CPWR
THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

Safety Benefits of Mandatory OSHA 10 Hour Training

Edward L. Taylor, BS, MBA, MA
University of Tennessee

June 2014
CPWR Small Study Final Report

8484 Georgia Avenue
Suite 1000
Silver Spring, MD 20910

PHONE: 301.578.8500
FAX: 301.578.8572

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Edward L. Taylor, BS, MBA, MA
Executive Director
Construction Industry Research and Policy Center
University of Tennessee

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I. ABSTRACT

Construction is an inherently dangerous industry. Injury rates for the industry annually rank near the top of all U.S. industries. The U.S. Department of Labor Occupational Safety and Health Administration (OSHA) is charged with regulating workplace safety. Towards this end, they provide enforcement, authorize safety trainers, and issue training certifications. For construction, there is an introductory ten hour safety course appropriately named OSHA 10 Hour Training (OSHA 10). In the past decade, seven states mandated that construction workers on most public projects receive certification in OSHA 10 to learn awareness of construction hazards and best practices in safety. In an attempt to validate these policy mandates, this paper constructs a statistical analysis for evidence of reduced injury rates in these states during the period 2004 – 2012 and examines fatality rate trends from 2008 - 2011. The results show mild evidence that injury rates were more than 1 percent lower as mandated training increased the trained workforce by 1 percentage point and that fatality rates post-mandate were lowest for training states.

II. OBJECTIVES

The study's objective is to determine if the mandated OSHA 10 for workers on public projects has a measurable impact on state fatal and non-fatal injury and illness rates reported by the Bureau of Labor Statistics (BLS).

III. ACCOMPLISHMENTS

The study looks at both non-fatal injuries and fatalities. The injury analysis includes variables in the model to compensate for known underreporting of injuries and the possibility that the 2008 economic recession or other exogenous shocks (i.e. state mandates) altered the nature of underreporting. In addition, the structure of the model attempts to capture the randomness in individual state underreporting.

The fatality analysis makes trend comparisons of different strata. The first set was between training states in post-mandate years vs. all others. The second stratification examined fatality trends by state private construction union density.

