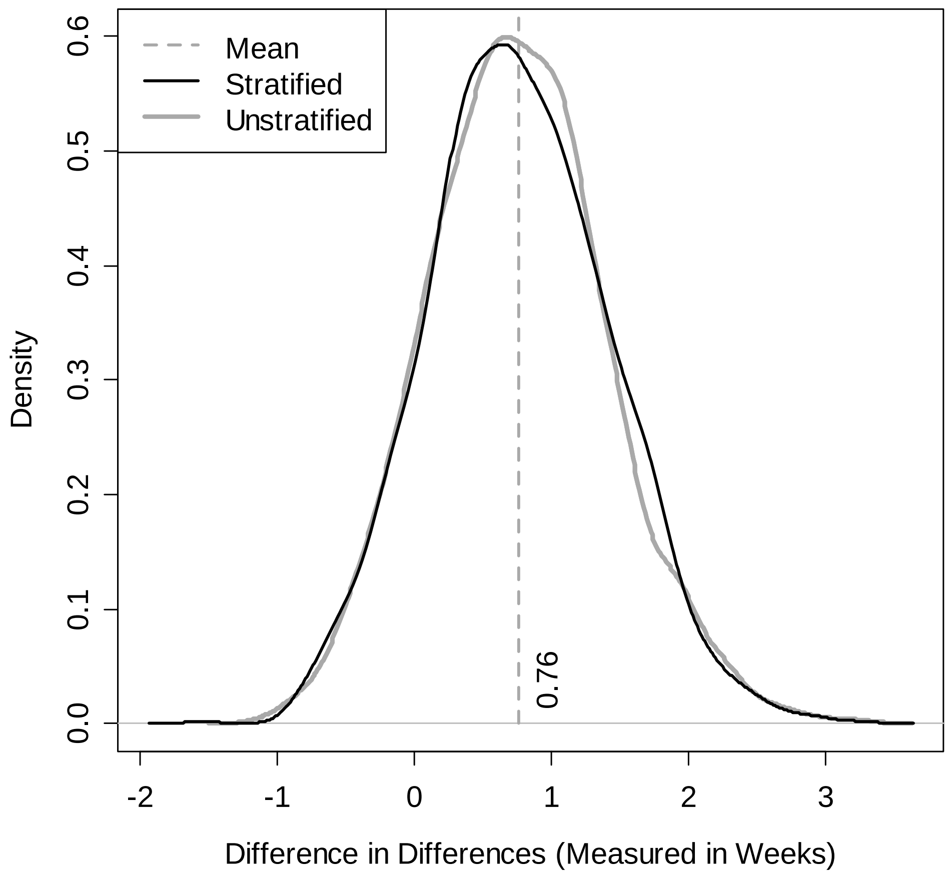
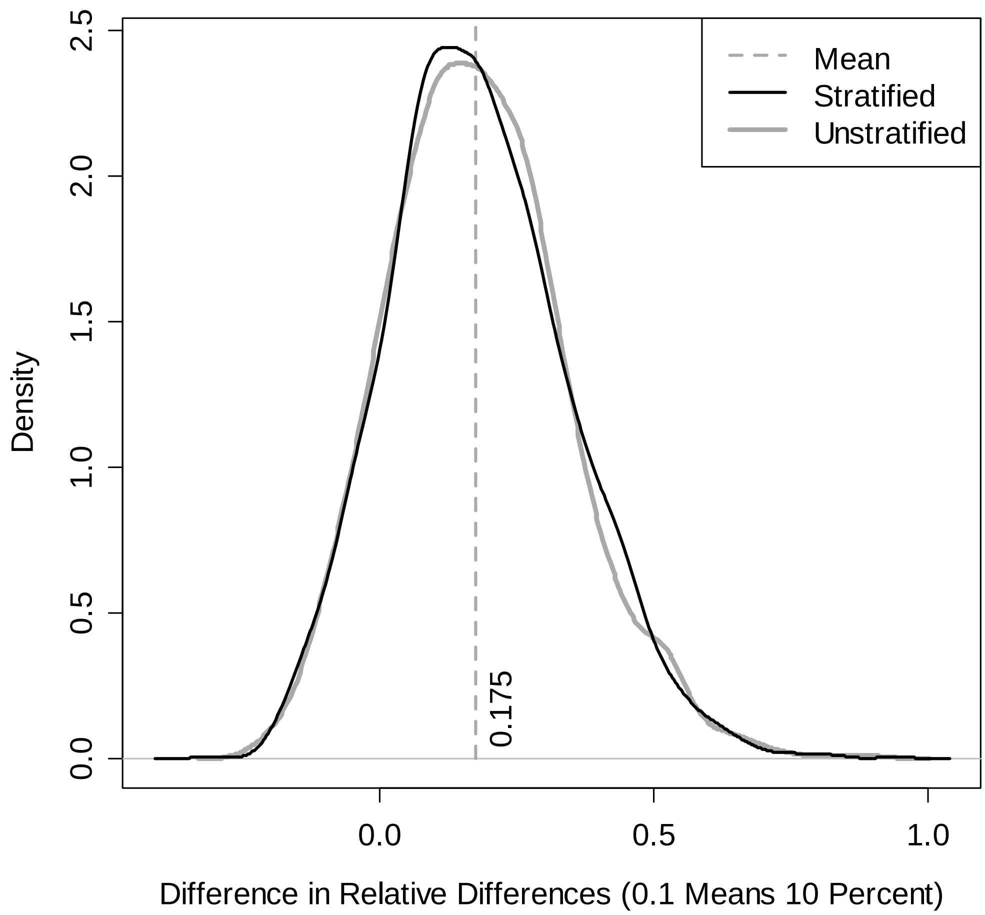


