The Seasonal Timing of Work-Related Injuries October 2013

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Abstract
The Bureau of Labor Statistics' Survey of Occupational Injuries and Illnesses (SOII) is an establishment survey designed to produce annual estimates of nonfatal workplace injury counts and rates. The SOII collects substantial detail on worker and case characteristics, including the injury date, for injuries that lead to lost work time. I utilize this information to show within-year patterns of the timing of injuries. More injuries occur during the summer months than at other times of the year. In addition, injuries are much less frequently reported near the end of the calendar year. Lower end-of-year injury rates are pronounced for types of injuries that are harder to verify, suggesting a reporting effect whereby some injuries may not be identified in time for respondents to report them to the survey.

Key Words: workplace injuries, post-stratification

1. Introduction

The Bureau of Labor Statistics' Survey of Occupational Injuries and Illnesses (SOII) is an establishment survey designed to produce annual estimates of nonfatal workplace injury counts and rates.[1] The SOII collects substantial detail on worker and case characteristics, including the injury date, for injuries that lead to lost work time. I combine these data with data on actual work time from the American Time Use Survey (ATUS) to construct seasonal patterns in injury counts and rates.

The SOII design supports annual estimates, and it need not appropriately represent its chosen population for any particular month or season of the year. For example, SOII weights are benchmarked to represent annual (not monthly or quarterly) employment totals within sampling cells. One purpose of this project is to derive a post-stratification strategy that allows one to study various within-year injury patterns using SOII microdata.

There are several reasons to study within-year temporal patterns of work-related injuries. Economists are interested in seasonal patterns of worker productivity as they relate to economic activity (Barsky and Miron (1998)), and avoidance of injury is one form of worker productivity. Some work has been done on whether workplace injuries are more likely to be reported early in the workweek, and why that might be so (Card and McCall (1996), Ruser (1998)). Others are interested in direct physiological effects associated with time of work or changing temperature or light (Forston (2004), Barnes and Wagner (2009)).

One reason stressed here for looking at seasonal variation in injuries is to gauge the possible importance of a particular type of misreporting. Recent work comparing the SOII to Workers' Compensation (WC) administrative data concludes that the SOII undercounts injury and illness cases, and one avenue for this undercount may be a failure of employers to recognize some injuries in time to report to the SOII (Boden and Ozonoff (2008), Ruser (2008), Nestoriak and Pierce (2009)). Under this hypothesis, injuries that

[1] The SOII includes data on both injuries and illnesses, which I refer to in shorthand as "injuries" or "injury cases".

occur late in the year and that have less clear onset are more likely to be overlooked. Declines in reported injury rates near year end for such injury types would be consistent with that hypothesis.

2. Data Sources

The SOII is unique in being the only recurring, large scale survey of work-related injuries in the U.S. The SOII contacts approximately 250,000 sampled establishments each year and collects information recorded on injury logs as required under Occupational Safety and Health Administration (OSHA) law and regulation. Employers record information on the OSHA log, based on their understanding of OSHA reporting requirements. Participants in the survey – participation is mandatory under law – are notified of their selection prior to the beginning of the reference year. Data are then collected by BLS in the first few months of the year following the reference year. In addition to summary data providing total numbers of recordable injury cases, additional worker demographics and case characteristics are collected for the subset of injuries that result in one or more days away from work (DAFW cases). Additional details available for these cases include the age and gender of the injured worker and the date of incident, the nature of the disabling condition including the part of the body affected, and the event and source producing the condition.

The SOII is a stratified sample so that summary statistics can be published for a set of pre-determined industries for each state. Each stratum is defined by the establishment's state, industry, size class, and ownership (private, state government, or local government). The sample is allocated across strata in order to minimize variance in the total recordable cases incidence rate. Each establishment is assigned a weight based on the sampling rate within its strata (some strata are certainty strata). Weights adjustments correct for factors such as nonresponse, subsampling of cases within some establishments, and employment growth in the population between date of sampling and the reference period.[2] The final weight is then used in conjunction with the injury and illness information to estimate population level totals. As mentioned above, SOII weights are designed to reflect an annual rather than a monthly population. For this project I further post-stratify the SOII weights (as described in the appendix) so that they represent injury totals for each month in the reference year.

The SOII sample analyzed here consists of 2003-2010 U.S. private sector cases, with certain exclusions. Data for some industry sectors, the mining and railroad industries, are not collected via survey instrument but are based on administrative data from other sources. These records do not include date of injury and are excluded from the analysis. I also exclude the agricultural industry; SOII does not cover small farms, and short of excluding the entire industry I cannot harmonize the SOII and ATUS population scopes. Finally, observations with missing values for worker characteristics are excluded. The years 2003-2010 are convenient in being fairly recent and having consistent industry and occupation coding structures. Pooling of years is helpful in obtaining precision. The final sample contains approximately 1.7 million injury and illness records.

