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Evaluating the effect of an audit-based occupational health and safety recognition program on firm work-injury rates in British Columbia, Canada, 2003-2016: a matched difference-in-difference approach

Final report

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Christopher McLeod[1, 2], William Quirke[1], Kim McLeod[1], Adebayo Aderounmu[1]

1 Partnership for Work, Health and Safety, School of Population and Public Health, University of British Columbia, Vancouver, British Columbia, Canada
2 Institute for Work & Health, Toronto, Ontario, Canada

Correspondence to:
Dr. Christopher McLeod, PhD
331-2206 East Mall
Vancouver, BC V6T 1Z3
The University of British Columbia
E: chris.mcleod@ubc.ca
T: (604) 822-0348

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1 Main Research Findings

- The effect of achieving an audit-based occupational health and safety certification standard (COR) on firm-level injury rates was assessed using a matched difference-in-differences observational research design that compared COR firms to similar non-COR firms. The effect of COR certification was assessed for 2003-2016 overall, and for 2003-2008, 2009-2012, and 2013-2016 time periods.
- A comparable group of COR firms and non-COR control firms was identified using coarsened exact matching (CEM) applied to firm size, 4-digit subsector, year and classification unit base rate. The study sample comprised of 5,224 COR and 4,334 non-COR firms. 429 COR firms were not matched and therefore excluded from the analysis. Negative binomial generalized estimating equations (GEE) regression with an exchangeable correlation matrix was used to estimate the intervention effect.
- Participation in COR was associated with a 12% reduction in the risk of a short-term disability, long-term disability or fatality (SLF) injury (IRR: 0.88 [0.84,0.92]), an 11% reduction in the risk of a serious injury (IRR: 0.89 [0.84,0.95]) and no difference in risk of a health care only (HCO) injury, after adjusting for differences in firm characteristics and year. By time period, COR certification was not associated with a lower relative injury rate in 2003-2008 for either SLF or serious injuries, but was associated with 14% reduction in the SLF injury rate in both 2009-2012 and 2013-2016 and a 12% and 14% reduction in serious injury rate for these two periods respectively.
- COR certification was associated with a reduction in both SLF and serious injuries for most industrial sectors, and this effect was greater in later years.
    - In construction, across all years, the reduction in the SLF injury rate was 9% and for serious injuries it was 6%. By time period the effect was greatest for SLF injuries in the 2009-2012 (17% reduction) and 2013-2016 periods (13%), while for serious injuries it was 14% and 15% respectively.
    - In forestry, across all years, the reduction was 24% for both SLF and serious injuries. By time period the effect was greatest for SLF injuries in the 2009-2012 (30% reduction) and 2013-2016 periods (27%), while for serious injuries it was 25% and 40% respectively.

- In oil and gas, across all years, the reduction in the SLF injury rate was 31% and for serious injuries it was 37%. Consistent findings in the reduction in the injury rate were found across most time periods.
- In manufacturing, across all years, reduction in the SLF injury rate was 25% and for serious injuries it was 22%, while for HCO injuries it was 11%. By time period the effect was greatest in 2013-2016 with a 29% reduction for SLF, a 22% reduction for serious injuries, and a 15% reduction for HCO.
- For transportation and warehousing only modest and non-statistically significant effects were found by injury type and by time period. The exception was SLF injuries in the 2013-2016 period where the reduction was 15%.

- Sensitivity testing indicated that the results were robust to match specification, with the exception of the oil and gas sector, where the exclusion of very large firms attenuated the results. Matched results tended to be smaller than unmatched results, indicating that voluntary selection into the COR program may be a partial factor in the observed effect in the unmatched sample.
- The results support the conclusion that COR certification leads to an injury rate reduction in most sectors. However, inferences on the effectiveness of COR certification in reducing a firm's injury rate are limited to firms similar to those examined in the matched analysis.

2 Introduction

Occupational health and safety (OHS) regulators in Canada and worldwide are increasingly offering voluntary audit-based occupational health and safety management system (OHSMS) certification programs to promote and acknowledge recognized OHS practices. These programs are intended to help certified firms achieve lower injury rates and commensurately lower workers' compensation costs. One of the main rationales behind these programs is that industry sectors with high uptake of these certifying programs should see lower industry-wide injury rates, leading to a safer industry for workers and lower workers' compensation insurance base rates.

Within Canada, voluntary audit-based certification programs have been implemented in most Canadian provinces, particularly in the construction sector. Despite widespread use of audit-based OHSMS

programs, there has been limited evaluation examining whether these programs lead to improved OHS outcomes.

To address this gap, the Partnership for Work, Health and Safety (PWHS) previously evaluated whether participation in the province-wide certificate of recognition (COR) program was associated with lower firm-level injury rates in BC for the years 2005-2012 (McLeod, Quirke and Koehoorn, 2015). That research involved the use of a difference-in-difference (DiD) observational research design that compared COR firms to non-COR firms drawn from COR-eligible industrial subsector. In that first impact evaluation of the COR program, COR certification was associated with a lower injury rate for both short-term disability (STD), long-term disability (LTD) and fatalities and for serious injuries, particularly in the construction and forestry sectors and in the years 2009-2012. Results indicated the health and safety COR audit certification was associated with lower firm-injury rates compared to eligible non-certified firms.

In 2017, the research was updated to include additional years of follow up – 2013 and 2014 – and a refined analytical technique that strengthened inference regarding COR certification leading to lower injury rates or increased reduction in injury rates (McLeod, Quirke and Aderounmu, 2017). This extended technique used matching to create a control group that was similar to COR certified firms on key characteristics. Taken together, matching and DiD permit stronger inferences on the causal effect of COR certification than DiD alone. In addition, the revised 2014 BC serious injury indicator was applied[1]. This analysis further strengthened the finding that COR certification led to decreased injury rates. In previous analyses, lower injury rates from COR certification might have been attributed to the selection of safer firms into the COR program, rather than COR certification (or the COR certification process) leading to the decrease.

This report constitutes an update to the research that was developed and provided to WorkSafeBC in 2015 and 2017 (McLeod, Quirke and Koehoorn, 2015; McLeod, Quirke and Aderounmu, 2017). This research updates the years of follow-up through to 2016, improves our matching approach, and incorporates firm registration data provided by WorkSafeBC that better identifies firms during the study period, enabling an improved identification of intervention and control firms and a longer follow-up.

[1] Short-term (at least one day of time loss) or long-term disability claims with at least one of: serious medical diagnosis; potentially serious medical diagnosis with 50 or more work days lost; or fatality.

2.1 Background: Safety management system programs and injury rate outcomes

In evaluating safety intervention effectiveness, observing a lower injury rate or a greater relative reduction in the injury rate compared to non-intervention firms are key indicators of success. In 2007, Robson et al. completed an extensive review on the effectiveness of OHSMS interventions. The authors concluded that research gaps and methodological limitations prevented concrete conclusions from the literature (Robson *et al.*, 2007). Since publication of that review, three cohort studies have been published that examine the effect of voluntary OHSMS or safety programs on injury rates that considered performance both before and after OHSMS implementation. The results from these studies, while equivocal, tended to show positive results from the implementation of OHSMS. Two studies showed benefits from OHSMS implementation (Abad, Lafuente and Vilajosana, 2013; Lo *et al.*, 2014). Another study (Liu *et al.*, 2010) showed little benefit from firms participating in a state safety committee program. However, further analysis of a subset of firms that were externally audited showed that compliant participating firms did experience a decrease in injury rates, while those with deficiencies did not.

Several cross-sectional and case studies have also investigated the effect of OHSMS on injury rates. Studies finding lower injury rates for firms with OHSMSs evaluated OSHA Form 33 scores in dairy and poultry (Autenrieth *et al.*, 2016), NOSA Five-Star System in manufacturing firms (Hedlund, 2014), OHSAS 18001 (Ghahramani and Summala, 2017) and non-standardized systems in a random selection of firms (Bottani, Monica and Vignali, 2009). However, the study design and analysis methods used in these studies did not allow for inferences on causality, which limit conclusions regarding the effectiveness of OHSMS certification.

2.2 Research objectives

This current research was designed to update the impact evaluation of the COR certification program in BC published in 2015. The impact of the COR program on injury rates was analyzed with additional years of follow up and a dataset improved to provide more consistent information on firm registration with WorkSafeBC and firm industrial classification. The research question addressed in this study remains: What is the effect of COR certification on firm-injury rates, when COR-certified firms are compared to similar non-COR certified firms?

3 Methods and Data

3.1 Evaluation approach

This study uses a retrospective observational research design to identify the effect of COR certification on firm injury rates. Specifically, it uses matched difference-in-differences (DiD) in multi-variable negative binomial regression estimation. DiD analysis is a commonly used strategy for evaluating the effects of real word intervention programs, such as the COR certification program. The DiD method accounts for changes between the intervention (COR) and control group (non-COR) prior to certification (difference 1 and the changes over time between the pre- and post-intervention period (difference 2) to determine the overall *change* in the injury rate that can be can be attributed to the effect of the program. As such, the intervention effect is a measure of whether a larger observed change is seen in the intervention group relative to changes in the control group accounting for baseline differences in the injury rate. DiD methods provide an unbiased intervention effect if, in the absence of the intervention, the change in the injury rate over time would have been the same between the COR-certified and non-COR firms (this is known as the parallel trends assumption). See McLeod, Quirke and Koehoorn 2015 for a fuller description and motivation of the DiD approach applied to program evaluation.

COR certification is largely voluntary and a non-random and self-selected intervention group is a consequence of the program design. As a result, the intervention effect obtained from DiD analysis alone may be biased if study groups are not comparable or similar, especially on key factors known to be associated with change in firm injury rates and those that predict or influence the decision to become COR certified. Our prior work found that COR certified firms were larger and had been in business longer that non-COR certified firms; characteristics associated with better firm injury performance. Conversely, they were also more likely to be from high injury risk sectors than non-certified firms. Accordingly, we combined the DiD approach with matching (described in more detail below) to account for differential selection in COR certification that might violate the parallel trends assumption underpinning DiD.

3.1.1 Difference-in-differences observational research design

To estimate the treatment effect of COR certification on the outcome of interest Y_{it}, we specify the following model:

$$\boldsymbol{Y_{it} = \alpha + \beta INT_i + \delta T_{it} + \lambda(INT_i . T_{it}) + \gamma X_{ijt} + \mathcal{E}_{it},} \quad (1)$$

where T is the indicator of the time period (0 for baseline, 1 for follow-up), INT is a dummy variable for the treatment (0 for non-COR firms, 1 for COR-certified firms), INT*T (intervention effect) is the cross variable including periods and treatment and β, δ, λ are their respective coefficients, γ represents a set of estimates for the effects of *j* covariates, and ε is the usual error term.

3.1.2 Matching method

To balance the non-COR and COR-certified firms on observable characteristics, Coarsened Exact Matching (CEM) was applied prior to the difference-in-differences analyses. The main objective of the Coarsened Exact Matching (CEM) method, described by Iacus, King and Porro (2012), is to allow the reduction of imbalanced pre-intervention covariates between intervention and control groups. We have used CEM in recently published research (Maas, Koehoorn and McLeod, 2018), but to our knowledge this is one of the first implementations of CEM combined with DiD in an evaluative context.

CEM is an algorithm applied where groupings of variable values are generated by dividing continuous variables into discrete intervals. Categorical variables can be grouped into further coarsened categories or simply matched on their original categories. This creates a set of strata with the same values across the 'coarsened' matching variables. In other words, a continuous variable like base rate would be 'coarsened' so that base rates of similar magnitudes could serve as matches without the requirement of an exact match on this variable, which can be very precise. Control observations are matched randomly to treatment observations within the same stratum to generate one control per treatment in each stratum. Observations within strata that do not contain at least one COR-certified and non-COR unit are not matched and excluded from the analytic cohort. A consequence of this is that COR certified firms with rare characteristics (e.g., very large forestry firms) are less likely to be matched.

CEM has been found to yield estimates of the causal effect with the lowest variance and bias for any sample size than other matching methods. See Iacus, King and Porro (2011, 2012) for a detailed discussion of CEM properties and comparisons with other matching methods. The Stata user-written CEM package was used in the analysis and is described in Iacus, King and Porro, 2009.

In this analysis, CEM was used to match COR-certified firms to non-COR firms on four characteristics: group base rate, subsector, firm size as a categorical variable, and year of first COR certification. Consequently, control firms could serve as a match for more than one COR-certified firm depending whether they were selected as a match for COR firms that became first certified in different years.

3.1.3 Regression model

Matched DiD analysis was conducted using multivariable regression that can be extended to estimate the effect of the intervention for separate time periods by estimating regression coefficients on a set of indicator variables that represent a time period-by-intervention interaction.[2] For the multiple regression models, the following variables were defined:

Table 1: Variables used for analysis

Intervention variables	**Description**
COR firms indicator	Identifies the firms that are currently, will be eventually, or were in the past a COR-certified firm. Controls for differences in baseline risk between control and intervention firms.
COR participation/ intervention indicator	Captures the effect of COR participation by indicating the period when the COR firms were actually certified.
Covariates	**Description**
Year	17 categorical variables from 2000 to 2016 denoting study year.
Firm size	Used as a continuous variable and as a categorical variable. Measured in full time equivalents (FTEs) at the subsector level for each study year. Categories were defined as: less than 1 FTEs, 1-4, 5-9, 10-14, 15-19, 20-39, 60-99 and greater than 100 FTEs (reference).
Subsector (4-digit Classification Unit)	24 categorical variables denoting the industry 4-digit subsectors in the study.
Group base rate	Continuous variable denoting the base assessment rate at the 6-digit classification unit for each year. Measured in dollars per 100 dollars of payroll. The assessment rate reflects the underlying injury risk at the subsector level and is used to control for other unmeasured factors at the subsector-level that may affect injury risk.

The DiD model described above was used along with population-averaged generalized estimating equation (GEE), with negative binomial regression, to estimate the effect of COR certification on three work-injury rates:

1) Short-term, long-term and fatalities (SLF),
2) Serious injuries (SI) only, and
3) Health care only (HCO) claims.

The effect of certification on work-injury rates was calculated overall from 2003-2016 and by period, for 2003-2008, 2009-2012, and 2013-2016.

[2] In other words, the time variable "*t*" in equation 1 can be expanded to a set of year indicators that are interacted or multiplied with the "INT" variable to provide a yearly intervention effect. In our study, we split the years into three periods; period 1 is from 2003 through 2008, and period 2 is from 2009 through 2012, and period 3 is from 2013 to 2016. Both periods were multiplied with the "INT" to provide by-period intervention effect.

Injury data are count data that are typically over-dispersed with many zeroes and a limited number of high positive values. The data are also likely to be correlated across years at the firm-level. Accordingly, we used the GEE approach that provided the population average effect of the intervention estimate. In GEE, to take account of the intra-firm correlation, a correlation structure needs to be specified. This correlation structure can be specified as: independence, exchangeable, autoregressive, stationary, nonstationary, or unstructured. As conventional model fit statistics, such as Akaike Information Criterion (AIC), cannot be applied to GEE directly, we used an alternative to the AIC, the quasi-likelihood under the independence model criterion (QIC) method proposed by Pan (2001) to determine the preferred correlation structure. Among the working correlation structures examined, exchangeable correlation structure had the smallest QIC in most model specifications and was used across all models for consistency.[3]

In sum, population-averaged models were estimated with an exchangeable covariance matrix and semi-robust standard errors. To account for differences in exposure-time (FTEs at firm-subsector year), an exposure offset was used. For consistency, population-average (GEE) negative binomial regression was used for all statistical models presented in this report.