Chart 10: Bootstrapped Relative Change of Benefit Duration (in Calendar Time), Oregon



4.2 Treatment Effect in Relative Terms

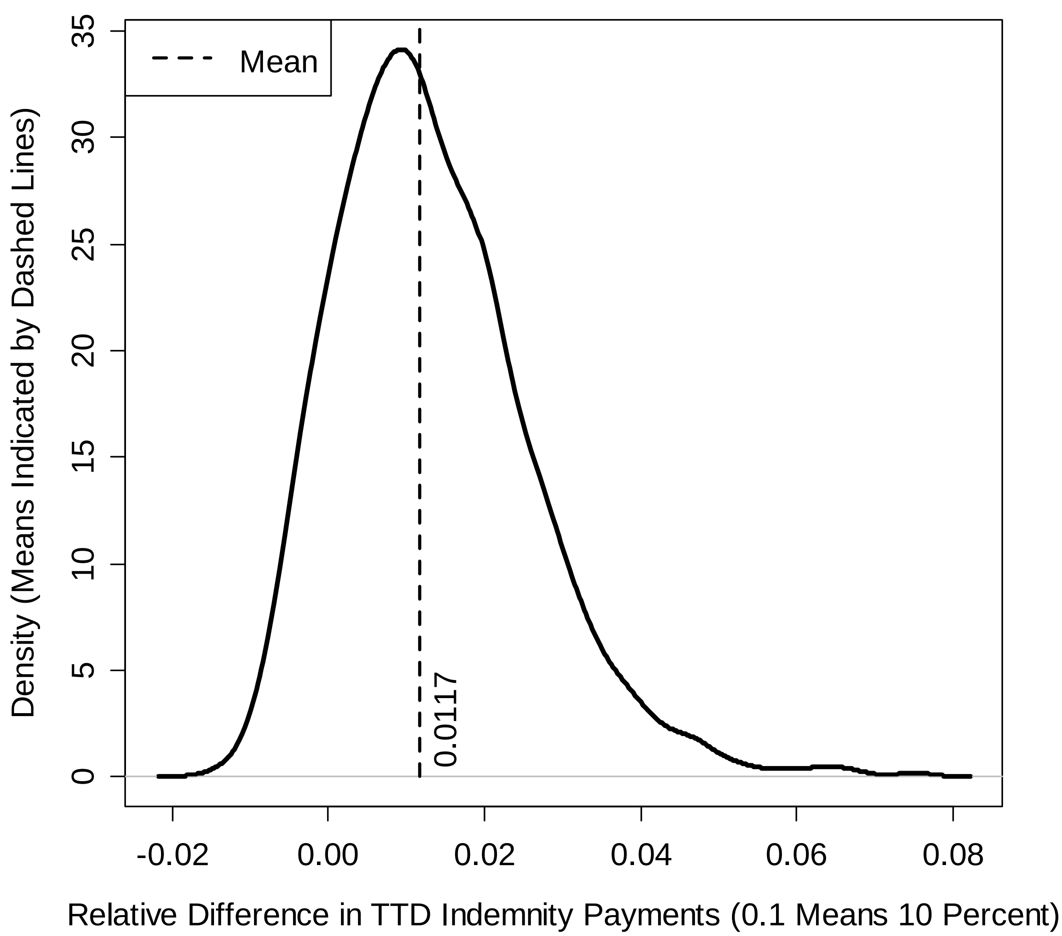
Calculating the treatment effect in terms of a relative (percentage) change in the indemnity payments is more complex than calculating the treatment effect in terms of benefit duration. For one, in order to quantify the total dollar impact, the group of claimants located between control and treatment groups (see Chart 1) can no longer be ignored; this group is partially affected by the hike in the weekly maximum benefit. Further, because inflation-adjustment necessitates information on the timing of the payments, the treatment effect in dollar terms is preferably computed using indicated (instead of recorded) benefit payments. Indicated benefit payments are obtained by applying the benefits schedule to the claimant's pre-injury weekly wage, scaled by the computed benefit duration in calendar time. For the purpose of calculating indicated benefits, all observations of the pre-injury weekly wage are inflation-adjusted to the official state average weekly wage effective at the time of the reform (as mentioned, such normalization also applies to Chart 3 and Chart 4).

When calculating the treatment effect in dollar terms, the benefit duration of each claim in the pre-reform treatment group is scaled up according to the measured percentage treatment effect on benefit duration. Yet, such cannot be done directly, as benefit durations (in calendar time) of 11, 12, and 13 days are unobservable (because of the 14-day retroactive period). For instance, a claimant with a 13-day injury duration has a benefit duration (in calendar time) of at most 10 days (depending on how many days per week this claimant worked, and on which day the claimant was injured), due to the three-day waiting period; on the other hand, a claimant with a 14-day injury duration always has a benefit duration (in calendar time) of 14 days, due to the 14-day retroactive period. For this reason, the treatment effect (in calendar time) is calculated for injury duration (instead of benefit duration); then, the injury durations of the claimants in the pre-reform treatment group are scaled up according to the resulting relative (percentage) treatment effect. Having obtained the injury durations in such way, the benefit durations (in calendar time) of the individual claims can be calculated (by factoring in the 14-day retroactive period); finally, by applying the benefit schedule, the indicated benefits can be computed from these benefit durations.