For the purposes of constructing injury rates, I also use information on the timing of work from the American Time Use Survey (ATUS). The ATUS collects information on individuals' daily activities, including work, through time use diaries. The ATUS is a particularly useful source because it has information on actual work hours at identified dates and times, alongside worker and job characteristics. For example, employees on leave at the interview reference date will not register as supplying hours worked. As a follow-on survey to the Current Population Survey (CPS), the ATUS is a household survey designed to represent the U.S. civilian population aged 15 and older. The ATUS also contains labor force

[2] See U.S. Department of Labor (2013) and Selby, Burdette, and Huband (2008) for details.

information on the respondent collected via a modified CPS questionnaire.[3] To harmonize the scopes of the injury and hours worked data, I pool 2003-2010 ATUS data, restricting the samples to include private sector employees exclusive of the mining, railroad and agriculture industries. The resulting ATUS sample includes approximately 32,000 records.

3. Results

To derive counts for given injury type, month, and year, one adds up the adjusted SOII sampling weights for cases of the given type and time period, as in

$$X_{kmt} = \sum_i \alpha_{it} \, d_{ikmt}$$

where the α_{it} are adjusted sampling weights for case i, the d_{ikmt} are indicator variables equal to one if case i is of type k and occurs in month m and year t, and X refers to injuries. In the tables below, these statistics are normed by the number of days in the month (to abstract from differences in length of month), and averaged over years.[4]

To derive injury rates, one needs to incorporate hours worked. Define hours worked in the month and year as

$$H_{mt} = \sum_j \beta_{jt} \, h_{jmt}$$

where the β_{jt} are adjusted ATUS sampling weights for person j, h_{jmt} is hours worked by person j in month m and year t. H_{mt} is constructed in full-time equivalent (FTE) units.[5] As above, these statistics are averaged over years. Monthly injury rates are constructed as the 2003-2010 average injury count divided by the 2003-2010 average for hours worked, for the month in question.

Table 1 gives injury statistics by month of injury. The column labeled “Injuries per Day” shows the number of DAFW injuries occurring per day within the stated month; showing daily rather than monthly totals standardizes for the fact that months differ in length. For example, the January figure indicates there were on average 3097.2 injuries reported per day in that month over the 2003-2010 period. The annual statistic at the bottom of the column, 3036.9, implies that there were about 1.1 million DAFW injuries reported annually over this period (3036.9 per day times 365¼ days gives about 1.1 million per year).

Injury counts rise somewhat in the summer months, and decline beginning in autumn, with especially large drops in November and December. The Injury Index column measures the injury counts relative to the annual statistic, to more clearly show percentage changes. The December daily injury count is 23 percent lower than the corresponding January statistic. There is something different at the end of the year, including perhaps work-time exposure, which results in a different measured injury count.

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[3] ATUS data is available via annual public use files. For ATUS background and documentation visit http://www.bls.gov/tus/. For a discussion of ATUS hours worked measures see Frazis and Stewart (2004).

[4] Within-year seasonal patterns are very similar across the pooled years. However, pooling does obscure a downward trend in injury rates over the entire period.

[5] Injury rates are shown on a per 10,000 FTE basis. One FTE unit is defined as 2000 hours worked, which is equivalent to a 40 hour workweek over 50 weeks during the year. Because the injury rates presented here are constructed from ATUS data, they are not comparable to injury rates normally produced by the SOII. The SOII does not collect monthly hours worked data to construct within-year injury rate statistics.

To net out any seasonality due to work-time exposure, the next column presents injury rate statistics. Injury rates are constructed by dividing injury counts by hours worked, normed to be on a per 10,000 FTE basis. The annual statistic of 101.9 per 10,000 indicates that DAFW injuries are unusual but not rare, occurring roughly one time per 100 FTE workers. The final column in table 1 presents an injury rate index, which is the monthly injury rate divided by the annual injury rate statistic.

Injury rate and injury count patterns show some similarities. In particular, netting out work exposure by looking at injury rates does not eliminate the year-end decline. Injury rates are roughly 15 percent higher in January than in December. This may reflect real seasonal effects, as well as reporting effects where employers do not recognize all late-year cases in time for reporting to SOII.