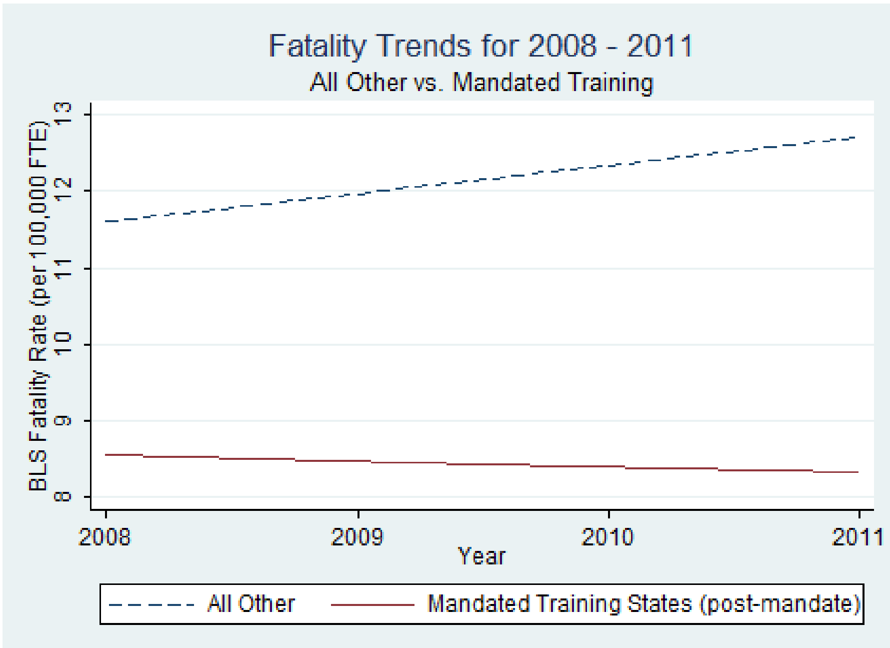

Figure 1. Fatality Trends All Other vs. Mandatory Training

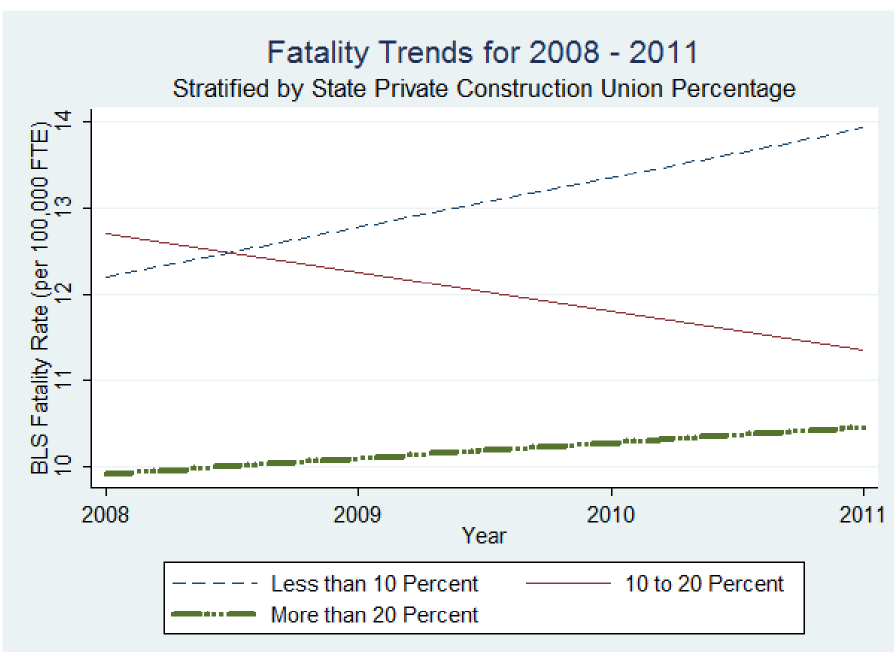

Figure 2. Fatality Trends by Union Density

IV. KEY FINDINGS

The following are key findings:

- With the most comprehensive data set (43 states), two analyses show that mandatory training narrowly misses having a conclusive beneficial effect as defined by statistical practice.
- In additional analyses limited to states with significant union participation (26 states), the evidence of a mandatory training effect diminishes slightly.
- In post-mandate years, mandatory training states have lower fatality rates than any other group (see Figures 1 and 2).
- The 2008 recession caused a significant decrease in reported injury rates (see Figure 3).

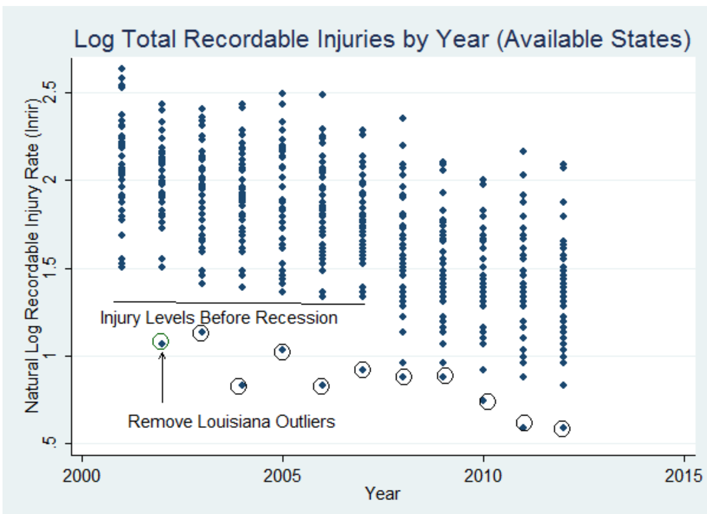

FIGURE 3. The Natural Log of State Injury Rates by Year (2001 – 2012)

V. PUBLICATIONS AND PRESENTATIONS

To date there have been no publication submittals or presentations. In the coming weeks, we will be actively seeking an appropriate publication outlet and welcome suggestions from CPWR.

VI. SUMMARY

The fatality trend analysis results are easy to visualize from Figures 1 and 2. The mandatory training group clearly has the lowest levels and a non-increasing trend. Given that unions actively promote themselves as providing more and better training, it is encouraging that the training states outperformed even those with the highest union density.

The statistical analyses isolate the effect of training in post-mandate years for the mandatory training states and compare their injury rates to those of control groups while also considering unobserved differences between the individual states. The statistical model used, a regression analysis, provides a tool to isolate and measure the training effect apart from other effects on injury rates. Other effects include adjustments for the economic downturn of 2008, a trend of declining injury rates, the timing of the individual state mandates, and the union share of the private construction workforce. The key variable interacts mandated training and a proxy for the proportion of the trained workforce to test for a marginal effect from the state mandates.

Data available included the proportion of state private construction union membership by year and the BLS state injury rates for 43 states during the study period. The union share is of particular importance since previous research indicated that mandated training occurred primarily in the union sector.

Results indicate moderately improved safety with mandatory training. In mandated training states, a one percentage point increase in a state's union sector (hence additional workers trained) results in a 1.2 percent decrease in injury rates for those states. However, the results are not statistically significant because this significance requires that the observed data meet a certainty threshold. Typically the analysis must exhibit no more variability than that which could cause a false conclusion up to one time in twenty (a 0.05 probability). Unfortunately our conclusion of improved safety has as much as a 0.08 probability of occurring randomly while actually being false. A second smaller analysis of 26 more homogeneous states fares worse with a 0.15 probability of a false conclusion.

Though the study uses advanced techniques to overcome data limitations, improved data collection on injury rates and more information on the mode of the training delivery might have resulted in significance. Other research studies have shown non-conclusive evidence of improved safety outcomes after training. This is particularly vexing because the same studies show training increases knowledge and improves behaviors. In conclusion, the results are highly encouraging but more work is needed to validate the policy of mandated training in the public construction sector.