Computing the increase in nominal benefits for the treatment group does not suffice for computing the relative (percentage) increase in indemnity payments; this is because the group located between the control and treatment groups (as shown in Chart 1) is also affected by the benefit change. In order to capture this effect, these claims are subjected to a weighted treatment effect (in injury time) when calculating the change in benefit duration. For a given claim, this weight equals the proportion by which the claimant experienced an increase in the weekly benefit due to the hike in the weekly maximum; based on the numbers displayed in Chart 1, the weight equals $(w-967.50)/(1286.78-967.50)$, where w is the pre-injury weekly wage of the claimant after inflation-adjusting this wage to the average weekly wage applicable at the time of the reform.

In conclusion, when scaling up the benefit payments of the pre-reform claims in the treatment group and the group located between control and treatment groups in the way detailed above, then the resulting treatment effect in dollar terms relative to the total indemnity payments equals 1.17 percent. In other words, the lengthening of the benefit duration as caused by the increase in the maximum weekly benefit from 100 to 133 percent of the state average weekly wage produced an increase in total indemnity payments for TTD claims (within award type category TTD/TPD) of 1.17 percent. Chart 11 displays this effect, along with a bootstrapped probability distribution.

Chart 11: Relative Increase in Payments on TTD Claims due to Treatment Effect, Oregon

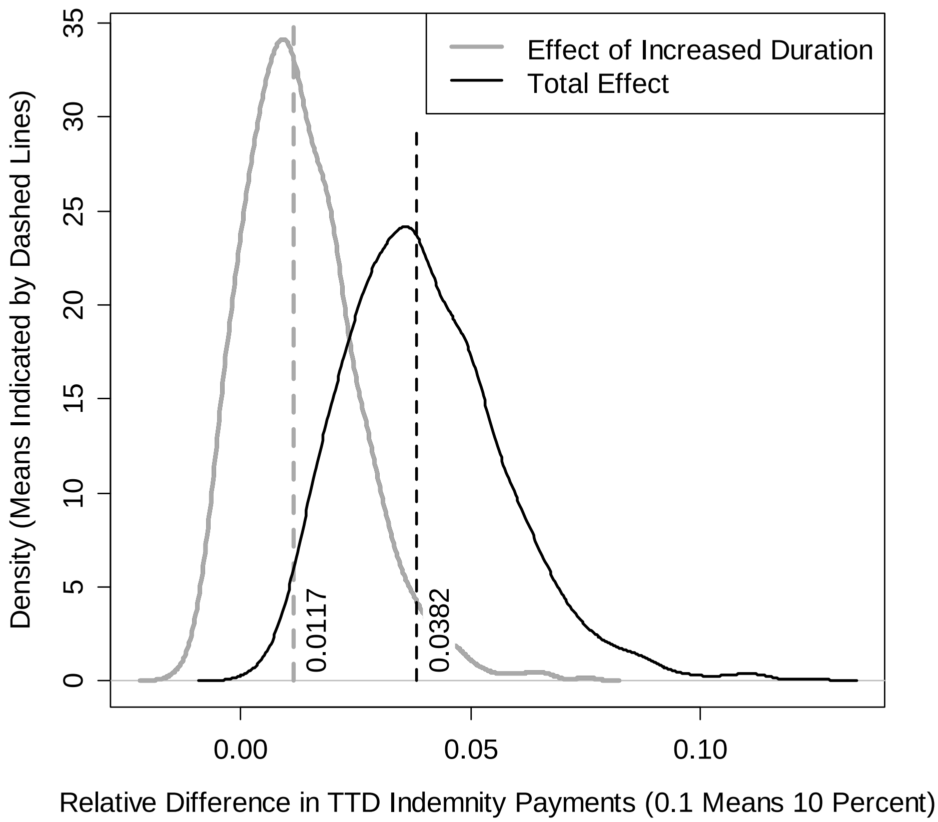


Finally, in order to obtain the total effect of the benefit change on payments going to claims of award type TTD, the benefit change itself (at given injury durations) has to be factored in; this effect is in addition to the discussed treatment effect (which quantifies the increase in payments caused by an increase in duration). When adjusting the pre-reform claims of the treatment group and the group between the control and the treatment groups for the increased duration, while at the same time applying the benefit schedule with the increased maximum weekly benefit, the percentage increase in total indemnity payments on claims of award type TTD is 3.82 percent. Thus, about 31 percent of the total effect of the benefit change is due to an increase in utilization (as caused by an increase in benefit duration among claimants affected by the benefit increase). Chart 12 displays the total effect alongside the treatment effect (that is, the utilization effect of increased duration), again with bootstrapped probability distributions.

In the analysis above, the treatment effect was applied to the pre-reform benefit durations before the post-reform benefit schedule was administered to the ensuing post-reform durations for the purpose of calculating the total effect; the resulting percentage of the utilization effect (as caused by the increase in durations) equals 31 percent. An alternative way of breaking down the (same) total effect is to apply first the post-reform benefit schedule to the pre-reform durations before scaling up these pre-reform durations by the treatment effect; when doing so, the percentage effect of increased benefits at given, pre-reform durations equals 2.36 percent, thus delivering a utilization effect that measures 38 percent of the total dollar impact.