Incidence rate ratios (IRR) can be obtained by exponentiating the results of the model estimates. An IRR can be interpreted as the change in the relative risk of injury compared to the reference group. Values above one indicate an increase in risk and values below one a decrease in risk. The IRR of the indicator of current participation (INT) is the DiD estimate and can be interpreted as the population-averaged change in the relative risk of injury for certified firms compared to similar non-certified firms.

All analyses were performed using Stata 14 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.)

[3] Unlike generalized linear models (GLM), which are based on the maximum likelihood theory for independent observations (McCullagh and Nelder, 1989), the GEE method is based on the quasi-likelihood theory (Wedderburn, 1974). Under this theory, no assumption is made about the distribution of response observations. Without this assumed distribution, many statistics developed to select the best model out of a set of models, such as the Akaike Information Criterion (AIC) which was derived under the likelihood theory, cannot be applied. An alternative to the AIC, the quasi-likelihood under the independence model criterion (QIC) method proposed by Pan (2001) can be used and the correlation structure with the smallest QIC is the preferred correlation structure.

3.2 Study data and cohort definition

3.2.1 Study data

Data for this study was drawn from information supplied by WorkSafeBC Industry and Labour Services on COR firms for the period of 2003 to 2016 and from workers' compensation claims and registered firm data for the period of 1998 to 2016.

As COR certification is granted at the level of the classification unit and a firm may be certified in multiple classification units, the firm-subsector combination was used as the base unit of analysis. The starting year and, where applicable, the ending year of COR certification were derived at the level of classification unit for each COR-certified firm. The yearly total claim count was derived for selected injury classifications at the level of firm-subsector. Data on firm registration, activity status, payroll and assessment premiums were obtained from firm registration and assessment files. All data were linked at the yearly level using a firm-subsector specific identifier.

For this analysis, we used WorkSafeBC derived mapped firm identification variables. This mapped data allowed the aggregation of related employer records that would have indicated uniquely registered firms due to a firm merging or changing registration, or changing industry subsector. Assessment year, person years, and claim counts were aggregated and rolled up to the relevant mapped firm-subsector unit. Combined base rates were generated based on a weighted average by person years across subsectors. The application of the mapped employer ID level increases coherence of cohort and better enables identification of COR firms and respective control firms over the course of the study.

3.2.2 Cohort definition

The study cohort was defined as all firms with an active workers' compensation registration between 2000 and 2016. For a firm to be included for analysis, it was required to have a minimum of three continuous years of assessable data in a given subsector. Firm data at the yearly level was only included if firms had positive payroll in that year. COR firms with only a single year of certification were excluded, thus firms certified in 2016 were excluded. The **intervention** group was defined as all firms that became COR certified between 2003 and 2015. COR firms with no pre-COR baseline (a full year of observation prior to their first year of COR-certification) were also excluded. The **control** group was defined as non-COR firms meeting the relevant conditions described above.

Table 2 denotes the study cohort by sector and COR participation. Overall, 5,653 COR-certified firms were identified for inclusion in this analysis. *Table 3* denotes the number of COR firms by year of participation.

Table 2: Study cohort by sector

Sector	Non-COR Firms	COR Firms	Total
70	13,108	1662	14,770
71	14,166	346	14,512
72	57,989	1314	59,303
73	31,931	1039	32,970
74	27,926	73	27,999
75	975	28	1003
76	106,995	1191	108,186
Total	**253,090**	**5653**	**258,743**

Table 3: Number of COR firms by year of participation

Year	Number of COR Firms
2003	29
2004	137
2005	327
2006	501
2007	993
2008	2,160
2009	2,997
2010	3,423
2011	3,632
2012	3,747
2013	3,660
2014	3,455
2015	3,397
2016	3,067

3.2.3 Research ethics

The Behavioural Research Ethics Board of the University of British Columbia reviewed and approved the research protocol (certificate # H12-03354). This study was based on secondary usage of existing

administrative data on workers' compensation claims. The data was made available in accordance with the research agreement between WorkSafeBC and the University of British Columbia that governs the privacy and confidentiality conditions for use of the data for research purposes.

4 Results

4.1 Matching results: Characteristics of study firms

The CEM strategy yielded exact matches on categorical variables – firm size, 4-digit subsector and year, a nearly exact match on the continuous variable base rate (COR: 4.70 vs Non-COR 4.68), and a good match on continuous firm size (35.92 vs. 32.42 FTE). Accordingly, in the first year of COR certification, COR-certified and non-COR were considered sufficiently similar on these variables known to be associated with certification. The majority of the matched sample are drawn from forestry (21%), general construction (20%), transportation and related services (20%), and professional scientific and technological services (12%) (Table 4). The control sample was approximately 83% of the matched COR firms, indicating that some control firms served as matches more than once across different years.

In the process of matching, treatment observations are dropped due to the lack of a suitable match in the control group. In this sample, less than 10% of the treated COR firms were dropped due to lack of a suitable match. The characteristics of the unmatched COR firms differed from the matched COR sample in a number of ways. Unmatched COR firms had higher average base rates than matched COR firms. They were also more likely to be larger firms (greater than 5 FTE). Forestry firms were over-represented in the unmatched group. The comparison of the matched and unmatched COR firms can be found in *Appendix A*.

Table 4: Matched COR firms and non-COR firms based on year of first COR-certification

	COR Firms (n=5,224)	Non-COR Firms (n=4,334)
Percentage (N) of COR-firms and non-COR-firms by study covariates		
Agriculture	0.57 (30)	0.69 (30)
Fishing	0.06 (3)	0.05 (2)
Forestry	21.15 (1,105)	17.35 (752)
Oil & Gas or Mineral Resources	4.27 (223)	4.22 (183)
Food and Beverage Products	0.33 (17)	0.37 (16)
Metal and Non-Metallic Mineral Products	2.35 (123)	2.61 (113)
Petroleum, Coal, Rubber, Plastic & Chemicals	1.09 (57)	1.18 (51)
Wood and Paper Products	1.97 (103)	2.05 (89)
Other Products (not specified elsewhere)	0.5 (26)	0.53 (23)
General Construction	19.68 (1,028)	20.7 (897)
Heavy Construction	0.75 (39)	0.69 (30)
Road Construction or Maintenance	3.27 (171)	3.09 (134)
Warehousing	0.1 (5)	0.12 (5)
Transportation and Related Services	19.66 (1,027)	19.89 (862)
Retail	0.48 (25)	0.58 (25)
Wholesale	0.88 (46)	1.02 (44)
Public Administration	0.52 (27)	0.55 (24)
Accommodation, Food, and Leisure Services	1.97 (103)	2.22 (96)
Business Services	0.56 (29)	0.67 (29)
Professional, Scientific & Tech Services	12.39 (647)	12.76 (553)
Other Services (not specified elsewhere)	5.44 (284)	6.25 (271)
Education	0.21 (11)	0.25 (11)
Health Care and Social Assistance	1.55 (81)	1.87 (81)
Utilities	0.27 (14)	0.3 (13)

4.2 Impact of COR participation on firm injury rates

The results of the matched DiD analysis indicate that participation in COR was associated with a lower injury rate for STD, LTD or fatal injuries and serious injuries, but not for health care only injuries (Table 5). COR firms had similar baseline injury rates for STD, LTD or fatal injuries and serious injuries, but a

higher baseline health care only injuries rate. The "Baseline Risk" represents the first difference and the "COR Participation" represents the second difference.

Table 5: GEE NB results for matched cohort, full sample: STD, LTD, and fatalities; serious injuries; and health care only claims

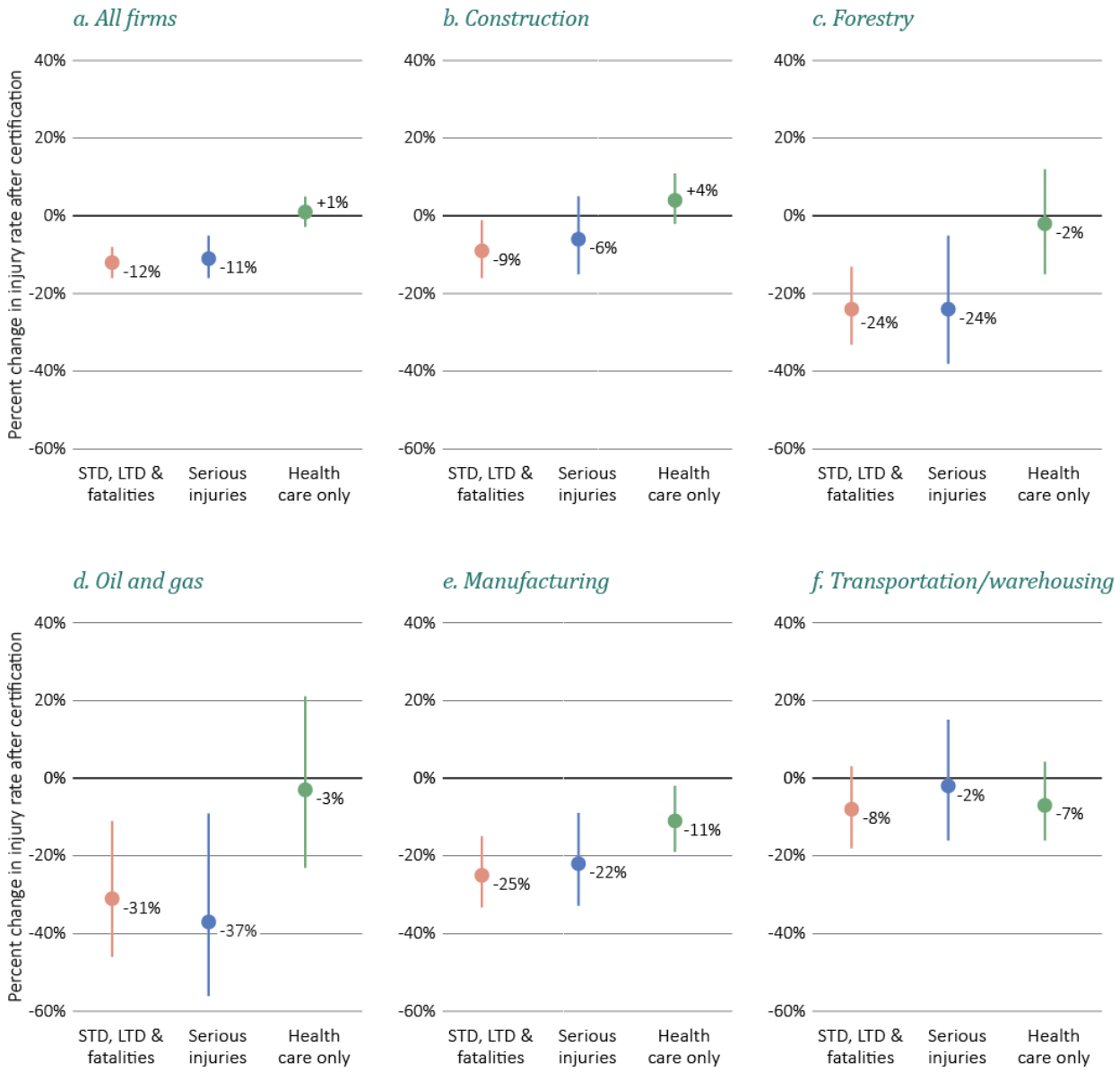
	IRR [95% Confidence Interval]		
	STD/LTD/Fatalities	**Serious Injuries**	**Health Care Only**
COR Firm	1.05 [0.98,1.11]	1.03 [0.97,1.10]	1.22 [1.16,1.28]
COR Participation	0.88 [0.84,0.92]	0.89 [0.84,0.95]	1.01 [0.97,1.05]
Firm-Subsector Years	116,529	116,529	116,529
Firm-Subsector	9,565	9,565	9,565

Once COR firms participated in the program, they had a 12% lower relative risk of a STD, LTD or fatal (SLF) injury (IRR: 0.88 [0.84,0.92]), an 11% lower relative risk of a serious injury (IRR: 0.89 [0.84,0.95]), and no difference in risk of a health care only injury, after adjusting for differences in firm characteristics and year (Figure 1). This does not mean that they had a lower absolute injury risk during the COR certification period, but rather, compared to the pre-COR certification period, their SLF injury risk decreased an additional 12% compared to non-certified firms. See *Appendix Table A1* for full regression results.

4.3 Impact of COR participation and sector on firm injury rates

Analysis by industrial sector found reductions in injury risk for SLF injuries with COR participation in each study sector except for transportation and warehousing. The overall reduction in the SLF injury rate for COR participation was 9% in construction, 24% in forestry, 31% in oil and gas and, 25% in manufacturing. There was no significant effect on firms in transportation/warehousing. For serious injuries, significant reductions in injury rate were observed with decreases of 24% in forestry, 37% in oil and gas and 22% in manufacturing. For health care only injuries the only effect found was for manufacturing, where there was an 11% relative reduction. *Figure 1* below graphically illustrates these results. See *Appendix A* for full regression results.

Figure 1: Summary of impact of COR for matched full cohort and by industry sector, on selected injury rates (2003-2016), with 95% confidence intervals

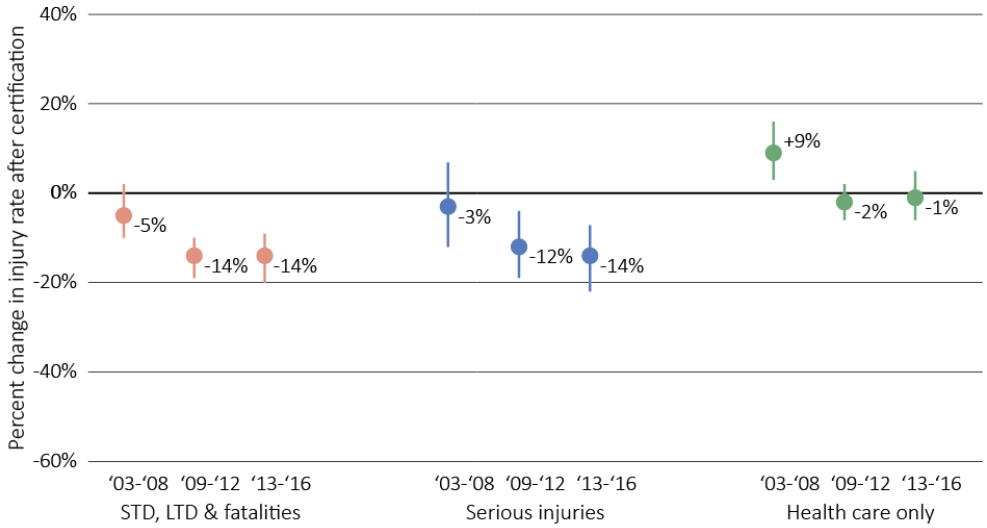


4.4 Impact of time period of COR certification

Analysis showed that the time period of COR certification affected the magnitude of the injury rate reduction associated with COR certification. Overall, the relative reductions in the SLF and serious injury rates associated with COR participation were smaller in the 2003-2008 period and larger in the 2009-2012 and 2013-2016 periods. SLF injury risk decreased by a non-statistically significant 5% for COR firms in 2003-2008, and by a statistically significant 14% in both the 2009-2012 and 2013-2016 periods. The

serious injury risk decreased 3% in 2003-2008, 12% in 2009-2014, and 14% in 2013-2016. For health care only claims, an increase in risk of 9% was observed in 2003-2008, but not in the other time periods.