To further gauge the possibilities, I present monthly statistics by injury type. Two important dimensions along which injuries vary are the nature of the injury and the duration of the injury. Table 2 gives distributions of the data along each of these dimensions. The first panel shows the nature of injury (in essence, what physical harm was caused by the injury or illness). The categories shown are important groupings for SOII published statistics, and have been used elsewhere (Card and McCall (1996), Ruser (1998)) to distinguish between injuries in terms of severity and ease of identification.

The modal DAFW case in the SOII data is a soft tissue damage injury. There are, apparently, a huge variety of ways that workers can reach, twist, or lift their way to injury. There is a suspicion that it is hard to objectively identify the severity and even work-relatedness of such injuries (Nestoriak and Pierce (2009)). For example, it may be difficult to distinguish between initial injury and re-injuries for these sorts of cases. These injuries tend to be more severe in terms of duration than the average injury. Some other categories of injuries in the table, including fractures, wounds, and cases with multiple injuries, are arguably more likely to occur with sudden onset and be more apparent or objectively identifiable. On the other hand, injuries due to soreness or pain would seem especially hard to identify or quantify. The SOII also captures illnesses, although the survey is widely understood to miss long latent illnesses such as asbestosis (Ruser (2008)). Among conditions that typically have long latency, I show Carpal Tunnel Syndrome (CTS) and tendonitis cases. Although quite different maladies, CTS and tendonitis can be long-lived, chronic conditions arising with slow onset.

Table 2 also shows the distribution of cases by injury severity as measured by days away from work. There are many short-duration cases in the SOII. The distribution is one with a long tail, and the distribution shown here truncates at a fairly low level.

Table 3 gives monthly statistics for select natures of injury. The table reports the injury rate index, which corresponds to the last column from table 1. Because the statistics are derived from injury rates, they net out any seasonal differences in work exposure. The first two types of injuries, fractures and multiple injuries, are chosen as types where one expects more sudden onset and less ambiguity about severity or work-relatedness. The final two columns show statistics for soreness and pain, and CTS and tendonitis, types where cases may have less clarity about the date of onset.

The fractures and multiple injuries columns do not show a drastic drop in injury rates near the end of the calendar year. There is some within-year variation in injury rates for these two nature types, but generally speaking the variation is smaller in magnitude and not coincident with the whole sample results. For example, the injury rate index for fractures is 1.09 for December, 1.06 for January and 1.11 for February. This pattern may suggest a cold weather effect for this type of injury, but does not in itself suggest a late year reporting issue.

The final two columns give the injury rate index for what are perhaps more ambiguous injuries. The series for soreness and pain injuries shows a substantial January/December differential in injury rates. The CTS/tendonitis series is quite remarkable and deserves further consideration. That series has quite substantial within-year variation in injury rates. It is unique in having a fairly pronounced downward trend in injury rates through most of the year, and not just at the end of the year. A randomly chosen SOII CTS case is approximately 4 times more likely to be a January case than a December case. It is unlikely that January work is truly four times as dangerous as December work for risk of developing CTS or tendonitis. Some cases – especially late-year cases – may not be detected by employers in time for inclusion on the OSHA logs. However, the CTS/tendonitis series suggests differential effects throughout the year, and not just at the end of the year, and it is unclear why employers would not learn about (say) most July injuries in time to report them on the OSHA logs prior to survey response.

A slightly different aspect of injuries is shown in table 4. Here I distinguish injury cases by the resulting number of days away from work. For shorter duration injuries, December injury rates have an index value of approximately 1.0, meaning the December injury rate has a similar magnitude to the analogous annual injury rate. Longer duration injuries, those with 11 or more days away from work, show a stark December/January contrast. One explanation for these results is that injury duration may indicate the difficulty of injury ascertainment.[6]

4. Discussion and Further Work

This paper is the first to explicitly document the seasonal pattern of work-related injuries in the SOII. In particular, there is a decided year-end decline in reported SOII injury cases. One hypothesis behind this pattern is that some injuries are difficult to identify, or to identify as work-related, in time for reporting to SOII. The fact that the year-end decline in reported injuries is substantial for more difficult to diagnose injury types is consistent with this hypothesis.

How important is this possible reporting effect? Unfortunately, it is unclear what the seasonal pattern of injuries would be, absent such reporting effects. One possible approach is to use autumn injury reports as a counterfactual. For instance, based on table 1 results, SOII annual totals would be about 4 percent higher if October-December injury counts were as high as September injury counts. This is a small estimate of under-reporting as compared to the results of Boden and Ozonoff (2008). Of course, I only examine differential year-end reporting, whereas the Boden-Ozonoff study does not restrict consideration to any single reporting mechanism.