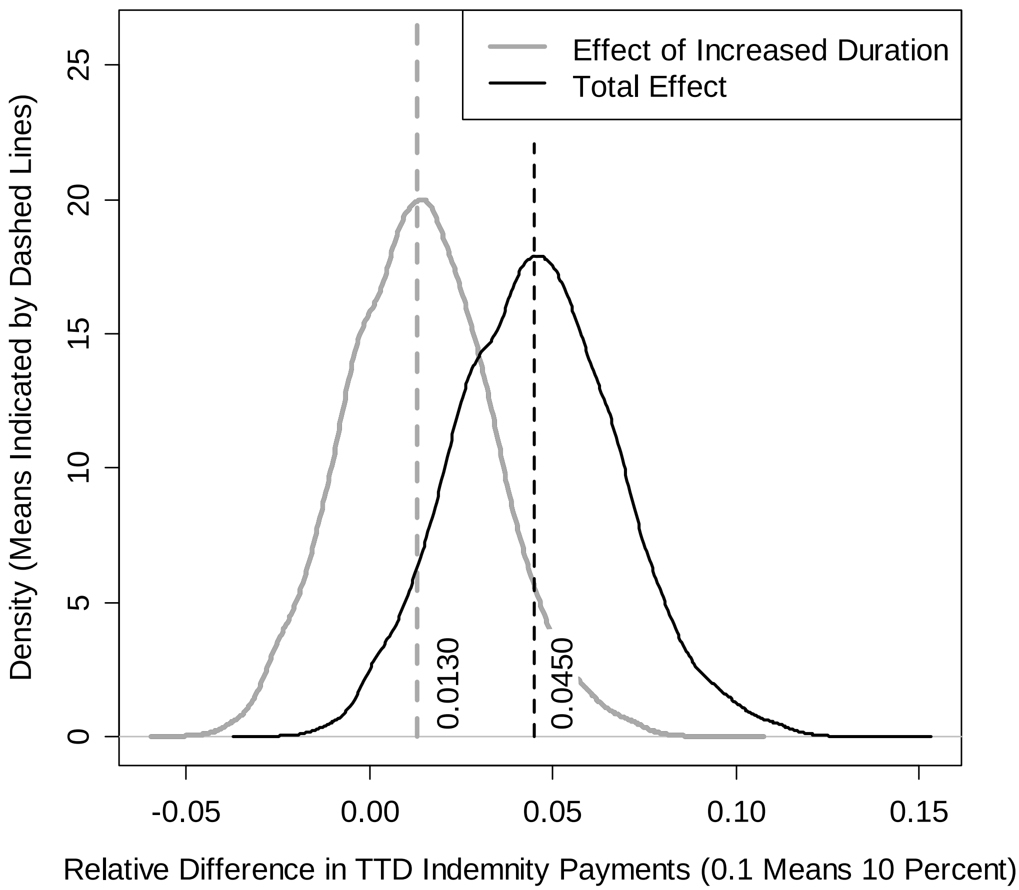
The second approach of breaking down the total effect has the advantage of delivering a ready-to-use formula for arriving at the total effect once the post-reform benefit schedule has been applied to the observed pre-reform durations. Let b be the relative (percentage) increase in costs due to the change in the benefit schedule for observed pre-reform durations, let u be the proportion of the utilization impact in the total effect (as calculated using the second approach), and let $d^{pre-reform}$ and $d^{post-reform}$ be the dollar amounts of pre-reform and post-reform indemnity payments, respectively. Then, we can write: $d^{post-reform} = d^{pre-reform} \times \left(1 + b / \left(1 - u\right)\right)$.

Chart 12: Relative Increase in Payments on TTD Claims: Treatment Effect and Total, Oregon



When calculating the treatment effect for New Mexico, we obtain as the total effect on indemnity payments of the change in the maximum weekly benefit a 4.50 percent increase (compared to 3.82 percent for Oregon). Of this total effect, 1.30 percentage points are due to the utilization increase, which amounts to about 29 percent of the total effect and, thus, is close to the 31 percent established for Oregon. Note that for New Mexico, the waiting period equals 7 days (compared to 3 days for Oregon), and the retroactive period equals 28 days (compared to 14 days for Oregon). Chart 13 exhibits the means and probability distributions of the total impact and the utilization effect, using 4,000 draws for the bootstrapped distributions.

Chart 13: Relative Increase in Payments on TTD Claims: Treatment Effect and Total, New Mexico



Finally, Table 1 summarizes the findings for Oregon and New Mexico. Columns 9 and 10 offer alternative ways of calculating the proportion of the utilization effect in the total effect. For the purpose of adjusting the direct cost effect of a reform (which is obtained by applying the post-reform benefit schedule to the pre-reform durations) using the discussed formula, the values in column 10 have to be used.