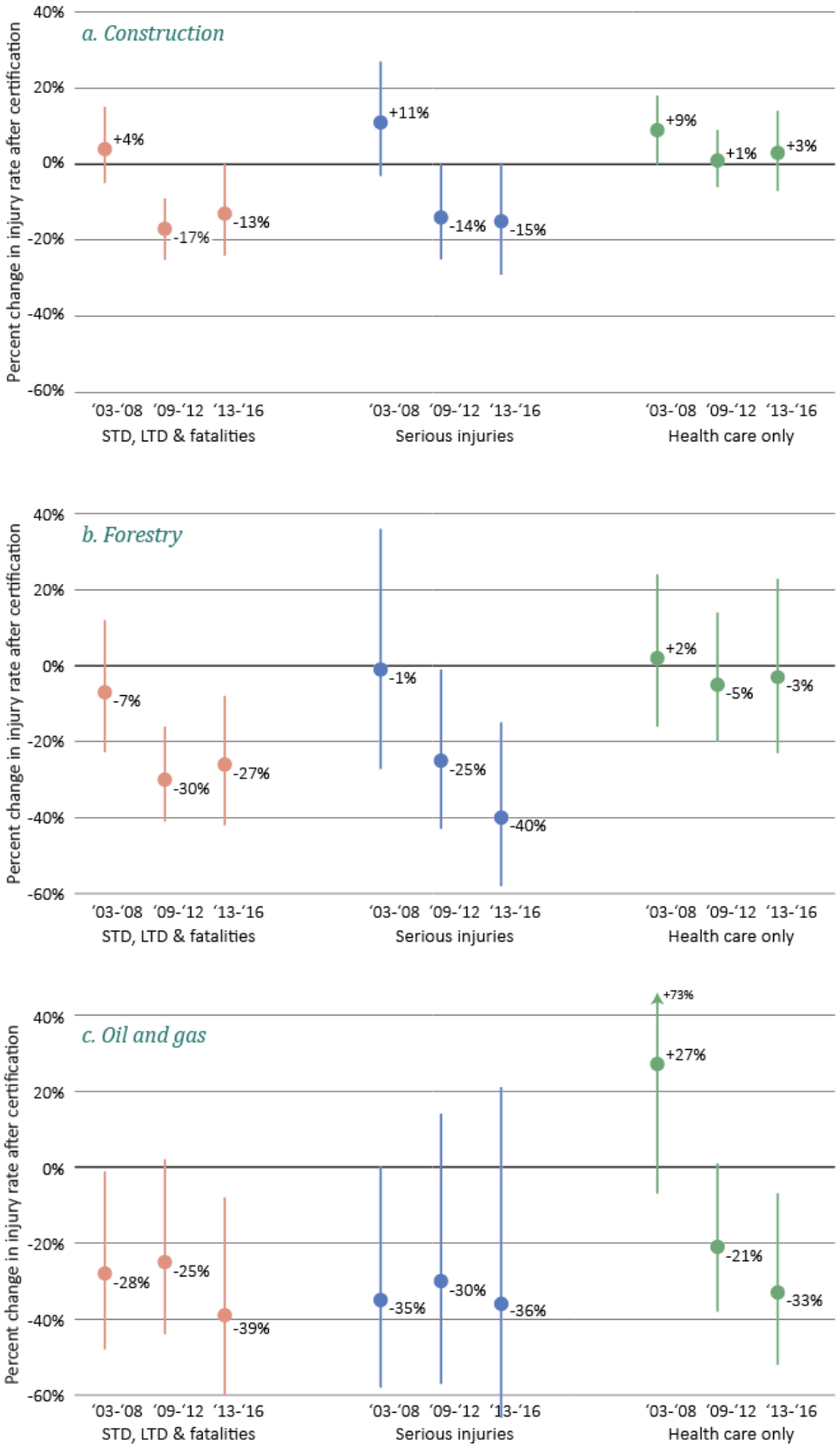
Figure 2: Summary of impact of COR for matched full cohort firms, on selected injury rates by period (2003-2008, 2009-2012, 2013-2016), with 95% confidence intervals

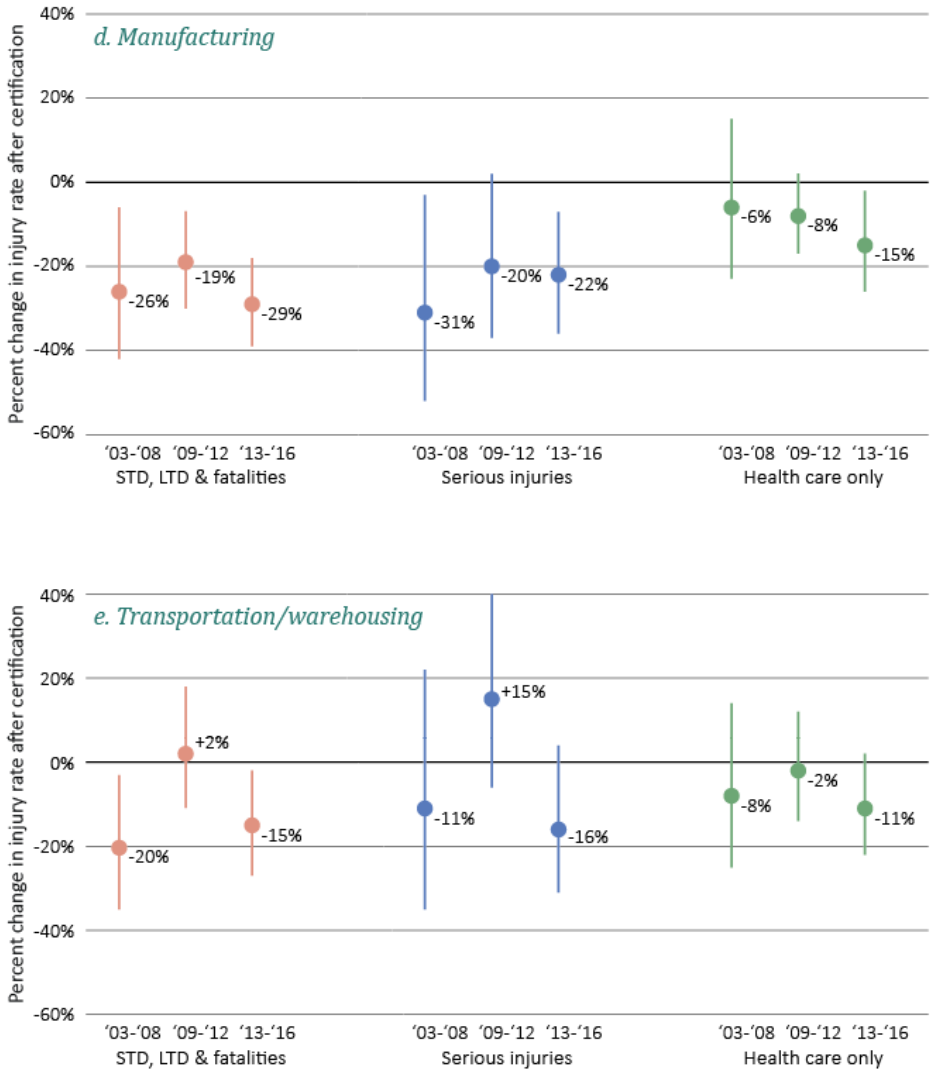


4.5 Impact of time period of COR participation, by sector

When examined by sector, the trend of COR certification being associated with larger declines in the relative injury rate in recent time periods continued. Analysis by industrial sector and period for SLF, serious, and health care only injuries in 2003-2008 found statistically significant reductions in the manufacturing, oil and gas, and transportation sectors. However, in the 2009-2012 and 2013-2016 time periods, statistically significant or near significant effects on SLF and serious injuries were found in most industries.

Figure 3: Summary of impact of COR for matched construction, forestry, oil and gas, manufacturing, and transportation and warehousing firms, on selected injury rates by period (2003-2008, 2009-2012, 2013-2016), with 95% confidence intervals





4.6 Sensitivity analyses

While the overall results presented in this report are consistent with previously published analyses (McLeod, Quirke and Koehoorn, 2015) and research updates (McLeod, Quirke and Aderounmu, 2017), we do find differences in some sector-specific intervention effects in manufacturing and oil and gas in comparison to what has been previously presented. The differences noted can be attributed to the improved specification of the intervention and the control group via the application of mapped employer identification variables, the longer period of follow-up, the specification of the matching variables, and inherent statistical and sampling variability due to the selection of a random match. In the case of the latter two reasons, we would expect greater variation in sectors with a smaller number of COR certified firms compared to those with larger numbers.

In the 2015 report, no intervention effect was found for manufacturing, while in this report a large effect was found in both the matched and unmatched results. This can be attributed to the larger sample size and longer period of follow-up in the manufacturing sector in the most recent analysis. We also find that the specification of the match affects the magnitude and statistical significance of the intervention effect in the oil and gas sector. This can be attributed to the inclusion/exclusion of very large firms (>1,000 FTEs). Excluding these firms (as in the 2017 update (McLeod, Quirke and Aderounmu, 2017)), attenuated the effect compared to the results presented here. In the case of the oil and gas sector, the unmatched results are more similar to the matched results that exclude very large firms. However, given the relatively small number of COR-certified oil and gas firms in BC, we cannot conclude that the differences across models are meaningfully different as this could be due to sampling variability. Nevertheless, we do find an association between COR certification and injury rate in the unmatched sample in oil and gas and an intervention effect in the unrestricted CEM sample. That the results are sensitive to exclusion of very large firms may warrant further examination in future analysis.

In the case of the larger industry subsectors (construction; forestry; and transportation and warehousing), the results are more consistent across match specifications (in particular the exclusion of large firms has a minor effect on model estimates). Matched intervention estimates tend to be smaller than the unmatched estimates, which is consistent with a hypothesis that some of the observed differences in the injury rate between COR and non-COR firms may be due to the voluntary selection of safer firms into COR certification. *Table 6* below presents a comparison of the intervention effect for the unmatched sample, and the two CEM samples with and without very large firms. The full unmatched results can be found in *Appendix B.*

Table 6: Comparison of COR certification intervention effect, unmatched and by CEM specification

Incidence Rate Ratio [95% CI]

	Type of matching	Sample Size Firm CU Years/ Firm CU	STD/LTD/FTL	Serious Injuries	Health Care Only
All firms	CEM (COR firms < 1000 FTE)	115,824/9,520	0.87 [0.83,0.91]	0.89 [0.84,0.95]	1.01 [0.97,1.04]
	CEM	116,529/9,565	0.88 [0.84,0.92]	0.89 [0.84,0.95]	1.01 [0.97,1.05]
	Unmatched	2,234,656/258,752	0.83 [0.80,0.86]	0.83 [0.79,0.88]	1.00 [0.97,1.04]
Construction firms	CEM (COR firms < 1000 FTE)	27,821/2,291	0.90 [0.83,0.98]	0.95 [0.85,1.05]	1.03 [0.97,1.09]
	CEM	28,068/2,294	0.91 [0.84,0.99]	0.94 [0.85,1.05]	1.04 [0.98,1.11]
	Unmatched	484,036/59,128	0.88 [0.83,0.95]	0.95 [0.86,1.04]	1.04 [0.98,1.09]
Forestry firms	CEM (COR firms < 1000 FTE)	20,949/1,822	0.76 [0.66,0.86]	0.74 [0.60,0.93]	1.00 [0.88,1.14]
	CEM	21,107/1,822	0.76 [0.67,0.87]	0.76 [0.62,0.95]	0.98 [0.85,1.12]
	Unmatched	54,650/6,761	0.75 [0.68,0.82]	0.76 [0.66,0.88]	0.98 [0.90,1.08]
Oil and gas firms	CEM (COR firms < 1000 FTE)	5,446/526	0.80 [0.62,1.04]	0.76 [0.52,1.11]	1.01 [0.81,1.26]
	CEM	5,418/523	0.69 [0.54,0.89]	0.63 [0.44,0.91]	0.97 [0.77,1.21]
	Unmatched	18,314/2,414	0.78 [0.62,0.98]	0.77 [0.56,1.06]	0.97 [0.80,1.17]
Manufacturing firms	CEM (COR firms < 1000 FTE)	8,234/620	0.77 [0.68,0.88]	0.83 [0.70,0.98]	0.90 [0.82,1.00]
	CEM	8,214/629	0.75 [0.67,0.85]	0.78 [0.67,0.91]	0.89 [0.81,0.98]
	Unmatched	134,266/14,484	0.72 [0.65,0.79]	0.74 [0.66,0.84]	0.90 [0.83,0.97]
Transportation and warehousing firms	CEM (COR firms < 1000 FTE)	23,523/1,917	0.93 [0.83,1.04]	0.97 [0.83,1.14]	0.94 [0.84,1.04]
	CEM	23,575/1,914	0.92 [0.82,1.03]	0.98 [0.84,1.15]	0.93 [0.84,1.04]
	Unmatched	276,992/33,145	0.97 [0.88,1.06]	0.99 [0.86,1.15]	0.98 [0.90,1.07]

5 Discussion

5.1 Findings

COR certification is associated with a greater reduction in SLF and SI rates compared to similar non-certified firms, overall and for most sectors. Moreover, the effect was greater in recent years. COR certification was found to be effective in all sectors except for transportation and warehousing. In some sectors, such forestry and construction, the effect was only statistically significant in later years. The effect was largest in the forestry, manufacturing, and oil and gas sectors. That similar or stronger effects are seen in later years after the program had 'matured' in these sectors suggests that the effect of COR certification may not be immediate and may require a critical mass within an industry. In contrast, the effect of COR certification in the manufacturing sector was large and stable over time. This may be because the manufacturing working environment is more static, so the COR requirements may have been easier to implement and adhere to than in sectors with more dynamic changing working environments.

There tends to be no change or an increase in health care only injury rate due to COR certification. This may be due to COR certification requirements leading to a greater number of these injuries being reported or that COR certification leads to injury management practices in which loss-time injuries are not completely prevented but are converted to no-loss time injuries. Evidence of the latter explanation was found in Alberta evaluation of COR (McLeod *et al.*, 2018) where the effect was greater for lost-time injures and smaller for disabling injuries, which are lost-time only, and injuries that only required modified return-to-work.

5.2 Strengths

5.2.1 Quality of the data

This analysis was possible with access to complete workers' compensation claims and firm records for all registered firms and all years relevant to the implementation of the intervention. The use of detailed claim-level workers' compensation data enabled an exact specification of what types of injury claims could be analysed, allowing a focus on the types of injuries most likely to be affected by COR certification. Comprehensive firm level data enabled characterization of industry type and size of the firms and the COR certification progress. These data were linked at the firm-level using unique firm and

industry identifiers on a yearly basis. The span of 16 years of data for all registered firms and for COR certification yield a large enough sample size to conduct multiple stratified analyses (e.g., sector, period, firm size).

5.2.2 Robustness of method

The observational research design using DiD and CEM matching offered a robust methodological approach to evaluate COR effectiveness in the absence of a randomized research design. DiD enabled the comparison of changes over time in the non-COR control group with the COR intervention group to provide causal counterfactual estimates. The CEM matching enabled the creation of a non-COR control group with baseline characteristics similar to the group of COR firms. Moreover, sensitivity testing of appropriateness of and variability due to the match was conducted. With the exception of the oil and gas sector, where the results were sensitive to the exclusion of the very large firm, results were consistent across matched specification and selection of control samples.