The results presented here should be interpreted cautiously, because of the possibility of real seasonal effects. As an example, workers may be more susceptible to fractures during colder weather, and if so drawing conclusions based on observed seasonal patterns becomes more difficult. As another example, injury timing may be somewhat elastic and subject to choice if workers can defer treatment or time off until more convenient periods (such as after end-of-year holiday periods). Furthermore, the nature of work or the industrial composition of economic activity may vary over the course of the year. Such possibilities point to the importance of incorporating additional controls where possible. Future work will include controls for industry, occupation, worker characteristics and other factors that vary over the year, in order to generate seasonal injury patterns net of such factors.

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[6] In addition, there may be a different type of reporting error at work here, with reported injury duration truncated for late-year cases. That is, duration of ongoing cases may be truncated by reporters at the time of report, and such truncation would more likely affect late-year cases. Of course, this particular type of reporting issue is separate and distinct from any failure to correctly identify the case in time for survey response.

The results here suggest other analyses and data sources. It would be helpful to document the seasonal pattern of work-related fatalities, which are for the most part well-identified. It would be useful to have external measures on the ease of determining work-relatedness for any particular case. Such external measures might be derived from, for example, the relative frequencies of injury types among workers admitted to emergency care facilities. Finally, comparisons to other data sources without any clear year-end reporting effects, possibly including workers' compensation administrative records, would provide an interesting falsification experiment.

References

Barnes CM, Wagner DT (2009). Changing to Daylight Saving Time Cuts into Sleep and Increases Workplace Injuries. *Journal of Applied Psychology*, 94(5): 1305–1317.

Barsky RB, Miron JA (1998). The Seasonal Cycle and the Business Cycle. *Journal of Political Economy*. 97(3): 503-534.

Boden LI, Ozonoff A (2008). Capture-recapture estimates of nonfatal workplace injuries and illnesses. *Annals of Epidemiology*. 18(6): 500-506.

Card D, McCall BP (1996). Is workers' compensation covering uninsured medical costs? Evidence from the 'Monday Effect'. *Industrial and Labor Relations Review*, 49, 690-706.

Fortson K (2004). The diurnal pattern of on-the-job injuries. *Monthly Labor Review*, September, 18–25.

Frazis H, Stewart J (2004). What can time-use data tell us about hours of work? *Monthly Labor Review*, December, 3-24.

Fuller W (1966). Estimation employing post strata. *Journal of the American Statistical Association*, 61, 1171-1183.

Holt D, Smith TMF (1979). Post stratification. *Journal of the Royal Statistical Society* Ser. A, 142, 33-46.

Nestoriak N, Pierce B (2009). Comparing workers' compensation claims with establishments' responses to the SOII. *Monthly Labor Review*, May, 57-64.

Ruser JW (1998). Does workers' compensation encourage hard-to-diagnose injuries? *The Journal of Risk and Insurance*, 65, 101-124.

Ruser JW (2008). Examining evidence on whether BLS undercounts workplaces injuries and illnesses. *Monthly Labor Review*, August, 20-32.

Selby PN, Burdette TM, Huband E (2008). Overview of the Survey of Occupational Injuries and Illnesses sample design and estimation methodology. In *JSM Proceedings*, Section on Survey Research Methods. Alexandria, VA: American Statistical Association. 1337-1344.

U.S. Department of Labor, Bureau of Labor Statistics (2013). Handbook of Methods. Accessed at http://www.bls.gov/opub/hom/pdf/homch9.pdf.

Zhang L (2000). Post-stratification and calibration – a synthesis. *The American Statistician*, 54(3), 178-184.

Table 1: Injury Estimates, by Month

Month	Injuries per Day	Injury Index	Injury Rate per 10,000 FTE	Injury Rate Index
January	3097.2	1.02	104.0	1.02
February	3119.0	1.03	103.5	1.02
March	2990.8	0.99	98.7	0.97
April	3036.4	1.00	97.5	0.96
May	3004.4	0.99	103.0	1.01
June	3336.0	1.10	110.9	1.09
July	3282.4	1.08	114.2	1.12
August	3375.5	1.11	105.8	1.04
September	3152.5	1.04	107.2	1.05
October	3062.0	1.01	96.8	0.95
November	2622.7	0.86	92.9	0.91
December	2371.3	0.78	87.7	0.86
Annual	3036.9	1.0	101.9	1.0

Notes. Statistics refer to days away from work (DAFW) injury cases. Injuries per Day is the number of DAFW cases occurring per day within the stated month. Injury Index is the monthly values divided by the annual value for Injuries per Day. Injury Rate is the number of DAFW injuries occurring per 10,000 full-time equivalent workers (defining a full-time worker equivalent as 2000 hours worked per year). Injury Rate Index is the monthly values divided by the annual value for Injury Rate. Source data for injuries is 2003-2010 SOII microdata. Source data for employment to construct injury rates is 2003-2010 ATUS data. Because employment source data is external to the SOII, injury rate estimates presented here are not directly comparable to injury rate estimates produced by the SOII program.