Table 1: Summary of Estimated Cost Effects

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Legislative Reform: Percentage increase in maximum weekly benefit	Increase in benefit duration in treatment group (measured in weeks)	Percentage increase in benefit duration in treatment group	Resulting duration/benefit elasticity (column 4, divided by column 2)	Total cost increase in percent	Percentage points of total cost increase that are due to utilization increase at pre-reform benefit levels	Percentage points of total cost increase that are due to increase in benefits at pre-reform duration levels	Percentage of utilization increase in total cost increase (column 7, divided by column 6)	Alternative concept of utilization increase as a percentage of total cost increase (column 6 minus column 8, divided by column 6)
Oregon	33.00	0.76	17.49	0.53	3.82	1.17	2.36	31	38
New Mexico	17.65	0.41	7.64	0.43	4.50	1.30	3.00	29	33

Note: All computations rest on unrounded numbers. Columns (7) and (8) do not add up to column (6) due to the changes not being infinitesimally small. For instance, let $z_0 = x_0 \cdot y_0$, then we can write: $dz \approx x_0 \cdot dy + y_0 \cdot dx$. This relation holds at equality if dx and dy are infinitesimally small.

5. REGRESSION APPROACH TO TREATMENT EFFECT

The "difference in differences approach" to gauging the effect of the increase in the maximum weekly benefit on benefit duration (the "treatment effect") assumes that changes in economic activity or an underlying trend in benefit duration bear on the control and treatment groups in similar ways. This assumption may be violated if the impact of an economic recession (or the subsequent economic recovery) affects the treatment group (which consists of high-wage earners) and the control group differently. As Chart 8 indicates, for Oregon, the time window prior to the reform was characterized by an economic slowdown, whereas the time window following the reform coincided with an economic expansion. The findings presented in the section pertain to Oregon.

In order to validate the 17.49 percent benefit increase obtained with the "difference in differences" approach, a partial linear regression model is estimated. This model reads

$$y_i = \boldsymbol{x}_i \cdot \boldsymbol{\beta} + f(z_i) \ , \qquad (1)$$

where y_i is the (natural) logarithm of the benefit duration of claimant i. In this semiparametric model, the vector $\boldsymbol{x}_i$ comprises the covariates in the linear, parametric component, whereas the smoother $f(z_i)$ models the (single) covariate in the nonparametric part. Here, the covariates in the parametric component are exclusively indicator variables, which represent the claimant's gender, occupation, injury year, affiliation with the control group, and affiliation with the post-reform treatment group. The covariate in the nonparametric component, the influence of which is allowed to be nonlinear, is the claimant's age at injury, measured in full years; this covariate was centered. Occupation is categorized into nine major groups based on the U.S. Census Bureau Occupation Codes, as used in the 1990 Census of Population and Housing (see www.census.gov). The reference group consists of male claimants that are employed in a service occupation, sustain a workplace-related injury in 2002 and belong to the post-reform treatment group. As in the "difference in differences" approach, only claims that belong to the control or treatment group are included in the analysis.

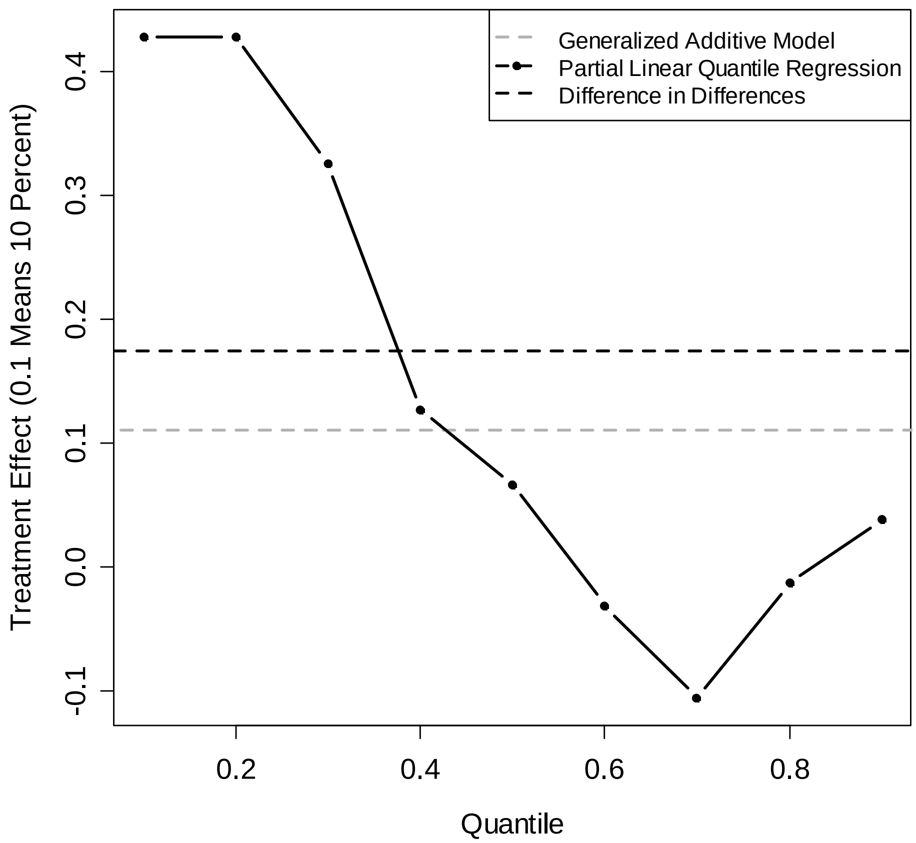
Model (1) is estimated using a generalized additive framework, as provided by the R package *mgcv* (http://cran.r-project.org/web/packages/mgcv/index.html; version 1.5-5, May