VII. FURTHER STUDY

The study assumes that the magnitude of injury underreporting was constant unless there is an exogenous shock. Though compensated for within the model, the recession of 2008 appears to be such a shock. Construction was one of the hardest hit industries in the recession. One theory is that injury reporting drops because workers fear for their jobs. It would be interesting to test this hypothesis. The Construction Industry Research and Policy Center is hoping to receive research funds from a partner to pursue this and other ideas tangential to this work.

Safety Benefits of Mandatory OSHA 10 Hour Training

Edward L. Taylor*

June 20, 2014

Abstract

Construction is an inherently dangerous industry. Injury rates for the industry annually rank near the top of all U.S. industries. The Occupational Safety and Health Administration (OSHA) is charged with regulating workplace safety. Towards this end, they provide enforcement and promote training. A standardized 10 hour training course sanctioned by OSHA is available for construction workers in all states. In 2004, Massachusetts became the first of seven states to legislate mandated OSHA 10 hour training for construction workers on most public projects. Previous studies have shown that occupational safety training has beneficial effects on knowledge gain and improved behavior but there is weak evidence for improved safety outcomes. The natural experiment created by mandated training provided the opportunity to study the effects of mandated training on these outcomes. This study uses the Bureau of Labor Statistics (BLS) 2004 - 2012 State Occupational Injury and Illness data in a random effects multiple regression analysis and BLS 2008 - 2011 fatality data from the Census of Fatal Occupational Injuries to examine fatality trends across different strata. The results are highly encouraging but fall short of definitive evidence. The post-mandate fatality trend results compare favorably against other state groupings and the non-fatal injury regression indicated a nearly statistically significant marginal effect for mandated training. However these results are clouded by the short duration of trend data and of injury data known to be underreported. Recommendations include more extensive recordkeeping for OSHA 10 hour training and improved injury surveillance. These changes would result in more reliable data that could help affirm that mandatory training improves construction safety outcomes.

1 Introduction

Construction is an inherently dangerous industry. In 2012, there were 775 private sector construction fatalities;[1] more than any other industry. The Occupational Safety and Health Administration (OSHA) is charged with the regulation of construction safety. With approximately 2200 inspectors for 8M worksites,[2] only a tiny percentage of worksites ever get inspected. Therefore, punishment for safety infractions may have limited effectiveness in accident prevention. Prevention through education and training appears to be the preferred and more effective alternative.

Recognizing the value of safety training, OSHA approves individuals and organizations to conduct a standardized 10 hour course for construction workers. The OSHA 10 hour construction training[3] teaches recognition and awareness of common hazards as well as prevention measures.

*The University of Tennessee, Knoxville, TN

[1] https://www.osha.gov/oshstats/commonstats.html

[2] Includes all industries, not just construction.

[3] For ease of composition, this training will be referred to as just OSHA 10 hereafter.

Construction unions have played a huge role in safety training during the last thirty years. In 1994, The Center for Construction Research and Training (CPWR) was a partner in forming the National Resource Center (NRC). The NRC worked with affiliated trade unions to structure an OSHA 10 curriculum and become an authorized education center eligible to train the trainers for OSHA 10. Commercial and industrial building trade unions have since made OSHA 10 a mandatory part of their apprenticeship programs and campaigned for public agencies to mandate the training on public construction contracts. As a result, it is estimated that 25 percent of U.S. construction workers (Sinyai et al. 2013) have now received this training.

In 2004, Massachusetts became the first of seven states[4] to legislate mandated OSHA 10 training for workers on public projects. Since public work comprises over one-fourth of all construction and nearly all public construction falls under the individual state mandates, a measurable state level reduction in injuries and illnesses might be anticipated in those states.[5] One study (Roelofs 2012) clearly demonstrated qualitative benefits from this mandated training within Massachusetts where union workers were much more likely to receive OSHA 10 (97 percent) than nonunion workers (17 percent). To date, no follow up quantitative study has been made to determine if these seven mandates have yielded relative improvements in fatality and injury rates.

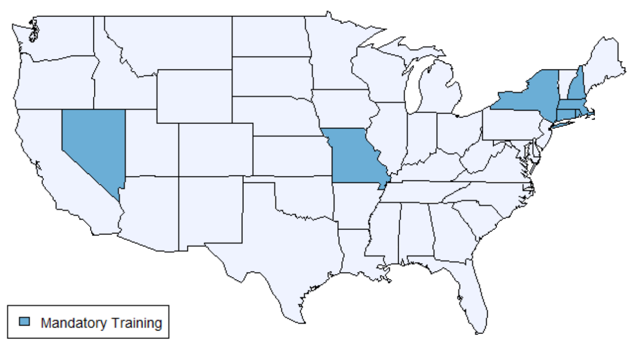

Figure 1: States Having Mandatory OSHA 10 Training

With seven states (see Figure 1) now requiring OSHA 10 trained workers for most public projects, sufficient data is available to attempt a quantitative analysis. The collective state mandates effectively created a natural experiment allowing the testing of a marginal effect on injury rates. Given sufficient data, marginal effects can be verified or discounted by using regression analysis. Unfortunately, insufficient observations exist for regression on fatality data, but trend comparisons can be made.