5.3 Limitations

This study has a few limitations. The data used in the study were collected primarily for administrative purposes, such as workers' compensation registration, payment of insurance premiums, and adjudication of accepted work-related injuries and illnesses, rather than for the purpose of analytic evaluation. Accordingly, there may be bias due to errors in the data or misclassification. It is also possible that accepted workers' compensation claims data underestimates the actual work-injury rate (Koehoorn *et al.*, 2015). However, for under-reporting to bias the results away from a null (or no effect of COR on reduction in injury rates), COR firms, while certified, would have had to have a greater under-reporting rate than when not certified compared to their non-certified matched firms.

The matched DiD observational research design can provide a causal test of the effect of an intervention. For this causal test to be valid, the assumption that COR and non-COR firms would follow the same injury trends over time, had the intervention not occurred, must be true. Furthermore, the matching method should sufficiently identify appropriate control firms; it appears that the control group was similar to the COR group on observable matched characteristics. Unmatched COR firms were more common in the forestry sector and among larger firms. While the matching of firms increases the internal validity of the study, unmatched COR firms may have had an injury response to COR certification. Accordingly, causal inferences on the effectiveness of COR certification in reducing a firm's injury rate are limited to firms with similar characteristics.

Recent research on the use of matching with DiD has shown that in circumstances where the assumption of parallel trend holds without matching, matching may increase bias (Ryan, 2018). This would mean that a non-matched DiD model would be preferable. However, in the case of this study, matching on pre-intervention differences in variables related to COR certification and on firm injury rates almost certainly improves model specification and internal validity as non-COR firms and COR firms, in aggregate, differ substantially on these characteristics. Notwithstanding this, parsimony should be sought in selecting matching variables.

The derivations of the full-time equivalent (FTE) and consequent firm size variables also present a limitation. Firm size is calculated using a firm's assessable payroll and the average earnings of employees in that industry. This measure can underestimate the number of workers in a firm, which could introduce bias if the assessment of firm payroll is distributed differentially across COR and non-COR firms. The FTE variable is a key component of the negative binomial equation in that it enabled the estimation of a rate ratio conditional on the number of workers exposed.

5.4 Directions for future research

Our research has found in both BC and Alberta that COR certification leads to a reduction in firm injury rates. Overall, this provides support for program effectiveness, but does not identify why the program is effective or how to improve the program. Moreover, we cannot conclude that COR certification would be effective if applied to firms dissimilar to those in this study. Of particular note, we did not find an association with COR certification in oil and gas in Alberta, but did so in BC, albeit on a smaller sample size. Conversely we found an association in Alberta in the transportation sector, but not in BC.

Accordingly, future research could focus on the following:

1) Identifying the mechanisms through which COR certification leads to improved health and safety practices and improved firm injury performance.
2) Identifying what components of the COR audit are most effective or important in improving injury outcomes.
3) Investigating the contexts and circumstances where COR certification may be more or less effective, especially where difference in effectiveness across jurisdictions or sectors (i.e., across oil and gas and transportation in BC and Alberta, firm types, or auditing practices)
4) Examining the effect of workers' compensation rebates or incentives and the impact of pre-bid OHSMS qualification on the uptake and effectiveness of the COR program.

5) Investigating the relationship between other relevant regulatory practices (inspections) or OHS indicators (safety culture) in understating how OHSMS certification integrates with other prevention approaches.

6 Conclusions

This research shows that COR firms experience greater reductions in their injury rate when certified, compared to similar non-certified firms. COR certification appears to be identifying the "right firms" in so far as, after certification, COR firms have lower injury rates than non-COR firms. Analysis by industrial sector found reductions in injury risk for STD, LTD or fatality (SLF) injuries with COR participation in each study sector, except for transportation and warehousing.

The improvement to the cohort derivation via the use of mapped employer identifier, the use of matched DiD estimation, and the longer period of follow-up provides additional support to the interpretation that COR certification (or the process of COR certification) is causally related to improved OHS performance. This interpretation is supported by our similar findings for the effect of COR certification on firm-injury rates in our study on the Alberta COR program, which used a similar research methodology (McLeod *et al.*, 2018).

While the results of this study indicate that COR certification leads to a larger relative decline in injury rates compared to similar non-certified firms, these findings may not generalize to firms with different characteristics, or in different sectors or jurisdictions. The results also suggest that COR certification, while having a larger effect in later years, is not equally effective in all sectors. Future research could investigate the specific circumstances under which COR certification leads to lower injury rates and identify how the broader implementation of OHSMS can further improve firm OHS outcomes.

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Appendix A: Matched Regression Results

Table A 1: Matching sensitivity analysis, COR firms only, STD, LTD, and fatalities, serious injuries and health care only claims

	Matched COR Firm (n=5224)	Unmatched COR Firm (n=429)
Average Base Rate (95% CI)	4.69 (4.61, 4.77)	7.34 (7.08, 7.60)
Average Firm Size (95% CI)	46.04 (39.02, 53.06)	54.59 (45.26, 63.93)
Percentage (N) of COR-firms and non-COR-firm by study covariates		
Agriculture	0.57(30)	0
Fishing	0.06(3)	0.23(1)
Forestry	21.15(1105)	66.67(286)
Oil & Gas or Mineral Resources	4.27(223)	3.26(14)
Food and Beverage Products	0.33(17)	0.23(1)
Metal and Non-Metallic Mineral Products	2.35(123)	0.23(1)
Petroleum, Coal, Rubber, Plastic & Chemicals	1.09(57)	0.47(2)
Wood and Paper Products	1.97(103)	3.5(15)
Other Products (not elsewhere specified	0.5(26)	0.23(1)
General Construction	19.68(1028)	6.53(28)
Heavy Construction	0.75(39)	4.2(18)
Road Construction or Maintenance	3.27(171)	6.99(30)
Warehousing	0.1(5)	0.23(1)
Transportation and Related Services	19.66(1027)	1.4(6)
Retail	0.48(25)	0
Wholesale	0.88(46)	0.47(2)
Public Administration	0.52(27)	0.23(1)
Accommodation, Food, and Leisure Services	1.97(103)	2.56(11)
Business Services	0.56(29)	0.23(1)
Professional, Scientific, & Tech Services	12.39(647)	0.47(2)
Other Services (not elsewhere specified)	5.44(284)	1.86(8)
Education	0.21(11)	0
Health Care and Social Assistance	1.55(81)	0
Utilities	0.27(14)	0
Firm Size (average per year)		
Less than 1 FTE	23.16 (1,210)	1.63(7)
1 to 4 FTE	28.92 (1,511)	1.17(5)

5 to 9 FTE	12.42 (649)	15.62(67)
10 to 14 FTE	6.05 (316)	17.72(76)
15 to 19 FTE	4.27 (223)	14.22(61)
20 to 39 FTE	8.79 (459)	16.32(70)
40 to 59 FTE	4.33 (226)	8.39(36)
60 to 99 FTE	4.15 (217)	8.39(36)
More than 100 FTE	7.91 (413)	16.55(71)

Table A 2: Coarsened Exact Matching (CEM) and Generalized Estimating Equation (GEE) Negative Binomial (NB) Regression Results [95% Confidence Interval], overall sample: STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	1.05 [0.98,1.11]	1.03 [0.97,1.10]	1.22 [1.16,1.28]
COR Firm Certification Indicator	0.88 [0.84,0.92]	0.89 [0.84,0.95]	1.01 [0.97,1.05]
Base Rate	1.08 [1.07,1.10]	1.14 [1.12,1.15]	1.08 [1.07,1.10]
2000	1.00	1.00	1.00
2001	1.17 [1.12,1.23]	1.17 [1.08,1.28]	1.25 [1.19,1.30]
2002	1.06 [1.02,1.11]	1.01 [0.93,1.11]	1.19 [1.14,1.25]
2003	0.98 [0.94,1.03]	0.96 [0.88,1.05]	1.16 [1.11,1.22]
2004	0.96 [0.91,1.00]	1.00 [0.92,1.09]	1.11 [1.06,1.16]
2005	1.00 [0.95,1.05]	1.07 [0.98,1.16]	1.16 [1.11,1.21]
2006	1.01 [0.97,1.06]	1.04 [0.96,1.13]	1.14 [1.10,1.19]
2007	1.04 [0.99,1.08]	1.15 [1.06,1.24]	1.16 [1.11,1.21]
2008	1.04 [1.00,1.08]	1.17 [1.08,1.26]	1.11 [1.06,1.15]
2010	0.81 [0.77,0.84]	0.95 [0.88,1.04]	0.94 [0.90,0.98]
2011	0.87 [0.83,0.91]	1.01 [0.93,1.09]	1.02 [0.97,1.06]
2012	0.85 [0.81,0.90]	0.96 [0.87,1.06]	1.00 [0.96,1.04]
2013	0.84 [0.80,0.88]	0.90 [0.82,0.98]	0.97 [0.93,1.02]
2014	0.80 [0.76,0.84]	0.91 [0.83,0.99]	0.99 [0.94,1.04]
2015	0.81 [0.77,0.86]	0.96 [0.88,1.05]	0.96 [0.91,1.00]
2016	0.77 [0.73,0.81]	0.89 [0.81,0.98]	0.94 [0.89,0.98]
Less than one full time equivalent	1.14 [1.01,1.29]	2.14 [1.80,2.53]	1.20 [1.07,1.35]
1 to 4 full time equivalents	0.84 [0.78,0.91]	1.16 [1.03,1.31]	0.85 [0.79,0.91]
5 to 9 full time equivalents	0.86 [0.80,0.92]	1.13 [1.01,1.26]	0.85 [0.80,0.91]
10 to 14 full time equivalents	0.92 [0.86,0.99]	1.10 [0.98,1.23]	0.94 [0.89,1.00]
15 to 19 full time equivalents	0.98 [0.91,1.05]	1.07 [0.96,1.20]	0.92 [0.86,0.98]
20 to 39 full time equivalents	1.04 [0.99,1.10]	1.11 [1.02,1.21]	1.00 [0.96,1.05]
60 to 99 full time equivalents	1.00 [0.95,1.05]	0.99 [0.91,1.08]	0.99 [0.95,1.03]
More than 100 full time equivalents	0.97 [0.91,1.03]	0.85 [0.78,0.93]	0.96 [0.91,1.01]
3 to 6 years	1.02 [0.90,1.15]	1.01 [0.88,1.17]	1.03 [0.93,1.14]
7 to 10 years	1.00	1.00	1.00
11 to 13 years	0.95 [0.85,1.07]	1.00 [0.89,1.12]	0.96 [0.89,1.05]
14 to 16 years	0.92 [0.83,1.03]	0.99 [0.88,1.11]	0.90 [0.83,0.98]
17 years	1.00 [0.91,1.10]	0.95 [0.87,1.04]	1.00 [0.93,1.07]
7010 Agriculture	0.63 [0.47,0.86]	0.90 [0.61,1.33]	0.80 [0.58,1.10]
7020 Fishing	1.08 [0.69,1.71]	1.02 [0.53,1.95]	1.87 [1.35,2.59]
7030 Forestry	0.64 [0.52,0.78]	0.93 [0.73,1.18]	0.70 [0.57,0.85]
7040 Oil & Gas or Mineral Resources	0.35 [0.26,0.47]	0.68 [0.53,0.88]	0.96 [0.77,1.21]
7110 Food and Beverage Products	1.00	1.00	1.00
7120 Metal and Non-Metallic Mineral Products	0.89 [0.73,1.08]	1.10 [0.88,1.37]	1.67 [1.38,2.02]
7130 Petroleum, Coal, Rubber, Plastic & Chemical	0.34 [0.24,0.49]	0.47 [0.32,0.70]	0.67 [0.47,0.97]
7140 Wood and Paper Products	0.60 [0.48,0.75]	0.94 [0.74,1.19]	1.36 [1.11,1.67]
7150 Other Products (not elsewhere specified)	0.89 [0.68,1.16]	1.10 [0.83,1.47]	1.21 [0.94,1.56]
7210 General Construction	0.65 [0.54,0.78]	0.97 [0.79,1.21]	1.11 [0.93,1.33]
7220 Heavy Construction	0.73 [0.52,1.00]	1.14 [0.81,1.62]	1.56 [1.17,2.07]
7230 Road Construction or Maintenance	0.46 [0.37,0.57]	0.80 [0.63,1.02]	0.73 [0.60,0.90]

7320 Transportation and Related Services	0.65 [0.53,0.80]	0.96 [0.77,1.21]	0.68 [0.56,0.82]
7410 Retail	0.50 [0.37,0.68]	0.60 [0.44,0.81]	0.75 [0.55,1.00]
7420 Wholesale	0.47 [0.34,0.64]	0.56 [0.41,0.76]	0.57 [0.44,0.74]
7530 Public Administration	0.72 [0.58,0.89]	0.79 [0.63,0.99]	0.84 [0.69,1.03]
7610 Accommodation, Food, and Leisure Service	0.38 [0.31,0.46]	0.41 [0.31,0.54]	0.54 [0.43,0.67]
7620 Business Services	0.15 [0.08,0.29]	0.53 [0.33,0.86]	0.26 [0.16,0.41]
7630 Professional, Scientific, & Tech Service	0.29 [0.23,0.36]	0.30 [0.22,0.40]	0.55 [0.44,0.68]
7640 Other Services (not elsewhere specified)	0.58 [0.46,0.72]	0.76 [0.61,0.95]	0.98 [0.80,1.19]
7650 Education	0.28 [0.18,0.45]	0.43 [0.30,0.61]	0.42 [0.30,0.59]
7660 Health Care and Social Services	0.78 [0.58,1.05]	0.63 [0.45,0.88]	0.62 [0.49,0.79]
7670 Utilities	0.17 [0.08,0.39]	0.30 [0.17,0.51]	0.30 [0.20,0.45]
Firm-CU Years	116,529	116,529	116,529
Firm-CUs	9,565	9,565	9,565