Table 2: Distribution of Injuries by Nature and Duration

Nature of Injury	Percent of Injuries
sprains, strains, tears	40.4
fractures	7.8
open wounds	10.4
surface wounds	10.6
multiple injuries	4.0
soreness, pain	9.3
other injuries	10.8
CTS, tendonitis	1.7
all other natures	4.9
Duration of Injury	**Percent of Injuries**
1-2 days	25.7
3-5 days	18.2
6-10 days	12.4
11+ days	43.6

Notes. Statistics refer to days away from work (DAFW) injury cases. Source is 2003-2010 SOII microdata.

Table 3: Injury Rate Indexes, by Month and Nature of Injury

Month	Fractures	Multiple Injuries	Soreness, Pain	CTS, Tendonitis
January	1.06	1.04	1.09	1.52
February	1.11	0.98	1.04	1.30
March	0.88	0.96	0.98	1.14
April	0.89	0.93	0.94	1.22
May	0.97	0.99	1.00	1.19
June	1.02	1.05	1.05	1.10
July	1.00	1.09	1.06	1.00
August	0.99	0.99	1.02	0.96
September	1.05	1.08	1.04	0.84
October	0.98	0.96	0.98	0.73
November	0.99	0.94	0.95	0.54
December	1.09	0.98	0.85	0.41

Notes. Statistics refer to days away from work (DAFW) injury cases. The Injury Rate Index is the monthly value for the injury rate divided by the annual value for the injury rate. Source data for injuries is 2003-2010 SOII microdata. Source data for employment to construct injury rates is 2003-2010 ATUS data.

Table 4: Injury Rate Indexes, by Month and Duration of Injury

Month	1-2 days	3-5 days	6-10 days	11+ days
January	0.96	0.93	0.99	1.10
February	0.95	0.96	1.00	1.08
March	0.93	0.94	0.92	1.02
April	0.91	0.93	0.94	1.00
May	0.99	0.98	0.99	1.04
June	1.10	1.08	1.05	1.10
July	1.12	1.13	1.13	1.12
August	1.05	1.05	1.05	1.03
September	1.05	1.08	1.04	1.05
October	0.97	0.99	0.96	0.92
November	0.99	0.95	0.92	0.85
December	1.00	0.99	1.02	0.68

Notes. Statistics refer to days away from work (DAFW) injury cases. The Injury Rate Index is the monthly value for the injury rate divided by the annual value for the injury rate. Source data for injuries is 2003-2010 SOII microdata. Source data for employment to construct injury rates is 2003-2010 ATUS data.

Appendix: Post-Stratification Weights Adjustments for SOII

Neither the SOII nor the ATUS is designed to produce estimates at monthly intervals. In order to properly represent the finer time dimension used here, I post-stratify the sampling weights in both data sources (Fuller (1966), Holt and Smith (1979), Zhang (2000)). Because my interest is mainly on the injury side of the data, I focus here on the SOII adjustments.

SOII weights are adjusted for two reasons. One is that SOII benchmarks sample employment to annual rather than monthly totals. The second reason is that for some establishments the SOII does not collect information for all DAFW injuries occurring throughout the year, but rather subsamples cases by date of injury.

SOII weights for the private sector U.S. are designed to represent annual employment totals within detailed industry strata. I adjust SOII weights so that sample 3-digit NAICS industry employment totals within year and month sum to population employment totals. Population employment totals are derived from the BLS' Longitudinal Data Base (LDB) which forms the main component of the sampling frame for the SOII.

In order to reduce respondent burden, the SOII subsamples cases for establishments with large numbers of injuries. About 10 percent of (weighted) DAFW cases in any given year come from subsampling establishments. The subsampling is accomplished by randomly assigning reporting intervals within the year and directing the establishment to report case totals for the entire year but case details, including injury date, only for cases occurring within the assigned reporting intervals. To estimate case level statistics, the SOII weights up the collected cases to represent the establishment's total number of DAFW cases. So long as the reporting interval assignments are random and balanced, no bias in terms of date coverage will accrue. To avoid the possibility of unbalanced interval assignments, I adjust case weights among the subsampling establishments. These date-specific adjustment factors are derived by post-stratifying the assigned reporting windows to a uniform distribution of dates within any year. These adjustments undo any over- or under-sampling of a particular date for case collection.