[4]The others are CT, NH, NY, NV, MO, and RI. Though MA legislated first, RI implemented earlier.

[5]Fatality reductions are harder to assess since individual state counts are typically small and subject to much annual variation.

2 Background

There is such an abundance of available literature regarding training's effectiveness as a component of occupational safety and health that a literature search proved cumbersome. Many of the previous studies were small, narrowly focused, and of questionable quality. Therefore, gleaning useful information would have been extremely difficult except for three meta-analyses (Cohen and Colligan 1998, Burke et al. 2006, Robson et al. 2012). This literature review focused on these and a few other applicable studies.

The three meta-analyses possess a common set of factors for evaluation. They are:

- Does training increase safety knowledge?
- Does training result in safer workplace behavior?
- Does training result in better safety outcomes?

Also of note, Burke determined that the lesser engaging forms of training were less effective. See Table 1 for a summary of meta-analyses results. Given the relatively positive results on knowledge and behavior, it is puzzling that the evidence on improved outcomes is so weak.

Table 1: Meta-Analyses Selected Results

Study	**Knowlege**	**Behavior**	**Outcomes**
Cohen et. al.	+	+	?
Burke et al.	+	+	+
Robson et al.	?	+	?

+ Improved, ? Not Conclusive

Referring to three separate smaller studies, Cohen and Colligan posit, "... one could argue that faulty or bad training may have worse consequences than no training at all." Interestingly, a lesser engaging form of training, OSHA 10 <u>online</u> is growing more prevalent.

Since online training now approaches 20 percent of OSHA outreach training (see Figure 2), this is a matter of concern when considering the effectiveness of mandatory OSHA 10 and Burke's finding regarding the level of engagement. In the Massachusetts study, this form of training is denounced by Roelofs as having little or no value. None of the surveyed workers in Massachusetts received online training. No information is available on the other states.

In a study with important implications, non-fatal injury rates were shown to be vastly underreported (Probst et al. 2008). The authors showed construction injuries were underreported by over 80 percent in organizations with negative safety climates as by 47 percent in those with positive safety climates. Other studies (Dong et al. 2011 and Glazner et al. 1998) confirmed substantial injury underreporting in construction.

Weak evidence supporting the critical metric of training effectiveness, improved safety outcomes, and lack of studies specific to the construction industry led to the idea of assessing the marginal effect of mandated OSHA 10. Roelofs' qualitative evaluation of the benefits of OSHA 10 training lacked a quantitative verification of improved outcomes. A key finding stated, "More research is required to better understand the impact of construction safety training on safety

Figure 2: OSHA Online Training
https://www.osha.gov/dte/outreach/outreach_growth.html

performance." Cohen and Colligan previously reached the same conclusion: "Especially challenging and needed are studies to definitively tie immediate training results, e.g. increased knowledge of hazards and safer work behaviors, to outcome indicators such as reduced worker injuries and illness."

In addition to the seven states mandating OSHA 10 for most public projects, some private owners may insist on OSHA 10 trained workers for their projects on the assumption that fewer accidents and injuries bring lower project costs. Over the last decade, mandated OSHA 10 has yielded enough state data for some quantitative research specific to the construction industry.

Mandated training strengthens the training portfolio of many firms; especially in the non-union sector where training may be less emphasized. Quantitatively demonstrating the effectiveness and benefits of OSHA 10 might incentivize owners and employers, thus increasing the number of trained workers and the share of work they perform.

3 Data

This analysis focuses primarily on annual injury and illness data because comparable fatality rates are available only in years 2008 - 2011. To clarify, fatality counts and rates were published by the Bureau of Labor Statistics (BLS) prior to 2008 but the older rates were employment-based rather than the current exposure-based rates, and BLS expressly cautions against comparing the two measures. Although count data exist, constructing comparable employment-based fatality rates proves extremely difficult because of the lack of consistent and reliable state employment denominators. Instead a trend analysis using the most current BLS rates was performed.[6]

[6] There are no 2008 - 2011 BLS published fatality rates in the Census of Fatal Occupational Injuries for CO, DE, HI, NH, ME, RI, and VT.

The annual injury and illness data for the construction industry (NAICS industry code 23)[7] were obtained from the website of the BLS Survey of Occupational Injuries and Illness (SOII).[8] The state level data were available for most but not all states in the years 2001 - 2012. The injury analysis time frame will be restricted to 2004 - 2012 for current relevance. For comprehensiveness, the injury statistic used is the rate of recordable cases as defined by OSHA.[9] These are rates per 100 full-time equivalent workers and compiled using weighted sampling techniques. The natural log of these continuous numeric data constitutes the response variable in the regression model utilized. A preliminary plot (see Figure 3) of the injury data revealed an obvious set of outliers corresponding to data for Louisiana. Louisiana was then dropped from the analysis. Also obvious is a downward shift in the injury rates corresponding to the economic downturn of 2008. The analysis must consider this shift.