Exponentiated coefficients

Table A 3: CEM Matching and GEE NB regression results, overall sample, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	1.05 [0.99,1.11]	1.04 [0.97,1.11]	1.22 [1.16,1.28]
COR Firm Certification Period 2003-2008	0.95 [0.90,1.02]	0.97 [0.88,1.07]	1.09 [1.03,1.16]
COR Firm Certification Period 2009-2012	0.86 [0.81,0.90]	0.88 [0.81,0.96]	0.98 [0.94,1.02]
COR Firm Certification Period 2013-2016	0.86 [0.80,0.91]	0.86 [0.78,0.93]	0.99 [0.94,1.05]
Base Rate	1.08 [1.07,1.09]	1.14 [1.12,1.15]	1.08 [1.07,1.09]
2000	1.00	1.00	1.00
2001	1.17 [1.11,1.22]	1.17 [1.07,1.27]	1.24 [1.19,1.30]
2002	1.06 [1.01,1.11]	1.01 [0.93,1.10]	1.19 [1.13,1.24]
2003	0.98 [0.94,1.03]	0.96 [0.88,1.05]	1.16 [1.11,1.21]
2004	0.95 [0.91,1.00]	1.00 [0.91,1.09]	1.10 [1.05,1.15]
2005	0.99 [0.94,1.04]	1.06 [0.97,1.15]	1.15 [1.10,1.20]
2006	1.00 [0.95,1.05]	1.03 [0.95,1.12]	1.13 [1.08,1.18]
2007	1.02 [0.98,1.07]	1.13 [1.05,1.22]	1.14 [1.09,1.19]
2008	1.02 [0.98,1.06]	1.15 [1.06,1.24]	1.08 [1.04,1.13]
2010	0.81 [0.77,0.85]	0.96 [0.88,1.04]	0.94 [0.90,0.98]
2011	0.87 [0.83,0.91]	1.01 [0.93,1.10]	1.02 [0.98,1.07]
2012	0.86 [0.82,0.90]	0.96 [0.87,1.07]	1.01 [0.97,1.05]
2013	0.85 [0.80,0.89]	0.92 [0.84,1.01]	0.98 [0.93,1.03]
2014	0.81 [0.77,0.86]	0.92 [0.84,1.02]	1.00 [0.94,1.05]
2015	0.82 [0.78,0.87]	0.98 [0.89,1.08]	0.96 [0.91,1.02]
2016	0.78 [0.73,0.82]	0.91 [0.82,1.01]	0.94 [0.89,0.99]
Less than one full time equivalent	1.14 [1.01,1.29]	2.14 [1.81,2.54]	1.21 [1.08,1.35]
1 to 4 full time equivalents	0.84 [0.78,0.91]	1.16 [1.03,1.31]	0.85 [0.79,0.92]
5 to 9 full time equivalents	0.86 [0.80,0.92]	1.13 [1.02,1.27]	0.85 [0.80,0.91]
10 to 14 full time equivalents	0.92 [0.86,0.99]	1.10 [0.98,1.23]	0.94 [0.89,1.00]
15 to 19 full time equivalents	0.98 [0.91,1.05]	1.08 [0.96,1.20]	0.92 [0.87,0.98]
20 to 39 full time equivalents	1.04 [0.99,1.10]	1.11 [1.02,1.21]	1.00 [0.96,1.05]
40 to 59 full time equivalents	1.00	1.00	1.00
60 to 99 full time equivalents	1.00 [0.95,1.05]	0.99 [0.91,1.08]	0.99 [0.95,1.03]
More than 100 full time equivalents	0.97 [0.91,1.03]	0.85 [0.78,0.93]	0.96 [0.91,1.01]
3 to 6 years	1.01 [0.89,1.15]	1.01 [0.87,1.16]	1.03 [0.93,1.14]
7 to 10	1.00	1.00	1.00
11 to 13 years	0.96 [0.86,1.07]	1.00 [0.90,1.12]	0.97 [0.89,1.05]
14 to 16 years	0.93 [0.83,1.04]	0.99 [0.88,1.12]	0.91 [0.83,0.98]
17 years	1.00 [0.91,1.10]	0.96 [0.87,1.05]	1.00 [0.93,1.07]
7010 Agriculture	0.63 [0.47,0.86]	0.89 [0.60,1.33]	0.80 [0.58,1.09]
7020 Fishing	1.08 [0.69,1.71]	1.02 [0.53,1.95]	1.87 [1.35,2.59]
7030 Forestry	0.64 [0.52,0.78]	0.93 [0.73,1.18]	0.70 [0.58,0.86]
7040 Oil & Gas or Mineral Resources	0.35 [0.26,0.46]	0.68 [0.52,0.88]	0.96 [0.77,1.20]
7110 Food and Beverage Products	1.00	1.00	1.00
7120 Metal and Non-Metallic Mineral Products	0.89 [0.73,1.08]	1.10 [0.88,1.37]	1.67 [1.37,2.02]
7130 Petroleum, Coal, Rubber, Plastic & Chemicals	0.34 [0.24,0.49]	0.47 [0.32,0.70]	0.67 [0.47,0.97]
7140 Wood and Paper Products	0.60 [0.48,0.75]	0.94 [0.75,1.19]	1.37 [1.12,1.67]
7150 Other Products (not elsewhere specified)	0.89 [0.68,1.16]	1.10 [0.82,1.47]	1.21 [0.94,1.56]

7210 General Construction	0.65 [0.54,0.78]	0.97 [0.78,1.20]	1.11 [0.92,1.33]
7220 Heavy Construction	0.73 [0.52,1.00]	1.14 [0.80,1.62]	1.56 [1.17,2.07]
7230 Road Construction or Maintenance	0.46 [0.37,0.57]	0.79 [0.62,1.01]	0.73 [0.59,0.89]
7320 Transportation and Related Services	0.65 [0.53,0.80]	0.96 [0.77,1.21]	0.68 [0.56,0.82]
7410 Retail	0.50 [0.37,0.68]	0.60 [0.44,0.81]	0.74 [0.55,1.00]
7420 Wholesale	0.47 [0.34,0.64]	0.56 [0.41,0.76]	0.57 [0.44,0.74]
7530 Public Administration	0.72 [0.59,0.89]	0.79 [0.63,0.99]	0.84 [0.68,1.03]
7610 Accommodation, Food, and Leisure Service	0.38 [0.31,0.46]	0.41 [0.31,0.54]	0.54 [0.43,0.67]
7620 Business Services	0.15 [0.08,0.29]	0.53 [0.33,0.86]	0.26 [0.16,0.41]
7630 Professional, Scientific, & Tech Service	0.29 [0.23,0.36]	0.30 [0.22,0.39]	0.54 [0.44,0.68]
7640 Other Services (not elsewhere specified)	0.58 [0.46,0.71]	0.76 [0.61,0.94]	0.98 [0.80,1.18]
7650 Education	0.28 [0.18,0.45]	0.43 [0.30,0.61]	0.42 [0.30,0.59]
7660 Health Care and Social Services	0.78 [0.58,1.05]	0.62 [0.45,0.87]	0.62 [0.48,0.79]
7670 Utilities	0.17 [0.08,0.39]	0.30 [0.17,0.51]	0.30 [0.20,0.45]
Firm-CU Years	116,529	116,529	116,529
Firm-CUs	9,565	9,565	9,565

Exponentiated coefficients

Table A 4: CEM Matching and GEE NB regression results, construction only, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.95 [0.86,1.04]	0.90 [0.80,1.01]	1.16 [1.07,1.26]
COR Firm Certification Indicator	0.91 [0.84,0.99]	0.94 [0.85,1.05]	1.04 [0.98,1.11]
Base Rate	1.10 [1.08,1.12]	1.15 [1.13,1.17]	1.08 [1.07,1.10]
2000	1.00	1.00	1.00
2001	1.14 [1.04,1.24]	1.09 [0.93,1.28]	1.22 [1.13,1.31]
2002	1.05 [0.97,1.15]	1.02 [0.87,1.19]	1.23 [1.13,1.32]
2003	0.92 [0.85,1.00]	0.87 [0.72,1.04]	1.20 [1.11,1.30]
2004	0.90 [0.83,0.98]	0.90 [0.77,1.05]	1.08 [1.00,1.17]
2005	0.96 [0.88,1.04]	0.96 [0.83,1.11]	1.14 [1.05,1.23]
2006	1.00 [0.93,1.09]	0.98 [0.84,1.14]	1.18 [1.10,1.28]
2007	1.07 [0.98,1.15]	1.14 [0.99,1.32]	1.21 [1.12,1.30]
2008	1.10 [1.02,1.18]	1.19 [1.03,1.37]	1.17 [1.09,1.25]
2010	0.82 [0.75,0.89]	0.99 [0.84,1.16]	0.99 [0.92,1.06]
2011	0.92 [0.85,0.99]	1.08 [0.93,1.25]	1.09 [1.01,1.17]
2012	0.87 [0.80,0.94]	0.97 [0.83,1.14]	1.03 [0.96,1.11]
2013	0.83 [0.77,0.91]	0.87 [0.74,1.03]	0.97 [0.89,1.05]
2014	0.77 [0.70,0.84]	0.89 [0.76,1.04]	0.98 [0.90,1.06]
2015	0.79 [0.72,0.86]	0.97 [0.83,1.14]	0.97 [0.89,1.05]
2016	0.73 [0.67,0.80]	0.83 [0.71,0.98]	0.93 [0.86,1.01]
Less than one full time equivalent	1.16 [0.90,1.51]	2.35 [1.56,3.54]	1.29 [1.01,1.66]
1 to 4 full time equivalents	0.86 [0.73,1.01]	1.12 [0.89,1.42]	0.92 [0.78,1.07]
5 to 9 full time equivalents	0.81 [0.70,0.94]	0.98 [0.80,1.21]	0.83 [0.74,0.94]
10 to 14 full time equivalents	0.90 [0.79,1.03]	1.00 [0.82,1.21]	0.93 [0.83,1.04]
15 to 19 full time equivalents	0.97 [0.85,1.11]	1.06 [0.87,1.29]	0.91 [0.82,1.02]
20 to 39 full time equivalents	1.03 [0.91,1.16]	1.09 [0.93,1.28]	0.98 [0.89,1.08]
40 to 59 full time equivalents	1.04 [0.93,1.15]	1.01 [0.86,1.18]	1.00 [0.92,1.10]
60 to 99 full time equivalents	1.01 [0.91,1.11]	1.01 [0.87,1.17]	1.01 [0.94,1.09]
More than 100 full time equivalents	1.00	1.00	1.00
3 to 6 years	1.04 [0.86,1.25]	0.87 [0.71,1.07]	1.07 [0.94,1.23]
7 to 10 years	1.00	1.00	1.00
11 to 13 years	0.78 [0.65,0.93]	0.81 [0.67,0.97]	0.87 [0.76,1.00]
14 to 16 years	0.83 [0.70,0.98]	0.82 [0.68,0.98]	0.91 [0.81,1.03]
17 years	0.93 [0.81,1.06]	0.85 [0.73,0.99]	0.97 [0.88,1.07]
7210 General Construction	0.95 [0.72,1.26]	0.85 [0.63,1.14]	0.71 [0.56,0.89]
7220 Heavy Construction	1.00	1.00	1.00
7230 Road Construction or Maintenance	0.67 [0.49,0.92]	0.70 [0.51,0.97]	0.46 [0.36,0.59]
Firm-CU Years	28,068	28,068	28,068
Firm-CUs	2,294	2,294	2,294

Exponentiated coefficients

Table A 5: CEM Matching and GEE NB regression results, construction only, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.95 [0.86,1.05]	0.91 [0.81,1.02]	1.16 [1.07,1.26]
COR Firm Certification Period 2003-2008	1.04 [0.95,1.15]	1.11 [0.97,1.27]	1.09 [1.00,1.18]
COR Firm Certification Period 2009-2012	0.83 [0.75,0.91]	0.86 [0.75,1.00]	1.01 [0.94,1.09]
COR Firm Certification Period 2013-2016	0.87 [0.76,1.00]	0.85 [0.71,1.00]	1.03 [0.93,1.14]
Base Rate	1.10 [1.08,1.12]	1.15 [1.13,1.17]	1.08 [1.07,1.10]
2000	1.00	1.00	1.00
2001	1.12 [1.03,1.23]	1.08 [0.91,1.27]	1.21 [1.12,1.31]
2002	1.04 [0.96,1.13]	1.00 [0.85,1.18]	1.22 [1.13,1.32]
2003	0.91 [0.84,0.99]	0.85 [0.71,1.03]	1.20 [1.11,1.30]
2004	0.89 [0.82,0.96]	0.88 [0.76,1.03]	1.08 [1.00,1.17]
2005	0.92 [0.85,1.00]	0.92 [0.79,1.07]	1.12 [1.04,1.21]
2006	0.96 [0.88,1.04]	0.93 [0.80,1.08]	1.17 [1.08,1.26]
2007	1.02 [0.94,1.11]	1.08 [0.93,1.25]	1.19 [1.10,1.28]
2008	1.05 [0.97,1.13]	1.12 [0.96,1.30]	1.15 [1.07,1.23]
2010	0.83 [0.76,0.90]	1.00 [0.85,1.17]	0.99 [0.92,1.07]
2011	0.94 [0.86,1.01]	1.10 [0.94,1.28]	1.09 [1.02,1.17]
2012	0.89 [0.82,0.97]	0.99 [0.85,1.16]	1.04 [0.97,1.11]
2013	0.84 [0.77,0.92]	0.90 [0.75,1.07]	0.96 [0.89,1.05]
2014	0.77 [0.70,0.85]	0.92 [0.78,1.09]	0.98 [0.90,1.07]
2015	0.80 [0.73,0.87]	1.01 [0.85,1.20]	0.97 [0.88,1.06]
2016	0.74 [0.67,0.81]	0.86 [0.72,1.03]	0.93 [0.85,1.02]
Less than one full time equivalent	1.15 [0.90,1.49]	2.33 [1.57,3.46]	1.28 [1.01,1.62]
1 to 4 full time equivalents	0.86 [0.74,1.00]	1.11 [0.91,1.37]	0.91 [0.79,1.04]
5 to 9 full time equivalents	0.81 [0.71,0.92]	0.98 [0.82,1.16]	0.82 [0.74,0.91]
10 to 14 full time equivalents	0.90 [0.80,1.01]	0.99 [0.84,1.16]	0.92 [0.84,1.01]
15 to 19 full time equivalents	0.97 [0.86,1.09]	1.05 [0.90,1.23]	0.90 [0.82,0.99]
20 to 39 full time equivalents	1.02 [0.92,1.14]	1.08 [0.96,1.21]	0.97 [0.90,1.04]
40 to 59 full time equivalents	1.03 [0.96,1.11]	1.00 [0.89,1.11]	0.99 [0.94,1.05]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	0.99 [0.90,1.09]	0.98 [0.85,1.14]	0.99 [0.92,1.07]
3 to 6	1.03 [0.85,1.24]	0.86 [0.71,1.06]	1.07 [0.94,1.23]
7 to 10 years	1.00	1.00	1.00
11 to 13 years	0.79 [0.66,0.94]	0.82 [0.68,0.99]	0.88 [0.76,1.01]
14 to 16 years	0.84 [0.71,0.99]	0.83 [0.69,0.99]	0.91 [0.81,1.03]
17 years	0.94 [0.82,1.07]	0.86 [0.74,1.00]	0.97 [0.88,1.07]
7210 General Construction	0.94 [0.71,1.25]	0.84 [0.63,1.13]	0.71 [0.56,0.89]
7220 Heavy Construction	1.00	1.00	1.00
7230 Road Construction or Maintenance	0.66 [0.49,0.91]	0.70 [0.50,0.96]	0.46 [0.36,0.59]
Firm-CU Years	28,068	28,068	28,068
Firm-CUs	2,294	2,294	2,294