15, 2009), authored by Simon Wood. The smoother $f(z_i)$ is a thin plate regression spline; see Wood [15] for details. The business cycle effect on injury duration is controlled for by the set of year indicator variables. Variation in the composition of claimants by occupation, gender, or age is accommodated by the respective covariates. The treatment effect equals the regression coefficient of the post-reform treatment group indicator variable, after adjustment for the logarithmic nature of the dependent variable; for details on this adjustment, see Halvorsen and Palmquist [7] (and Kennedy [9], for a discussion of the properties). Chart 14 displays the transformed regression coefficient (as a gray dashed line) alongside the result of the "difference in differences" approach (black dashed line). The treatment effect of 11.1 percent, as obtained from the generalized additive model, is somewhat smaller than the treatment effect of 17.49 percent delivered by the "difference in differences" approach.

Standard regression approaches (such as least squares, iteratively reweighted least squares, or maximum likelihood approaches) typically regress on the mean of the distribution of the dependent variable. Although regression on the mean of the distribution offers important insights into the average effect, it also obscures a possible nonuniform influence across the range of observed benefit durations. Quantile regression, as developed by Koenker and Basset [11], offers a means of uncovering such a possible nonuniform influence. Thus, the partial linear specification of model (1) is reestimated following Koenker, Ng, and Portnoy [12]; in that approach, the smoother $f(z_i)$ rests on total variation regularization. Software for estimating the partial linear model is available as part of the R package *quantreg* (http://cran.r-project.org/web/packages/quantreg/index.html; version 2.6, February 5, 2009), authored by Roger Koenker.

Quantile regression minimizes the sum of absolute errors; this problem is solved using linear programming techniques (such as the family of interior point algorithms). If positive and negative errors receive equal weight, then quantile regression quantifies the effect of the covariates on the median of the dependent variable. If, on the other hand, errors are weighted asymmetrically, regression on quantiles other than the median becomes available. For instance, if underestimating the observed value is penalized (at the margin) three times higher than overestimating it, then the solution that emerges is for the 75th percentile (see Koenker [10]).

Chart 14: Regression Approaches to Measuring the Treatment Effect, Oregon



The quantile regression estimates of the treatment effect are displayed in Chart 14. There are estimates for the 10th, 20th,…, and the 90th quantiles. Whereas the legislative reform increases the benefit duration for very short durations by more than 40 percent, the effect on long durations is essentially nil.

6. BENEFIT DURATION AND CLAIM ATTRIBUTES

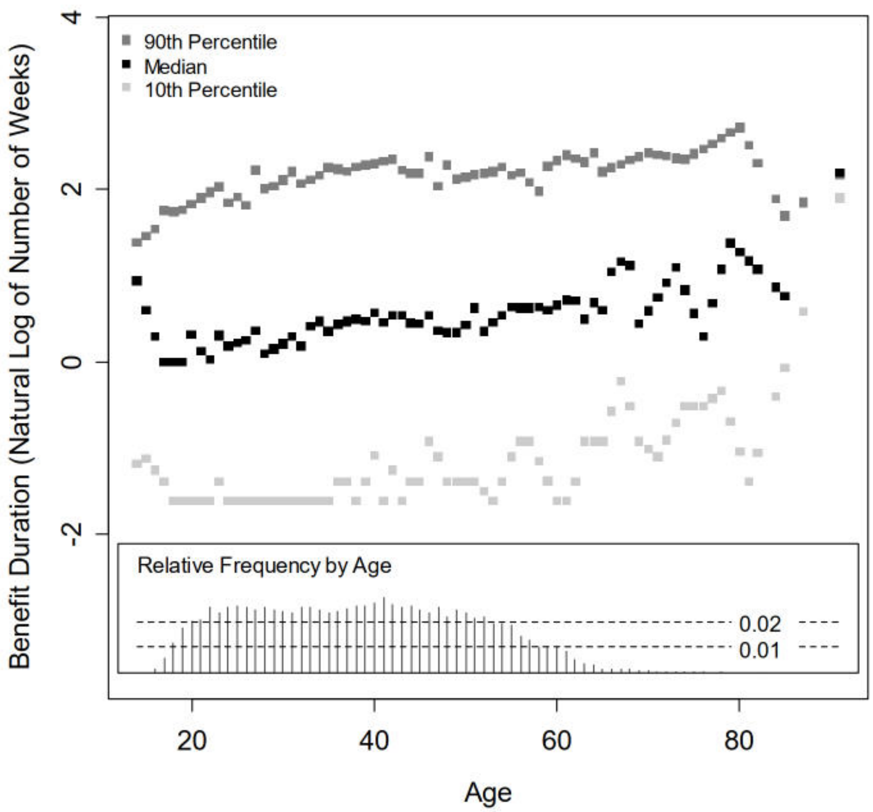
Quantile regression, due to its ability to offer a more differentiated picture of the behavior of the dependent variable in response to covariates, is a suitable framework for studying the effect on injury duration of the claimant's age and gender. Then again, when it comes to interpreting these regression results, it is important to remember that the TTD claims studied here are selected based on their final categorization. Many PTD (and even some Fatal) claims may have been categorized as TTD claims originally; such claims are not included in the analysis, as there is no information available on the initial categorization. Most importantly, claim attributes that are manifestations of the outcome of the event of injury (such as nature of injury or part of body) may be causal to the final categorization into TTD and PTD claims. For this reason, only covariates unrelated to the outcome of the injury, such as age and gender, are chosen in the following analysis. Unless stated otherwise, the findings presented in the section pertain to Oregon.