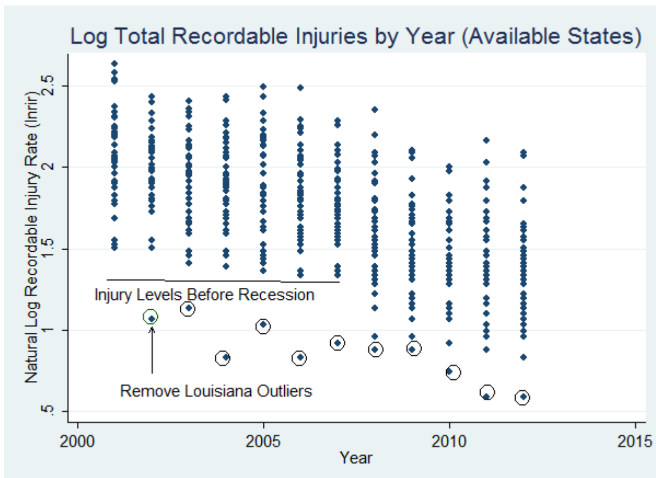

Figure 3: Preliminary Data Check for Response Variable

To identify the states and years of mandatory OSHA 10, a 0-1 indicator variable is utilized. In the mandatory training states, see Table 2, the value is 1 (Yes) in the first and all subsequent years if the mandate was in effect before July 1 of the first year. The value is 0 (No) for all other observations. These data resulted from a web search of the individual state mandates. Since injury data was not available for New Hampshire, it was omitted from the analysis.

Another data element[10] is the percentage of the unionized construction workforce for each state. This continuous variable is expressed as a percentage and a three-year moving average is used for smoothing. It is important as an explanatory variable because Wolford and Larson as

[7]North American Industry Classification System.

[8]In construction only about 3 percent of recordable cases are for illness. For brevity, injury will be used hereafter to refer to illness and injury.

[9]29 CFR 1904.7(a) Basic requirement. You must consider an injury or illness to meet the general recording criteria, and therefore to be recordable, if it results in any of the following: death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness. You must also consider a case to meet the general recording criteria if it involves a significant injury or illness diagnosed by a physician or other licensed health care professional, even if it does not result in death, days away from work, restricted work or job transfer, medical treatment beyond first aid, or loss of consciousness.

[10]From www.unionstats.com

Table 2: Mandatory OSHA10 Training by State

State	No	Yes
CT	2004 - 2006	2007 - 2012
MA	2004 - 2005	2006 - 2012
MO	2004 - 2009	2010 - 2012
NV	2004 - 2009	2010 - 2012
NH	-	-
NY	2004 - 2007	2008 - 2012
RI	-	2004 - 2012

well as Roelofs indicate that union workers are much more likely to receive OSHA 10. See Figure 4 to see a representation of the 2012 smoothed union density.

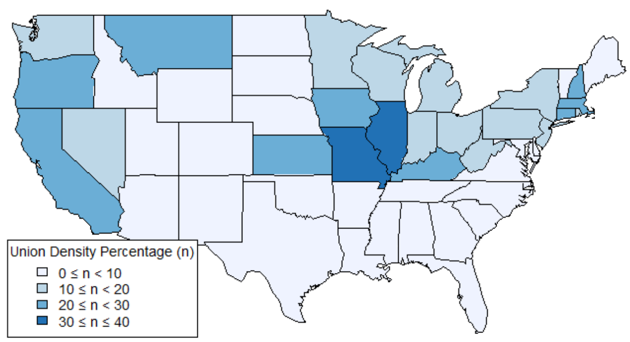

Figure 4: 2012 Three-Year Smoothed Union Density Percentage for Construction Private Sector (AK-22% and HI-34%)

4 Analytical Methods and Results

4.1 Fatalities

The fatality counts used to compile the BLS fatality state rates[11] represented in Figure 5 are considered complete and accurate. Therefore, fatality rate numerators are not subject to sampling variation. In this respect fatality rates are preferred to non-fatal injury rates as a measure of safety outcomes. Unfortunately, fatality rates are subject to higher relative variations especially in the smaller states. Keeping these limitations in mind, we observe some useful information from the stratified trends in Figure 6 and Figure 7.

Among all the subgroup strata, the lowest fatality rates are clearly found in the mandatory training states (post-mandate). Also note that this group has a four year non-increasing trend. Figure 6 clearly shows both the lower fatality rates and a more favorable trend.