Exponentiated coefficients

Table A 6: CEM Matching and GEE NB regression results, forestry only, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	1.14 [0.94,1.37]	1.06 [0.85,1.31]	1.04 [0.90,1.19]
COR Firm Certification Indicator	0.76 [0.67,0.87]	0.76 [0.62,0.95]	0.98 [0.85,1.12]
Base Rate	1.00 [0.94,1.06]	1.06 [1.00,1.12]	1.02 [0.99,1.05]
2000	1.00	1.00	1.00
2001	1.19 [1.00,1.42]	1.33 [1.02,1.74]	1.18 [0.97,1.44]
2002	1.03 [0.87,1.21]	1.10 [0.82,1.47]	1.20 [1.00,1.45]
2003	1.04 [0.88,1.22]	1.06 [0.79,1.41]	1.25 [1.05,1.49]
2004	0.94 [0.78,1.13]	1.13 [0.83,1.54]	1.06 [0.89,1.26]
2005	0.92 [0.77,1.11]	0.97 [0.73,1.29]	1.11 [0.93,1.33]
2006	0.90 [0.75,1.08]	0.91 [0.69,1.21]	1.00 [0.84,1.19]
2007	0.99 [0.84,1.17]	0.87 [0.65,1.17]	1.06 [0.91,1.24]
2008	1.02 [0.87,1.20]	1.13 [0.85,1.50]	0.94 [0.79,1.11]
2010	0.94 [0.78,1.12]	0.89 [0.64,1.25]	0.90 [0.74,1.08]
2011	0.93 [0.77,1.12]	0.95 [0.68,1.32]	0.92 [0.77,1.10]
2012	0.82 [0.68,1.00]	0.68 [0.48,0.97]	1.04 [0.87,1.24]
2013	1.02 [0.84,1.23]	0.94 [0.68,1.30]	0.90 [0.74,1.09]
2014	0.96 [0.79,1.17]	1.18 [0.86,1.63]	1.11 [0.92,1.34]
2015	0.96 [0.79,1.16]	0.89 [0.63,1.27]	0.87 [0.71,1.07]
2016	0.94 [0.75,1.16]	0.87 [0.59,1.28]	0.86 [0.70,1.06]
Less than one full time equivalent	1.30 [0.93,1.84]	2.54 [1.70,3.79]	1.50 [1.12,2.02]
1 to 4 full time equivalents	0.75 [0.54,1.04]	1.12 [0.77,1.61]	0.75 [0.57,0.99]
5 to 9 full time equivalents	0.80 [0.58,1.09]	1.32 [0.93,1.87]	0.74 [0.56,0.97]
10 to 14 full time equivalents	0.80 [0.58,1.10]	1.14 [0.77,1.67]	0.82 [0.62,1.10]
15 to 19 full time equivalents	0.84 [0.61,1.16]	1.09 [0.72,1.64]	0.76 [0.56,1.02]
20 to 39 full time equivalents	0.93 [0.69,1.24]	1.15 [0.79,1.66]	0.97 [0.73,1.29]
40 to 59 full time equivalents	0.94 [0.76,1.15]	1.23 [0.82,1.85]	1.00 [0.76,1.31]
60 to 99 full time equivalents	1.00	1.00	1.00
100+ full time equivalents	0.82 [0.56,1.22]	0.91 [0.49,1.69]	0.98 [0.67,1.45]
3 to 6 years	1.00	1.00	1.00
7 to 10	1.13 [0.88,1.45]	1.05 [0.76,1.44]	0.98 [0.75,1.26]
11 to 13 years	0.98 [0.76,1.27]	0.91 [0.65,1.27]	0.96 [0.75,1.23]
14 to 16 years	0.84 [0.65,1.10]	0.74 [0.52,1.05]	0.76 [0.59,0.99]
17 years	0.81 [0.63,1.03]	0.74 [0.55,1.01]	0.83 [0.65,1.05]
Firm-CU Years	21,107	21,107	21,107
Firm-CUs	1,822	1,822	1,822

Exponentiated coefficients

Table A 7: CEM Matching and GEE NB regression results, forestry only, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	1.14 [0.95,1.38]	1.08 [0.87,1.34]	1.04 [0.90,1.20]
COR Firm Certification Period 2003-2008	0.93 [0.77,1.12]	0.99 [0.73,1.36]	1.02 [0.84,1.24]
COR Firm Certification Period 2009-2012	0.70 [0.59,0.84]	0.75 [0.57,0.99]	0.95 [0.80,1.14]
COR Firm Certification Period 2013-2016	0.73 [0.58,0.92]	0.60 [0.42,0.85]	0.97 [0.77,1.23]
Base Rate	1.00 [0.94,1.06]	1.06 [1.00,1.12]	1.02 [0.99,1.05]
2000	1.00	1.00	1.00
2001	1.17 [0.98,1.39]	1.32 [1.01,1.74]	1.18 [0.96,1.43]
2002	1.01 [0.85,1.19]	1.09 [0.81,1.47]	1.19 [0.99,1.44]
2003	1.02 [0.86,1.20]	1.05 [0.79,1.41]	1.25 [1.04,1.49]
2004	0.92 [0.76,1.11]	1.12 [0.82,1.54]	1.05 [0.88,1.25]
2005	0.90 [0.75,1.09]	0.97 [0.73,1.29]	1.11 [0.92,1.32]
2006	0.88 [0.73,1.06]	0.90 [0.68,1.20]	0.99 [0.83,1.18]
2007	0.93 [0.78,1.12]	0.82 [0.60,1.13]	1.05 [0.88,1.24]
2008	0.92 [0.75,1.13]	1.00 [0.74,1.36]	0.91 [0.75,1.11]
2010	0.97 [0.81,1.15]	0.90 [0.64,1.27]	0.90 [0.75,1.09]
2011	0.96 [0.80,1.16]	0.96 [0.68,1.34]	0.93 [0.77,1.12]
2012	0.85 [0.70,1.04]	0.69 [0.48,0.99]	1.05 [0.88,1.26]
2013	1.03 [0.81,1.32]	1.12 [0.77,1.63]	0.89 [0.70,1.14]
2014	0.97 [0.75,1.26]	1.40 [0.96,2.06]	1.10 [0.86,1.42]
2015	0.97 [0.75,1.25]	1.07 [0.71,1.61]	0.87 [0.67,1.13]
2016	0.95 [0.72,1.26]	1.04 [0.66,1.64]	0.86 [0.66,1.12]
Less than one full time equivalent	1.31 [0.93,1.84]	2.53 [1.70,3.77]	1.51 [1.12,2.03]
1 to 4 full time equivalents	0.76 [0.55,1.05]	1.12 [0.78,1.62]	0.75 [0.57,0.99]
5 to 9 full time equivalents	0.81 [0.59,1.10]	1.33 [0.94,1.89]	0.74 [0.56,0.98]
10 to 14 full time equivalents	0.81 [0.59,1.11]	1.16 [0.79,1.70]	0.82 [0.62,1.10]
15 to 19 full time equivalents	0.85 [0.62,1.17]	1.10 [0.73,1.66]	0.76 [0.56,1.02]
20 to 39 full time equivalents	0.93 [0.70,1.24]	1.16 [0.80,1.68]	0.97 [0.73,1.29]
40 to 59 full time equivalents	0.94 [0.76,1.16]	1.23 [0.82,1.84]	1.00 [0.76,1.31]
60 to 99 full time equivalents	1.00	1.00	1.00
100+ full time equivalents	0.83 [0.56,1.23]	0.93 [0.50,1.72]	0.99 [0.67,1.46]
3 to 6 years	1.13 [0.88,1.45]	1.06 [0.77,1.46]	0.98 [0.75,1.27]
7 to 10	1.00	1.00	1.00
11 to 13 years	0.98 [0.76,1.27]	0.91 [0.65,1.29]	0.96 [0.75,1.23]
14 to 16 years	0.84 [0.65,1.10]	0.74 [0.52,1.05]	0.76 [0.59,0.99]
17 years	0.81 [0.63,1.03]	0.75 [0.55,1.02]	0.83 [0.65,1.05]
Firm-CU Years	21,107	21,107	21,107
Firm-CUs	1,822	1,822	1,822

Exponentiated coefficients

Table A 8: CEM Matching and GEE NB regression results, oil and gas only, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.98 [0.69,1.38]	1.30 [0.91,1.86]	1.48 [1.10,1.99]
COR Firm Certification Indicator	0.69 [0.54,0.89]	0.63 [0.44,0.91]	0.97 [0.77,1.21]
Base Rate	1.14 [1.03,1.28]	1.25 [1.14,1.38]	1.13 [1.07,1.20]
2000	1.00	1.00	1.00
2001	0.93 [0.68,1.27]	0.96 [0.56,1.64]	1.42 [1.15,1.76]
2002	1.11 [0.85,1.45]	0.92 [0.59,1.43]	1.13 [0.86,1.49]
2003	0.88 [0.67,1.16]	1.16 [0.73,1.84]	1.23 [0.96,1.58]
2004	0.98 [0.75,1.28]	0.97 [0.62,1.53]	1.09 [0.85,1.40]
2005	1.08 [0.84,1.40]	1.36 [0.88,2.11]	1.37 [1.05,1.79]
2006	1.36 [1.02,1.83]	1.63 [1.06,2.50]	1.23 [0.99,1.54]
2007	1.23 [0.96,1.59]	1.26 [0.81,1.95]	1.26 [1.03,1.53]
2008	1.48 [1.17,1.88]	1.67 [1.11,2.51]	1.26 [0.96,1.66]
2010	0.86 [0.67,1.11]	1.22 [0.78,1.89]	0.68 [0.55,0.84]
2011	0.91 [0.69,1.18]	1.15 [0.73,1.80]	0.78 [0.63,0.95]
2012	0.96 [0.73,1.27]	1.03 [0.68,1.56]	0.82 [0.65,1.02]
2013	0.75 [0.52,1.09]	1.01 [0.59,1.72]	0.75 [0.59,0.96]
2014	0.73 [0.51,1.05]	1.09 [0.58,2.03]	0.62 [0.50,0.78]
2015	0.86 [0.61,1.21]	1.03 [0.59,1.80]	0.74 [0.57,0.96]
2016	0.90 [0.57,1.43]	1.81 [1.04,3.16]	0.72 [0.54,0.95]
Less than one full time equivalent	2.86 [1.59,5.15]	6.09 [2.78,13.33]	0.92 [0.54,1.56]
1 to 4 full time equivalents	1.31 [0.93,1.83]	1.35 [0.72,2.54]	0.59 [0.42,0.84]
5 to 9 full time equivalents	1.30 [0.93,1.83]	1.71 [0.98,2.96]	0.73 [0.51,1.04]
10 to 14 full time equivalents	1.33 [1.00,1.77]	1.35 [0.80,2.27]	0.77 [0.58,1.02]
15 to 19 full time equivalents	1.47 [1.14,1.90]	1.25 [0.74,2.12]	0.91 [0.69,1.20]
20 to 39 full time equivalents	1.73 [1.24,2.43]	1.86 [1.23,2.83]	1.00 [0.76,1.32]
40 to 59 full time equivalents	1.00	1.00	1.00
60 to 99 full time equivalents	1.08 [0.86,1.36]	1.03 [0.66,1.61]	0.81 [0.65,1.02]
More than 100 full time equivalents	0.56 [0.41,0.77]	0.71 [0.46,1.10]	0.72 [0.53,0.99]
3 to 6 years	0.62 [0.34,1.14]	0.85 [0.40,1.81]	1.27 [0.74,2.19]
7 to 10 years	0.58 [0.35,0.96]	0.64 [0.34,1.21]	0.97 [0.61,1.55]
11 to 13 years	0.80 [0.43,1.49]	0.78 [0.40,1.50]	1.05 [0.62,1.78]
13 to 16	1.00	1.00	1.00
17 years	1.35 [0.74,2.46]	1.23 [0.67,2.27]	1.65 [0.96,2.84]
Firm-CU Years	5,418	5,418	5,418
Firm-CUs	523	523	523

Exponentiated coefficients

Table A 9: CEM Matching and GEE NB regression results, oil and gas only, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.96 [0.68,1.35]	1.26 [0.88,1.80]	1.51 [1.11,2.04]
COR Firm Certification Period 2003-2008	0.72 [0.52,0.99]	0.65 [0.42,1.00]	1.27 [0.93,1.73]
COR Firm Certification Period 2009-2012	0.75 [0.56,1.02]	0.70 [0.43,1.14]	0.79 [0.62,1.01]
COR Firm Certification Period 2013-2016	0.61 [0.40,0.92]	0.64 [0.34,1.21]	0.67 [0.48,0.93]
Base Rate	1.14 [1.03,1.28]	1.26 [1.14,1.38]	1.12 [1.06,1.18]
2000	1.00	1.00	1.00
2001	0.95 [0.69,1.30]	0.98 [0.58,1.67]	1.38 [1.11,1.71]
2002	1.13 [0.86,1.49]	0.94 [0.60,1.46]	1.10 [0.83,1.45]
2003	0.90 [0.68,1.19]	1.18 [0.75,1.88]	1.19 [0.92,1.52]
2004	0.95 [0.72,1.24]	0.94 [0.60,1.47]	1.05 [0.81,1.36]
2005	1.10 [0.84,1.44]	1.38 [0.90,2.14]	1.24 [0.92,1.67]
2006	1.38 [1.01,1.88]	1.65 [1.07,2.55]	1.09 [0.84,1.41]
2007	1.24 [0.95,1.62]	1.28 [0.81,2.02]	1.11 [0.88,1.40]
2008	1.49 [1.18,1.88]	1.69 [1.13,2.55]	1.08 [0.84,1.39]
2010	0.85 [0.65,1.10]	1.20 [0.76,1.89]	0.70 [0.57,0.86]
2011	0.89 [0.68,1.16]	1.13 [0.71,1.80]	0.80 [0.65,0.97]
2012	0.95 [0.71,1.25]	1.02 [0.67,1.54]	0.84 [0.67,1.05]
2013	0.82 [0.52,1.29]	1.03 [0.59,1.79]	0.85 [0.63,1.14]
2014	0.79 [0.50,1.25]	1.11 [0.56,2.19]	0.71 [0.53,0.95]
2015	0.92 [0.60,1.41]	1.05 [0.58,1.90]	0.82 [0.60,1.13]
2016	0.96 [0.56,1.66]	1.84 [1.00,3.39]	0.80 [0.57,1.12]
Less than one full time equivalent	2.65 [1.46,4.83]	5.94 [2.77,12.77]	1.13 [0.68,1.87]
1 to 4 full time equivalents	1.21 [0.85,1.73]	1.31 [0.70,2.43]	0.72 [0.53,1.00]
5 to 9 full time equivalents	1.20 [0.84,1.70]	1.64 [0.99,2.72]	0.89 [0.63,1.24]
10 to 14 full time equivalents	1.22 [0.89,1.67]	1.29 [0.79,2.13]	0.95 [0.73,1.23]
15 to 19 full time equivalents	1.34 [1.01,1.80]	1.19 [0.73,1.96]	1.11 [0.85,1.44]
20 to 39 full time equivalents	1.59 [1.08,2.35]	1.79 [1.19,2.69]	1.23 [0.91,1.67]
40 to 59 full time equivalents	0.91 [0.73,1.15]	0.96 [0.62,1.50]	1.22 [0.98,1.53]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	0.52 [0.39,0.70]	0.69 [0.48,0.98]	0.88 [0.69,1.11]
3 to 6 years	0.62 [0.34,1.14]	0.85 [0.40,1.80]	1.20 [0.70,2.04]
7 to 10 years	0.59 [0.35,0.98]	0.65 [0.34,1.22]	0.93 [0.60,1.45]
11 to 13 years	0.82 [0.44,1.53]	0.78 [0.40,1.52]	1.03 [0.62,1.72]
13 to 16	1.00	1.00	1.00
17 years	1.36 [0.74,2.50]	1.24 [0.67,2.28]	1.60 [0.94,2.72]
Firm-CU Years	5,418	5,418	5,418
Firm-CUs	523	523	523