The impact of age is studied for the post-reform period, using model (1). To reduce noise, the data is pooled over the three post-reform years, with indicator variables controlling for differences among those years. A further covariate in the parametric component is gender. Age enters the nonparametric component, as before. The reference group consists of male claimants being injured in 2002.

Chart 15 displays the influence of age on claim severity as obtained for model (1) in a regression on the 10th percentile, the median, and the 90th percentile. There is a symbol for every year of age (where there is an observation for this age), except for the minimum age of 13, which serves as a reference; 18 claims with zero values for age were removed, thus resulting in 24,108 observations for the three-year time period. Note that the displayed effect of age includes the intercept (which is immaterial for the slope of the displayed duration trajectories). Also, at the bottom of the chart, there is a frequency distribution of claims by age; this distribution indicates that the data set is sparsely populated for claimant exceeding age 60; the maximum age is 91.

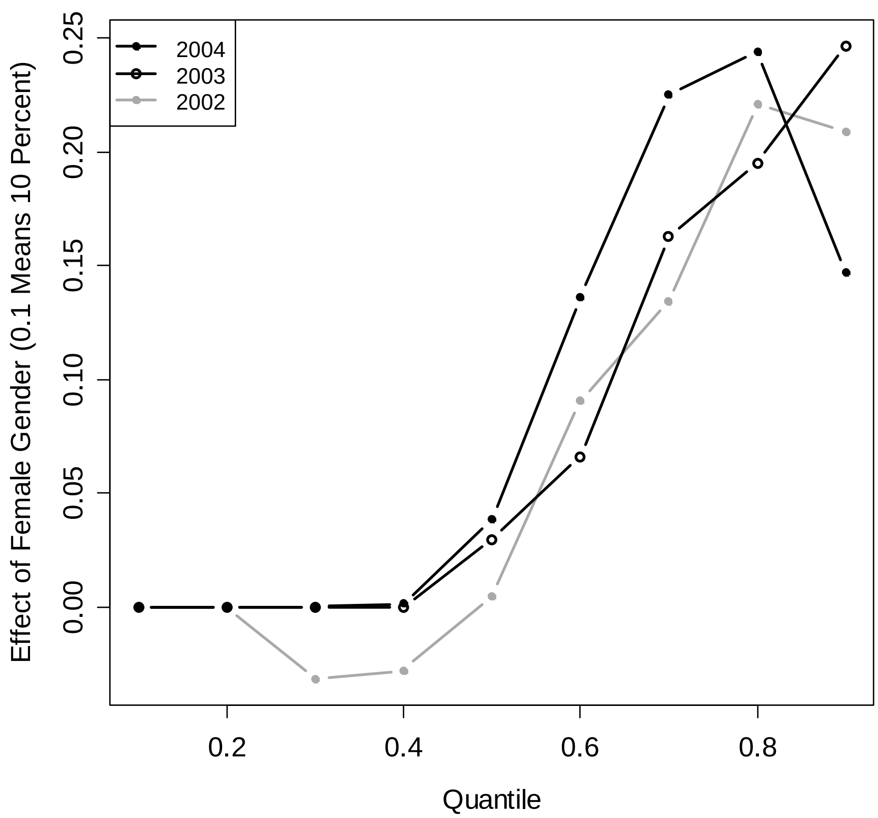
As Chart 15 shows, for the median, the benefit duration is roughly log-linear in age from the early twenties through the late fifties. An M estimator, applied to the estimated age effect at the median duration within the age bracket 20 through 60 delivers a geometric mean rate of growth per year of age of 1.0 percent. (A similar analysis for New Mexico delivers a geometric mean rate of growth of 0.72 percent.) The estimated age impact beyond the sixties is not meaningful due to the sparse number of claims. At the same time, there is no need to exclude these claims from the analysis, because the smoother adapts to the local environment. The measured age impact is less than the value established by Krueger [13] for Minnesota; using indicator variables for multi-year age brackets, this author finds an impact on the mean duration per one year of age to be about 1.6 percent (see his Table 3; calculated as ((exp(0.385)-1)/28.8 from the regression coefficient for the age group 45–54, relative to the reference group 18–24). The age effects presented by Meyer, Viscusi, and Durbin [14] are elasticities and, due to their nature of being partial derivatives, cannot be generalized to large age intervals.

Chart 15: Quantile Regression: Effect of Age on Benefit Duration, Oregon



Finally, the effect of gender on benefit duration is analyzed for the post-reform period, again using the partial linear framework of model (1). Here, every year is estimated in isolation. Gender enters the parametric component of the regression model, along with indicator variables for occupation. Age is again included in the nonparametric component. The reference group consists of male claimants that are employed in a service occupation. Chart 16 presents the influence of the female gender on benefit duration for the 10th, 20th,…, and 90th percentiles. This chart indicates that there is essentially no difference in benefit duration between female and male claimants up to the 40th quantile. But for claims of very long benefit duration, female claimants are on indemnity benefits about 20 percent longer than male claimants.