[11]Descriptive Statistics; n=155, Mean=11.7, Std. Dev.=6.4, Min.=3.7, Max.=40.5 (per 100,000 FTE)

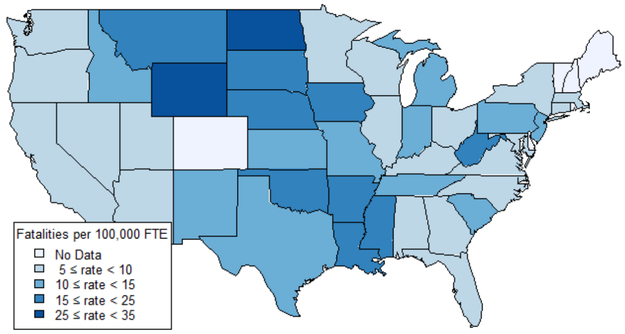

Figure 5: 2008 - 2011 BLS State Fatality Rate Averages (AK - 40.5 in 2010)

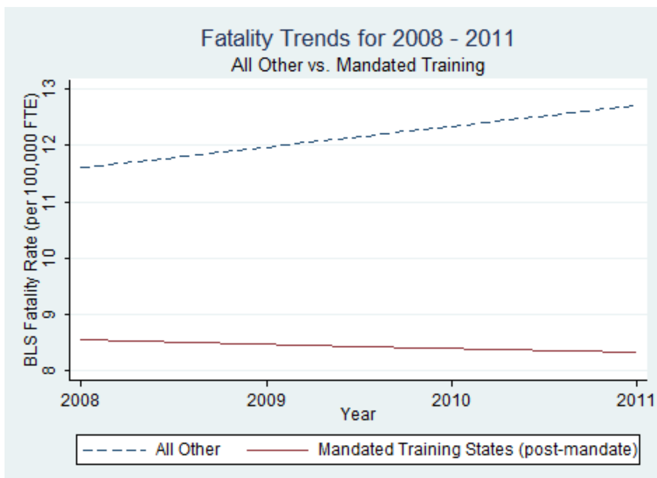

Figure 6: Trends in Fatalities - Training Strata

Figure 7 is also interesting. Considering that union density and training are generally highly correlated, it is interesting that the training group in Figure 7 performed better than the highest union density states (more than 20 percent) in terms of both level and trend. Though cause and effect cannot be established, this association between mandatory training and lower fatality rates seems both interesting and encouraging.

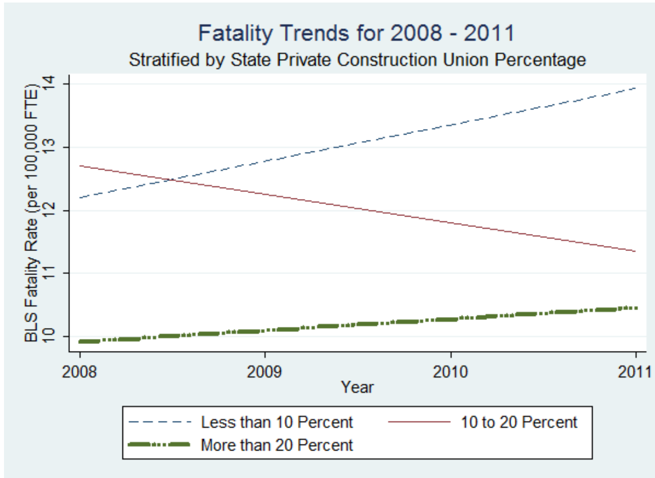

Figure 7: Trends in Fatalities - Union Density Strata

4.2 Non-fatal Injuries

Obviously many factors affect non-fatal construction injury rates. Among them are construction culture, management commitment, and training. The training component alone has sub factors such as quality, quantity, level of engagement, etc. With the available data, it is impossible to determine the share contribution of all of these factors. However, using marginal analysis it is possible to estimate the contribution of mandated OSHA 10 towards reducing injuries.

The panel structure of the data suggests employing either fixed effects (FE) or random effects (RE) analysis. In accordance with common practice, both methods were explored and tested. The model whose assumptions best fit the data was chosen.

The fundamental difference between the FE and RE models is that the unobserved effects in a FE model are assumed to be correlated with the explanatory variables whereas they are uncorrelated in a RE model. The FE analysis revealed a correlation of only 0.0118 and a Hausman test failed to show the difference in the FE and RE models was systematic with $\chi^2_5 = 1.27$ (p =0.94). Therefore the RE specification was validated as being both consistent and efficient. Using Stata 10, a generalized least squares (GLS) multiple regression with random effects and robust standard errors was performed. Again, note the response variable is the natural log of the OSHA recordable injury and illness rate (log RIR).