Exponentiated coefficients

Table A 10: CEM Matching and GEE NB regression results, manufacturing only, by year of certification (2003-2016), SLF, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.95 [0.80,1.11]	1.01 [0.87,1.17]	1.21 [1.05,1.41]
COR Firm Certification Indicator	0.75 [0.67,0.85]	0.78 [0.67,0.91]	0.89 [0.81,0.98]
Base Rate	1.11 [1.08,1.14]	1.14 [1.11,1.18]	1.09 [1.05,1.13]
2000	1.00	1.00	1.00
2001	1.18 [1.08,1.29]	1.21 [1.00,1.47]	1.18 [1.07,1.30]
2002	1.03 [0.92,1.14]	0.93 [0.76,1.13]	1.12 [0.99,1.26]
2003	0.97 [0.88,1.07]	0.91 [0.76,1.09]	1.03 [0.94,1.13]
2004	0.90 [0.80,1.00]	0.99 [0.81,1.20]	1.01 [0.92,1.11]
2005	1.00 [0.90,1.11]	1.01 [0.84,1.22]	1.13 [1.04,1.23]
2006	1.02 [0.92,1.13]	1.06 [0.90,1.24]	1.11 [1.02,1.21]
2007	0.99 [0.90,1.08]	1.23 [1.06,1.43]	1.15 [1.06,1.25]
2008	1.05 [0.97,1.15]	1.21 [1.02,1.44]	1.08 [0.99,1.17]
2010	0.74 [0.67,0.82]	0.98 [0.82,1.18]	0.86 [0.79,0.93]
2011	0.83 [0.74,0.93]	0.97 [0.80,1.17]	0.93 [0.85,1.01]
2012	0.81 [0.71,0.93]	1.14 [0.82,1.57]	0.94 [0.85,1.02]
2013	0.78 [0.69,0.87]	0.87 [0.71,1.07]	0.92 [0.83,1.01]
2014	0.75 [0.66,0.84]	0.91 [0.75,1.11]	0.93 [0.83,1.05]
2015	0.73 [0.64,0.84]	1.04 [0.87,1.24]	0.87 [0.77,0.99]
2016	0.63 [0.56,0.71]	0.94 [0.76,1.16]	0.81 [0.73,0.90]
Less than one full time equivalent	1.71 [0.48,6.08]	3.93 [0.90,17.16]	1.65 [0.56,4.81]
1 to 4 full time equivalents	0.79 [0.56,1.12]	1.82 [1.05,3.17]	0.82 [0.56,1.21]
5 to 9 full time equivalents	0.91 [0.72,1.15]	1.75 [1.15,2.65]	0.95 [0.77,1.17]
10 to 14 full time equivalents	0.88 [0.71,1.10]	1.42 [0.94,2.16]	1.06 [0.89,1.26]
15 to 19 full time equivalents	1.00	1.00	1.00
20 to 39 full time equivalents	1.03 [0.88,1.19]	1.49 [1.06,2.09]	0.99 [0.85,1.15]
40 to 59 full time equivalents	1.03 [0.84,1.27]	1.22 [0.85,1.75]	0.98 [0.83,1.17]
60 to 99 full time equivalents	1.01 [0.81,1.25]	1.20 [0.83,1.73]	1.01 [0.83,1.23]
More than 100 full time equivalents	0.83 [0.67,1.02]	0.89 [0.63,1.25]	0.98 [0.83,1.17]
3 to 6 years	1.00	1.00	1.00
7 to 10	0.95 [0.58,1.56]	0.61 [0.38,0.97]	1.24 [0.82,1.88]
11 to 13 years	0.83 [0.52,1.34]	0.66 [0.41,1.05]	1.20 [0.82,1.76]
14 to 16 years	0.85 [0.52,1.40]	0.69 [0.43,1.11]	1.00 [0.68,1.48]
17 years	1.02 [0.65,1.61]	0.75 [0.48,1.16]	1.16 [0.81,1.66]
7110 Food and Beverage Products	1.01 [0.73,1.39]	0.88 [0.65,1.19]	0.70 [0.53,0.92]
7120 Metal and Non-Metallic Mineral Products	0.90 [0.71,1.16]	0.98 [0.77,1.24]	1.28 [1.03,1.58]
7130 Petroleum, Coal, Rubber, Plastic & Chemicals	0.36 [0.24,0.53]	0.42 [0.28,0.63]	0.53 [0.35,0.81]
7140 Wood and Paper Products	0.66 [0.49,0.88]	0.90 [0.70,1.17]	1.06 [0.84,1.32]
7150 Other Products (not elsewhere specified)	1.00	1.00	1.00
Firm-CU Years	8,214	8,214	8,214
Firm-CUs	629	629	629

Exponentiated coefficients

Table A 11: CEM Matching and GEE NB regression results, manufacturing, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.95 [0.80,1.12]	1.01 [0.87,1.18]	1.22 [1.05,1.41]
COR Firm Certification Period 2003-2008	0.74 [0.58,0.94]	0.69 [0.48,0.97]	0.94 [0.77,1.15]
COR Firm Certification Period 2009-2012	0.81 [0.70,0.93]	0.80 [0.63,1.02]	0.92 [0.83,1.02]
COR Firm Certification Period 2013-2016	0.71 [0.61,0.82]	0.78 [0.64,0.93]	0.85 [0.74,0.98]
Base Rate	1.11 [1.08,1.14]	1.14 [1.11,1.18]	1.09 [1.05,1.13]
2000	1.00	1.00	1.00
2001	1.19 [1.09,1.29]	1.21 [1.00,1.47]	1.18 [1.07,1.31]
2002	1.03 [0.93,1.15]	0.93 [0.76,1.13]	1.13 [1.00,1.27]
2003	0.97 [0.88,1.08]	0.91 [0.76,1.09]	1.04 [0.94,1.14]
2004	0.90 [0.81,1.01]	0.99 [0.81,1.20]	1.01 [0.92,1.11]
2005	1.00 [0.91,1.11]	1.02 [0.84,1.23]	1.13 [1.04,1.24]
2006	1.02 [0.93,1.13]	1.06 [0.91,1.25]	1.11 [1.02,1.21]
2007	1.00 [0.91,1.09]	1.24 [1.07,1.45]	1.15 [1.06,1.25]
2008	1.06 [0.97,1.16]	1.22 [1.03,1.46]	1.08 [0.99,1.18]
2010	0.74 [0.67,0.81]	0.98 [0.81,1.17]	0.85 [0.79,0.93]
2011	0.82 [0.73,0.91]	0.96 [0.79,1.17]	0.92 [0.84,1.00]
2012	0.80 [0.69,0.91]	1.13 [0.81,1.57]	0.93 [0.85,1.01]
2013	0.80 [0.71,0.91]	0.88 [0.71,1.08]	0.94 [0.84,1.05]
2014	0.77 [0.68,0.88]	0.92 [0.74,1.13]	0.96 [0.83,1.10]
2015	0.76 [0.66,0.88]	1.04 [0.86,1.26]	0.90 [0.78,1.04]
2016	0.66 [0.58,0.74]	0.94 [0.76,1.17]	0.83 [0.73,0.95]
Less than one full time equivalent	1.72 [0.48,6.10]	3.95 [0.91,17.19]	1.64 [0.56,4.80]
1 to 4 full time equivalents	0.79 [0.56,1.12]	1.82 [1.05,3.17]	0.83 [0.56,1.22]
5 to 9 full time equivalents	0.92 [0.73,1.16]	1.75 [1.15,2.65]	0.95 [0.77,1.17]
10 to 14 full time equivalents	0.88 [0.71,1.10]	1.42 [0.94,2.16]	1.06 [0.89,1.26]
15 to 19 full time equivalents	1.00	1.00	1.00
20 to 39 full time equivalents	1.03 [0.89,1.20]	1.49 [1.06,2.09]	0.99 [0.85,1.15]
40 to 59 full time equivalents	1.03 [0.84,1.27]	1.22 [0.85,1.75]	0.98 [0.83,1.16]
60 to 99 full time equivalents	1.01 [0.82,1.25]	1.20 [0.83,1.73]	1.01 [0.83,1.23]
More than 100 full time equivalents	0.83 [0.67,1.03]	0.89 [0.63,1.25]	0.98 [0.83,1.17]
3 to 6 years	1.00	1.00	1.00
7 to 10	0.95 [0.57,1.56]	0.60 [0.38,0.97]	1.24 [0.82,1.89]
11 to 13 years	0.83 [0.52,1.34]	0.65 [0.41,1.05]	1.20 [0.82,1.76]
14 to 16 years	0.85 [0.52,1.40]	0.69 [0.43,1.11]	1.00 [0.68,1.48]
17 years	1.02 [0.65,1.61]	0.74 [0.47,1.16]	1.16 [0.81,1.67]
7110 Food and Beverage Products	1.01 [0.73,1.39]	0.88 [0.65,1.19]	0.70 [0.53,0.92]
7120 Metal and Non-Metallic Mineral Products	0.90 [0.71,1.16]	0.98 [0.77,1.24]	1.27 [1.02,1.58]
7130 Petroleum, Coal, Rubber, Plastic & Chemi	0.36 [0.24,0.53]	0.42 [0.28,0.63]	0.53 [0.35,0.80]
7140 Wood and Paper Products	0.66 [0.49,0.88]	0.90 [0.70,1.17]	1.06 [0.84,1.32]
7150 Other Products (not elsewhere specified)	1.00	1.00	1.00
Firm-CU Years	8,214	8,214	8,214
Firm-CUs	629	629	629

Exponentiated coefficients

Table A 12: CEM Matching and GEE NB regression results, transportation and warehousing, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.83 [0.72,0.95]	1.09 [0.94,1.27]	0.98 [0.86,1.10]
COR Firm Certification Indicator	0.92 [0.82,1.03]	0.98 [0.84,1.15]	0.93 [0.84,1.04]
Base Rate	1.08 [1.04,1.11]	1.15 [1.11,1.20]	1.08 [1.05,1.11]
2000	1.00	1.00	1.00
2001	1.16 [1.02,1.31]	1.20 [0.98,1.48]	1.21 [1.07,1.38]
2002	0.95 [0.84,1.07]	0.88 [0.71,1.10]	1.13 [0.99,1.29]
2003	0.94 [0.83,1.06]	0.95 [0.76,1.17]	1.10 [0.95,1.27]
2004	0.90 [0.79,1.02]	0.86 [0.69,1.07]	1.18 [1.04,1.34]
2005	0.90 [0.80,1.02]	1.04 [0.83,1.29]	1.08 [0.96,1.23]
2006	0.86 [0.77,0.98]	0.93 [0.75,1.15]	1.07 [0.94,1.21]
2007	1.00 [0.89,1.11]	1.09 [0.90,1.33]	1.03 [0.91,1.16]
2008	0.93 [0.83,1.04]	1.09 [0.89,1.32]	1.06 [0.94,1.21]
2010	0.87 [0.76,0.99]	0.94 [0.75,1.17]	0.98 [0.87,1.10]
2011	0.88 [0.77,1.00]	1.03 [0.83,1.27]	1.15 [1.00,1.32]
2012	0.86 [0.76,0.97]	0.80 [0.65,0.98]	1.03 [0.91,1.17]
2013	0.85 [0.75,0.96]	0.81 [0.65,1.00]	1.10 [0.97,1.26]
2014	0.89 [0.78,1.02]	0.87 [0.71,1.06]	1.13 [0.99,1.29]
2015	0.83 [0.72,0.95]	0.82 [0.66,1.02]	1.04 [0.91,1.19]
2016	0.84 [0.73,0.96]	0.76 [0.60,0.97]	1.06 [0.92,1.22]
Less than one full time equivalent	0.76 [0.60,0.95]	1.20 [0.87,1.68]	0.86 [0.68,1.08]
1 to 4 full time equivalents	0.64 [0.52,0.78]	0.93 [0.72,1.21]	0.78 [0.66,0.93]
5 to 9 full time equivalents	0.65 [0.53,0.80]	0.85 [0.64,1.12]	0.84 [0.70,1.01]
10 to 14 full time equivalents	0.76 [0.62,0.94]	1.02 [0.77,1.34]	0.94 [0.78,1.12]
15 to 19 full time equivalents	0.78 [0.62,0.99]	1.04 [0.77,1.41]	0.84 [0.70,1.02]
20 to 39 full time equivalents	0.85 [0.71,1.02]	0.83 [0.65,1.05]	0.96 [0.82,1.11]
40 to 59 full time equivalents	0.98 [0.83,1.15]	0.90 [0.66,1.24]	1.02 [0.89,1.17]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	1.09 [0.93,1.28]	0.79 [0.63,0.98]	1.10 [0.96,1.25]
3 to 6 years	0.99 [0.71,1.39]	0.91 [0.60,1.39]	0.98 [0.63,1.54]
7 to 10	1.00	1.00	1.00
11 to 13 years	1.10 [0.87,1.39]	1.00 [0.77,1.30]	0.94 [0.76,1.17]
14 to 16 years	1.01 [0.78,1.31]	0.95 [0.70,1.30]	1.00 [0.80,1.26]
17 years	0.87 [0.71,1.07]	0.70 [0.57,0.86]	0.98 [0.79,1.20]
7310 Warehousing	1.98 [1.41,2.79]	1.45 [0.87,2.40]	2.16 [1.46,3.20]
7320 Transportation and Related Services	1.00	1.00	1.00
Firm-CU Years	23,575	23,575	23,575
Firm-CUs	1,914	1,914	1,914

Exponentiated coefficients

Table A 13: CEM Matching and GEE NB regression results, transportation and warehousing, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.83 [0.72,0.95]	1.10 [0.95,1.29]	0.98 [0.86,1.11]
COR Firm Certification Period 2003-2008	0.80 [0.65,0.97]	0.89 [0.65,1.22]	0.92 [0.75,1.14]
COR Firm Certification Period 2009-2012	1.02 [0.89,1.18]	1.15 [0.94,1.40]	0.98 [0.86,1.12]
COR Firm Certification Period 2013-2016	0.85 [0.73,0.98]	0.84 [0.69,1.04]	0.89 [0.78,1.02]
Base Rate	1.08 [1.05,1.11]	1.16 [1.12,1.21]	1.08 [1.05,1.11]
2000	1.00	1.00	1.00
2001	1.17 [1.04,1.33]	1.23 [1.00,1.52]	1.22 [1.07,1.39]
2002	0.96 [0.86,1.09]	0.90 [0.72,1.13]	1.14 [0.99,1.30]
2003	0.95 [0.84,1.08]	0.97 [0.78,1.20]	1.10 [0.96,1.27]
2004	0.91 [0.80,1.03]	0.88 [0.71,1.10]	1.19 [1.05,1.35]
2005	0.91 [0.81,1.03]	1.06 [0.85,1.32]	1.09 [0.96,1.24]
2006	0.88 [0.78,0.99]	0.96 [0.77,1.19]	1.08 [0.95,1.23]
2007	1.02 [0.91,1.15]	1.13 [0.93,1.38]	1.03 [0.92,1.17]
2008	0.97 [0.86,1.10]	1.15 [0.93,1.41]	1.07 [0.95,1.22]
2010	0.85 [0.75,0.97]	0.91 [0.73,1.13]	0.97 [0.86,1.09]
2011	0.86 [0.76,0.97]	0.99 [0.80,1.23]	1.14 [0.99,1.31]
2012	0.83 [0.74,0.94]	0.76 [0.61,0.94]	1.02 [0.90,1.16]
2013	0.89 [0.78,1.03]	0.90 [0.71,1.13]	1.14 [0.99,1.32]
2014	0.94 [0.81,1.09]	0.97 [0.78,1.20]	1.17 [1.01,1.35]
2015	0.87 [0.74,1.02]	0.91 [0.72,1.15]	1.08 [0.93,1.24]
2016	0.88 [0.75,1.03]	0.85 [0.66,1.09]	1.09 [0.94,1.28]
Less than one full time equivalent	0.77 [0.61,0.97]	1.31 [0.87,1.99]	0.84 [0.67,1.05]
1 to 4 full time equivalents	0.65 [0.53,0.80]	1.02 [0.71,1.45]	0.76 [0.64,0.90]
5 to 9 full time equivalents	0.66 [0.54,0.82]	0.93 [0.65,1.34]	0.82 [0.69,0.98]
10 to 14 full time equivalents	0.77 [0.63,0.95]	1.12 [0.78,1.61]	0.92 [0.77,1.09]
15 to 19 full time equivalents	0.80 [0.64,1.00]	1.15 [0.79,1.67]	0.83 [0.69,1.00]
20 to 39 full time equivalents	0.87 [0.75,1.01]	0.91 [0.66,1.27]	0.94 [0.82,1.07]
40 to 59 full time equivalents	1.00	1.00	1.00
60 to 99 full time equivalents	1.02 [0.87,1.20]	1.10 [0.81,1.51]	0.98 [0.86,1.12]
More than 100 full time equivalents	1.12 [0.93,1.34]	0.88 [0.66,1.17]	1.08 [0.93,1.25]
3 to 6 years	1.00 [0.71,1.39]	0.92 [0.60,1.41]	0.99 [0.63,1.54]
7 to 10	1.00	1.00	1.00
11 to 13 years	1.09 [0.86,1.38]	0.99 [0.76,1.29]	0.94 [0.76,1.17]
14 to 16 years	1.01 [0.78,1.31]	0.95 [0.70,1.29]	1.00 [0.80,1.25]
17 years	0.87 [0.70,1.06]	0.70 [0.56,0.86]	0.98 [0.79,1.20]
7310 Warehousing	1.99 [1.42,2.80]	1.48 [0.89,2.45]	2.17 [1.47,3.21]
7320 Transportation and Related Services	1.00	1.00	1.00
Firm-CU Years	23,575	23,575	23,575
Firm-CUs	1,914	1,914	1,914