Chart 16: Quantile Regression: Effect of Female Gender on Benefit Duration, Oregon



As mentioned, because claims "self-select" (by final categorization) into TTD, PTD, and Fatal, the effects of claim attributes on TTD benefit duration (and the effect of gender, in particular) have to be interpreted with caution. For instance, it is conceivable that the longer benefit duration of females is related to a higher proportion of PTD claims for males. Put differently, whereas a female claimant may be on benefits for an extended period of time (as a TTD claim) but may eventually return to work, the corresponding male claimant may end up in the PTD category.

7. CONCLUSIONS

Studying temporary total disability claims, the impact of 33 percent (Oregon) and 17.65 percent (New Mexico) increases in the maximum weekly indemnity benefit on benefit duration and the associated percentage increase in indemnity payments were analyzed in a quasi-experimental setting. The effect on benefit duration was measured using a "difference in differences" approach applied to pre-reform and post-reform treatment and control groups. The resulting 17.49 percent (Oregon) and 7.64 percent (New Mexico) increases in benefit duration (the "treatment effects") translate into duration/benefit elasticities of 0.53 (Oregon) and 0.43 (New Mexico). These values agree with the rule of thumb suggested by Gardner [5], which states that a 20 percent increase in benefits comes with a (minimum) increase in utilization of 10 percent. At the same time, these elasticities are close to the values reported by Meyer, Viscusi, and Durbin [14] for TTD benefit increases of about 50 percent in Kentucky and Michigan; these authors' elasticities ranged from 0.27 to 0.62, but clustered mostly within the range of 0.3 to 0.4. On the other hand, the elasticities of 0.43 and 0.53 are considerably lower than the value of 1.67 that Krueger [13] established in his study of a 5 percent TTD benefit increase in Minnesota. Then again, Gardner [4], who studied a 50 percent TTD benefit increase in Connecticut, found that for every 20 percent increase in benefits, utilization increases by about 18 percent, thus resulting in an elasticity located between the values established by Meyer, Viscusi, and Durbin [14] and Krueger [13].

For Oregon, the treatment effect was validated using a generalized additive regression model, which yielded a somewhat lower increase of 11.1 percent. Further, using quantile regression on the Oregon data, it was demonstrated that most of this benefit duration increase originates in a lengthening of short durations; long benefit durations are nearly unaffected by the reform. This finding is consistent with evidence established by Krueger [13], Figure 3; further, Curington [3] found that the duration of PPD claims with minor impairment are more responsive to benefit changes than those with major impairment.

An increase in the maximum weekly benefit may give rise not only to longer benefit durations, but also to a higher number of indemnity claims, which would add to the cost of the reform. For instance, Gardner [4] finds in a study for Connecticut that a 50 percent increase in the maximum weekly benefit was associated with an increase in the number of indemnity claims of 5 percent. On the other hand, a recent study by Guo and Burton [6] arrives at the conclusion that the overall benefit elasticity (change in duration and frequency taken together) is in fact negative, which implies that frequency or duration (or both) drop in response to more generous benefit provisions.

No statement can be made with confidence on how the 33 percent increase in the maximum weekly benefit studied here may have affected the claim count. This is because the data-cleansing algorithms that separate TTD and TPD claims in the Oregon data set, while improving data quality for the study of duration, may adversely affect the validity of the claims count information. Further, the reform of interest, which is the increase in the maximum weekly benefit for TTD claims, was accompanied by an increase in compensation for both scheduled and nonscheduled PPD injuries; this change in PPD benefits may also have influenced the incentive to file claims, apart from the increase in the maximum weekly benefit of TTD claims.

Further research is necessary for a better understanding of the effect of benefit changes on claim counts and of the effect of socioeconomic attributes (beyond age and gender) on the duration/benefit elasticity.

Appendix

A generalized additive regression model (GAM) is a semiparametric (or, synonymously, partial linear) generalized linear model (GLM), specified as the sum of nonparametric and parametric regression components. The purpose of the nonparametric regression component is to accommodate a possibly nonlinear influence of a covariate (or a set of multiple covariates). The estimation of the nonparametric component requires a smoother.

Similar to generalized additive models, partial linear regression models consist of nonparametric and parametric components. Unlike traditional regression approaches (including generalized linear additive models), which quantify the influence of covarariates on the mean of the dependent variable, quantile regression models gauge the influence of covariates on quantiles of interest, such as the median.

The design of a quasi-experiment differs from that of a (controlled) experiment in that the assignment to control group and treatment group is not random (but still outside the control of the person conducting the experiment).

The thin plate regression spline is a smoother that finds its analogy in the bending of sheets of metal. A major advantage of the thin plate spline is that it has no free parameters that need tuning. Like other smoothers, the purpose of the thin plate regression spline is to discern a (potentially) nonlinear functional form in the data.

Total variation regularization is a method of "de-noising" data, that is, a way of discerning the underlying structure in data points observed with error. In the semi-parametric quantile regression model discussed here, total variation regularization serves as a smoother.

M estimation is a technique where extreme deviations from the conditional mean of the dependent variables are downweighted. That way, the estimated coefficients are robust to outliers (in the dependent variable). By contrast, least squares regression, which has a quadratic objective function, affords the same weight to all observations.

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Abbreviations and notations

NCCI, National Council on Compensation Insurance, Inc.
PPD, Permanent Partial Disability
PTD, Permanent Total Disability
TPD, Temporary Partial Disability
TTD, Temporary Total Disability

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