- RE Regression model

$$
\begin{aligned}
\log RIR_{it} &= \alpha + \beta_1 * (Trend)_{it} + \beta_2 * (PctUnion)_{it} + \beta_3 * (TrainReq)_{it} \\
&+ \beta_4 * (PctUnion * TrainReq)_{it} + \beta_5 * (Econ)_{it} + \epsilon_{it}
\end{aligned}
$$

Table 3 gives descriptive statistics for variables used in the injury analysis. A log-linear functional form was used so that the distribution of the response variable would more closely approximate the normal distribution in the GLS regression. $Trend$ is a variable to accommodate the general annual decline in injury rates. $PctUnion$ is the smoothed average of the percentage of union membership in private sector construction. It is a proxy for the percentage of OSHA 10 trained workers in individual states. $TrainReq$ is an indicator variable in which "0" represents control states in all years and "1" represents treatment states post-legislation. The economic recession of the last decade had far reaching consequences including an apparent change in injury underreporting as shown earlier. It seems that underreporting increased during the recession and $Econ$ absorbs this impact by effectively shifting the post-2007 observations.

The interaction variable, $PctUnion * TrainReq$, is key to this analysis. Recall that Roleofs' study determined that primarily union workers received OSHA 10. This interaction is a proxy for the percentage of OSHA 10 trained workers available and also provides a distinction between mandatory training states and the control group. It is feasible that legislative mandates and additional trained workers could create downstream effects beyond their separate immediate impacts. For example, a synergistic effect might occur for training mandates combined with a change in the percentage of trained workers beyond their individual effects on public projects. Consider that as workers initially trained to be eligible for public projects inevitably cross over to private projects and thereby increase the 'work share' performed by OSHA 10 workers. The work share might be further augmented if improved safety culture induces private owners to also require OSHA 10 training. Therefore, the significance and magnitude of the $\hat{\beta}$ coefficient of this interaction variable is a measure of the mandatory training marginal effect and is the crux of this analysis.

For completeness, the RE model was also estimated using maximum likelihood estimators (MLE) with standard errors from the observable information matrix. Table 4 summarizes the injury analyses conducted. Those analyses with the numeral 1 refer to the larger base group of states and 2 is the smaller peer group. The letters A and B designate GLS and MLE methods respectively

Using a RE analysis for panel data is key to overcoming the fact that some variables are unobservable (e.g. safety culture). It is assumed the unobservables are time invariant within states absent an exogenous shock but that unobservables can and do vary between states. Since these match the underlying assumptions of the RE model, the issue of unobservable variables is minimized.

Table 3: Descriptive Statistics for Injury Analysis 2004 - 2012 (Base Group n=363)

Variable	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
$Trend$	–	–	1	9
$PercentUnion$	15.0	10.5	0.7	45.4
$TrainingRequired$	0.07	0.26	0	1
$PercentUnion * TrainingRequired$	1.7	6.1	0	32.8
$EconomicChange$	0.55	0.50	0	1
log $RecordableInjuryRate$	1.64	0.34	0.83	2.49

Table 4: Injury Analysis Summary 2004-2012

Analysis	**Sample**	**Regression**
1A	Base Group	GLS
2A	Peer Group	GLS
1B	Base Group	MLE
2B	Peer Group	MLE

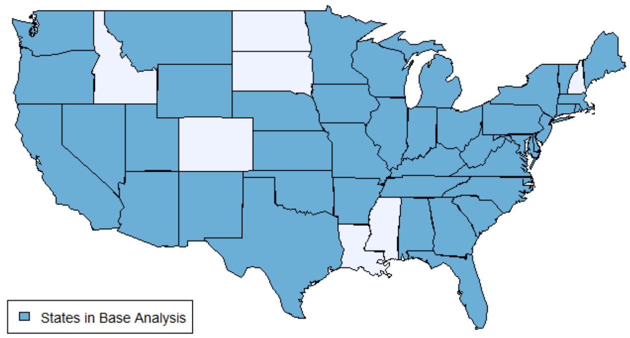

Figure 8: States in the Base Analysis (also AK and HI)

The most comprehensive data set (n=363) used in analyses 1A and 1B included state data for the base group (see Figure 8) for years 2004 - 2012. The GLS model had an overall $R^2 = 0.357$ and Wald $\chi^2_5 = 711.85$ ($p < 0.0001$). The coefficient on the interaction term was -0.0132. Since the model is log-linear, the proper interpretation is that the coefficients have a multiplicative effect of $\exp(\hat{\beta})$ on the response variable. Since exp(-0.0132) = 0.987, each percentage point increase in union membership combined with state mandated training has the effect of multiplying the response variable by 0.987. This is equivalent to a 1.3 percent decrease in the magnitude of the response.[12] Under GLS, the coefficient was not significant, but the MLE p-value was 0.056 and narrowly missed being significant at the five percent significance level. Table 5 contains the regression results for the base group.

The results show explanatory variables that were significant at the 1, 5, and 10 percent levels. $Trend$ was highly significant indicating a declining injury rate over time. The relatively large and positive coefficient for $TrainReq$ indicates an upward shift in injury levels for mandated training states. This is plausible if training states by their nature have less underreporting, if mandated training creates a decrease in the level of injury underreporting, or both. It is relevant that two hours of OSHA 10 are devoted to an *Introduction to OSHA* which includes a section on the duty to report injuries. It seems likely that the $TrainReq$ coefficient reflects increased injury levels from decreased underreporting. The upward shift is of no consequence to the marginal effect under investigation.

[12] In the log-linear functional form, for small values of $\hat{\beta}$, the coefficient*100 may be interpreted as the percent increase or decrease in the response variable for a one unit change in the explanatory variable.

Table 5: Coefficients for Injury Analysis of Base Group (Standard Errors)

Variable	Analysis 1A GLS	Analysis 1B MLE
$Trend$	-0.0553*** (0.0059)	-0.0553*** (0.0056)
$PercentUnion$	$\hat{\beta}_2 = 0.0028$ (0.0022)	0.0029 (0.0021)
$TrainRequired$	$\hat{\beta}_3 = 0.3571$* (0.2013)	0.3578** (0.1766)
$PercentUnion * TrainRequired$	$\hat{\beta}_4 =$ -0.0132 (0.0085)	-0.0133* (0.0070)
$EconomicChange$	$\hat{\beta}_5 =$ -0.1166*** (0.0271)	-0.1168*** (0.0288)
$Intercept$	$\hat{\alpha} = 1.930$*** (0.0575)	1.929*** (0.0526)
R^2	0.3568	-

Significance: $*p < 0.10, **p < 0.05, ***p < 0.01$

As an additional check, analyses 2A and 2B were used to further restrict the control group making it more homogeneous (see Figure 9). These analyses used a peer group of states having more than ten percent of the private construction workforce unionized. The smaller data set yielded results of similar magnitude, but with higher standard errors than in the base analysis. The interaction variable ($PctUnion * TrainReq$) coefficient was -0.0124 ($p = 0.146$) for GLS and -0.123 ($p = 0.083$) for MLE.

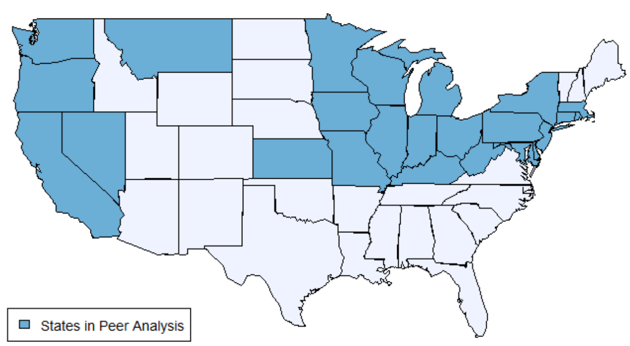

Figure 9: Peer Group States for Supplemental Analysis (also AK and HI)

5 Discussion

This study analyzed the results of the RE regressions were promising but failed to conclusively extend the qualitative results of Roelofs' Massachusetts study. Mandated OSHA 10, prevalent in the union sector, shows only mild evidence of reducing recordable injuries. In the base and peer analyses, the marginal effect was a 1.2 to 1.3 percent reduction in injuries with p-values ranging from 0.056 to 0.143. In summary, the results are highly encouraging but fall short of statistical significance. Likewise the fatality trends observed can be construed as encouraging but the data is too sparse to establish mandatory training as a definitive cause.

This analysis involves both strengths and weaknesses. A trial analysis demonstrated the appropriateness of RE over FE. The unobserved effects (e.g. safety culture, weather, etc.) clearly lacked correlation with the explanatory variables thus enabling this model to capture between state variation. In other words, each state has a unique random effect to capture its individual unobservables and thus the between state variation. At the same time, RE models are able to capture the serial relationship of data within states to produce more efficient estimators than a pooled cross section analysis. The ease of interpretation is a strength of the fatality analysis.

Study limitations include the limited time frame of the fatality trend analysis, sampling variation in the BLS injury data, the unknown scope and reduced effectiveness of online training, the use of the union membership proxy to enumerate trained workers, and the effects of rounding on the effective date of the individual state implementations. However, the primary weakness is the well documented underreporting of injuries. Though certainly undesirable, this weakness many not be as damaging as it appears. Three studies spanning between 1998 and 2011 all indicate substantial underreporting. There is no evidence to suggest that the level of underreporting changes without an exogenous shock. The model includes shift variables to absorb the shocks from the economic recession and the institution of the state training mandates. Assuming the underreporting is consistent absent a shock and independent of the regressors, the underreporting effect on the analysis is a biased intercept and biased shift variables that are of no consequence to the matter of a marginal effect.[13]

To overcome the study's weaknesses, more work is required to determine the reach and effectiveness of online training and to initiate annual recordkeeping of OSHA 10 training that enables disaggregation to the state level. Most importantly, a future analysis would be greatly aided by comprehensive injury databases which mitigated the injury underreporting issue. Encouraging is the fact that the National Institute of Occupational Safety and Health, the National Academies, and other stakeholders have called for development of workers compensation databases. These databases, accessible to researchers, should be far more comprehensive and accurate than the current sampling estimates.

[13] Wooldridge, 3rd Ed. pg. 319

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