Exponentiated coefficients

Appendix B: Unmatched Regression Results

Table B 1: Descriptive statistics for unmatched cohort

	COR Firm (n=5628)	Non-COR Firm (n=388,571)
Average Base Rate (95% CI)	4.89	2.64
Average Firm Size (95% CI)	46.69	11.02
Percentage (N) of COR-firms and non COR-firm by study covariates		
Agriculture	0.54 (30)	2.32 (5837)
Fishing	0.07 (4)	0.02 (50)
Forestry	24.79 (1385)	2.12 (5354)
Oil & Gas or Mineral Resources	4.24 (237)	0.71 (1790)
Food and Beverage Products	0.32 (18)	0.65 (1637)
Metal and Non-Metallic Mineral Products	2.22 (124)	1.52 (3841)
Petroleum, Coal, Rubber, Plastic & Chemicals	1.06 (59)	0.64 (1601)
Wood and Paper Products	2.01 (112)	1.83 (4608)
Other Products (not elsewhere specified	0.48 (27)	0.95 (2400)
General Construction	18.67 (1043)	22.14 (55805)
Heavy Construction	1 (56)	0.13 (324)
Road Construction or Maintenance	3.58 (200)	0.69 (1728)
Warehousing	0.11 (6)	0.11 (288)
Transportation and Related Services	18.37 (1026)	12.48 (31456)
Retail	0.45 (25)	8.4 (21176)
Wholesale	0.86 (48)	2.63 (6638)
Public Administration	0.48 (27)	0.37 (942)
Accommodation, Food, and Leisure Services	1.65 (92)	15.17 (38234)
Business Services	0.54 (30)	7.54 (19008)
Professional, Scientific, & Tech Services	11.58 (647)	6.29 (15844)
Other Services (not elsewhere specified)	5.17 (289)	10.02 (25254)
Education	0.2 (11)	1.13 (2840)
Health Care and Social Assistance	1.36 (76)	1.94 (4879)
Utilities	0.25 (14)	0.21 (539)
Firm Size (average per year)		
Less than 1 FTE	21.61 (1216)	34.52 (134139)
1 to 4 FTE	26.88 (1513)	33.56 (130387)
5 to 9 FTE	12.72 (716)	13.08 (50808)
10 to 14 FTE	6.97 (392)	6.7 (26049)
15 to 19 FTE	5.05 (284)	4.19 (16271)
20 to 39 FTE	9.36 (527)	4.31 (16738)
40 to 59 FTE	4.62 (260)	1.78 (6934)
60 to 99 FTE	4.46 (251)	1.14 (4416)
More than 100 FTE	8.33 (469)	0.73 (2829)

Table B 2: GEE NB regression unmatched results, overall sample, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	1.02 [0.97,1.07]	1.04 [0.98,1.09]	1.29 [1.24,1.34]
COR Firm Certification Indicator	0.83 [0.80,0.86]	0.83 [0.79,0.88]	1.00 [0.97,1.04]
Base Rate	1.13 [1.13,1.14]	1.19 [1.18,1.20]	1.11 [1.11,1.12]
2000	1.00	1.00	1.00
2001	1.16 [1.14,1.18]	1.11 [1.07,1.15]	1.18 [1.16,1.21]
2002	1.05 [1.03,1.07]	1.06 [1.02,1.11]	1.13 [1.10,1.15]
2003	0.98 [0.96,1.00]	1.01 [0.97,1.05]	1.10 [1.08,1.12]
2004	0.96 [0.94,0.97]	1.01 [0.97,1.04]	1.07 [1.05,1.09]
2005	0.98 [0.96,1.00]	1.03 [0.99,1.07]	1.10 [1.08,1.12]
2006	1.01 [0.99,1.03]	1.06 [1.02,1.10]	1.10 [1.08,1.12]
2007	1.03 [1.01,1.05]	1.14 [1.10,1.19]	1.13 [1.11,1.15]
2008	1.05 [1.03,1.07]	1.20 [1.15,1.24]	1.07 [1.05,1.09]
2010	0.85 [0.83,0.86]	1.04 [1.00,1.08]	0.91 [0.89,0.92]
2011	0.90 [0.89,0.92]	1.06 [1.02,1.10]	1.02 [1.00,1.04]
2012	0.88 [0.86,0.90]	1.02 [0.98,1.07]	1.00 [0.98,1.01]
2013	0.86 [0.85,0.88]	1.00 [0.96,1.04]	0.97 [0.96,0.99]
2014	0.84 [0.82,0.86]	0.96 [0.92,0.99]	0.95 [0.93,0.97]
2015	0.83 [0.82,0.85]	0.99 [0.95,1.03]	0.94 [0.92,0.95]
2016	0.78 [0.77,0.80]	0.94 [0.90,0.98]	0.92 [0.90,0.93]
Less than one full time equivalent	0.87 [0.84,0.91]	2.36 [2.25,2.48]	0.93 [0.90,0.97]
1 to 4 full time equivalents	0.57 [0.55,0.59]	1.27 [1.22,1.33]	0.72 [0.70,0.74]
5 to 9 full time equivalents	0.60 [0.58,0.62]	1.12 [1.07,1.17]	0.77 [0.75,0.79]
10 to 14 full time equivalents	0.67 [0.64,0.69]	1.13 [1.08,1.18]	0.84 [0.81,0.87]
15 to 19 full time equivalents	0.73 [0.71,0.76]	1.14 [1.09,1.20]	0.88 [0.85,0.91]
20 to 39 full time equivalents	0.81 [0.78,0.84]	1.13 [1.09,1.18]	0.95 [0.93,0.98]
40 to 59 full time equivalents	0.88 [0.85,0.91]	1.09 [1.04,1.14]	1.00 [0.97,1.03]
60 to 99 full time equivalents	0.93 [0.90,0.96]	1.06 [1.01,1.11]	1.00 [0.97,1.03]
More than 100 full time equivalents	1.00	1.00	1.00
3 to 6 years	1.21 [1.17,1.25]	1.14 [1.09,1.18]	1.14 [1.11,1.17]
7 to 10 years	1.07 [1.04,1.11]	1.03 [0.98,1.07]	1.05 [1.02,1.08]
11 to 13 years	1.01 [0.98,1.05]	1.00 [0.95,1.04]	1.01 [0.98,1.04]
13 to 16 years	1.00	1.00	1.00
17 years	0.99 [0.96,1.02]	0.94 [0.90,0.98]	1.01 [0.98,1.04]
7010 Agriculture	0.62 [0.57,0.66]	0.92 [0.84,1.01]	0.67 [0.62,0.73]
7020 Fishing	1.15 [0.90,1.46]	1.08 [0.80,1.45]	1.75 [1.44,2.11]
7030 Forestry	0.82 [0.76,0.89]	0.79 [0.72,0.87]	0.88 [0.81,0.95]
7040 Oil & Gas or Mineral Resources	0.47 [0.41,0.53]	0.68 [0.60,0.76]	1.05 [0.94,1.17]
7120 Metal and Non-Metallic Mineral Products	1.12 [1.05,1.20]	1.03 [0.95,1.12]	1.87 [1.74,2.01]
7130 Petroleum, Coal, Rubber, Plastic & Chemicals	0.58 [0.51,0.65]	0.62 [0.53,0.72]	0.83 [0.73,0.94]
7140 Wood and Paper Products	0.97 [0.91,1.04]	1.13 [1.04,1.23]	1.39 [1.29,1.49]

7150 Other Products (not elsewhere specified)	0.71 [0.65,0.78]	0.71 [0.63,0.79]	1.09 [0.99,1.20]
7210 General Construction	0.86 [0.81,0.91]	0.92 [0.86,0.99]	1.31 [1.22,1.39]
7220 Heavy Construction	0.64 [0.54,0.75]	0.64 [0.54,0.78]	1.42 [1.23,1.63]
7230 Road Construction or Maintenance	0.61 [0.55,0.66]	0.78 [0.70,0.87]	0.80 [0.73,0.88]
7310 Warehousing	1.00	1.00	1.00
7320 Transportation and Related Services	0.86 [0.80,0.91]	0.80 [0.74,0.86]	0.69 [0.64,0.74]
7410 Retail	0.39 [0.37,0.42]	0.37 [0.34,0.40]	0.61 [0.57,0.65]
7420 Wholesale	0.38 [0.35,0.41]	0.37 [0.34,0.41]	0.43 [0.40,0.47]
7530 Public Administration	0.68 [0.62,0.73]	0.72 [0.66,0.79]	0.97 [0.89,1.06]
7610 Accommodation, Food, and Leisure Service	0.38 [0.36,0.41]	0.36 [0.33,0.39]	0.62 [0.59,0.67]
7620 Business Services	0.08 [0.06,0.09]	0.11 [0.09,0.13]	0.11 [0.09,0.12]
7630 Professional, Scientific, & Tech Service	0.12 [0.10,0.13]	0.12 [0.11,0.14]	0.22 [0.20,0.24]
7640 Other Services (not elsewhere specified)	0.77 [0.73,0.82]	0.69 [0.64,0.74]	1.13 [1.06,1.21]
7650 Education	0.25 [0.22,0.28]	0.36 [0.31,0.40]	0.43 [0.38,0.48]
7660 Health Care and Social Services	0.82 [0.76,0.88]	0.48 [0.44,0.52]	0.74 [0.69,0.80]
7670 Utilities	0.26 [0.18,0.39]	0.32 [0.23,0.45]	0.44 [0.35,0.55]
Firm-CU Years	2,234,656	2,234,656	2,234,656
Firm-CUs	258,752	258,752	258,752

Exponentiated coefficients

Table B 3: GEE NB regression unmatched results, overall sample, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	1.02 [0.97,1.06]	1.03 [0.98,1.09]	1.29 [1.24,1.34]
COR Firm Certification Period 2003-2008	0.85 [0.81,0.90]	0.86 [0.79,0.94]	1.04 [0.99,1.09]
COR Firm Certification Period 2009-2012	0.83 [0.79,0.86]	0.85 [0.79,0.91]	0.98 [0.94,1.02]
COR Firm Certification Period 2013-2016	0.83 [0.79,0.87]	0.82 [0.77,0.87]	1.01 [0.97,1.05]
Base Rate	1.13 [1.13,1.14]	1.19 [1.18,1.20]	1.11 [1.11,1.12]
2000	1.00	1.00	1.00
2001	1.16 [1.14,1.18]	1.11 [1.07,1.15]	1.18 [1.16,1.21]
2002	1.05 [1.03,1.07]	1.07 [1.03,1.11]	1.12 [1.10,1.15]
2003	0.98 [0.96,1.00]	1.01 [0.97,1.05]	1.10 [1.08,1.12]
2004	0.95 [0.94,0.97]	1.00 [0.97,1.04]	1.07 [1.05,1.09]
2005	0.98 [0.96,1.00]	1.03 [0.99,1.07]	1.10 [1.08,1.12]
2006	1.01 [0.99,1.03]	1.06 [1.02,1.10]	1.10 [1.08,1.12]
2007	1.03 [1.01,1.05]	1.14 [1.10,1.19]	1.13 [1.11,1.15]
2008	1.05 [1.03,1.07]	1.19 [1.15,1.24]	1.07 [1.05,1.08]
2010	0.85 [0.83,0.86]	1.04 [1.00,1.08]	0.91 [0.89,0.92]
2011	0.90 [0.89,0.92]	1.06 [1.02,1.10]	1.02 [1.00,1.04]
2012	0.88 [0.86,0.90]	1.02 [0.98,1.06]	1.00 [0.98,1.02]
2013	0.86 [0.85,0.88]	1.00 [0.96,1.04]	0.97 [0.95,0.99]
2014	0.84 [0.82,0.86]	0.96 [0.92,1.00]	0.95 [0.93,0.97]
2015	0.83 [0.81,0.85]	0.99 [0.95,1.03]	0.93 [0.92,0.95]
2016	0.78 [0.77,0.80]	0.94 [0.91,0.98]	0.92 [0.90,0.93]
Less than one full time equivalent	0.87 [0.84,0.91]	2.36 [2.25,2.48]	0.93 [0.90,0.97]
1 to 4 full time equivalents	0.57 [0.55,0.60]	1.27 [1.22,1.33]	0.72 [0.70,0.74]
5 to 9 full time equivalents	0.60 [0.58,0.62]	1.12 [1.07,1.17]	0.77 [0.75,0.80]
10 to 14 full time equivalents	0.67 [0.64,0.69]	1.13 [1.08,1.18]	0.84 [0.81,0.87]
15 to 19 full time equivalents	0.73 [0.71,0.76]	1.14 [1.09,1.20]	0.88 [0.85,0.91]
20 to 39 full time equivalents	0.81 [0.78,0.84]	1.13 [1.09,1.18]	0.95 [0.93,0.98]
40 to 59 full time equivalents	0.88 [0.85,0.91]	1.09 [1.04,1.14]	1.00 [0.97,1.03]
60 to 99 full time equivalents	0.93 [0.90,0.96]	1.06 [1.01,1.11]	1.00 [0.97,1.03]
More than 100 full time equivalents	1.00	1.00	1.00
3 to 6 years	1.21 [1.17,1.25]	1.14 [1.09,1.18]	1.14 [1.11,1.17]
7 to 10 years	1.07 [1.04,1.11]	1.03 [0.98,1.07]	1.05 [1.02,1.08]
11 to 13 years	1.01 [0.98,1.05]	1.00 [0.95,1.04]	1.01 [0.98,1.04]
13 to 16 years	1.00	1.00	1.00
17 years	0.99 [0.96,1.02]	0.94 [0.90,0.98]	1.01 [0.98,1.04]
7010 Agriculture	0.62 [0.57,0.66]	0.92 [0.84,1.01]	0.67 [0.62,0.73]
7020 Fishing	1.15 [0.90,1.46]	1.08 [0.80,1.45]	1.75 [1.44,2.12]
7030 Forestry	0.82 [0.76,0.89]	0.79 [0.72,0.87]	0.88 [0.81,0.95]
7040 Oil & Gas or Mineral Resources	0.46 [0.41,0.53]	0.68 [0.60,0.76]	1.05 [0.94,1.17]
7120 Metal and Non-Metallic Mineral Products	1.12 [1.05,1.20]	1.03 [0.95,1.12]	1.87 [1.74,2.01]
7130 Petroleum, Coal, Rubber, Plastic & Chemicals	0.58 [0.51,0.65]	0.62 [0.53,0.72]	0.83 [0.73,0.94]

7140 Wood and Paper Products	0.97 [0.91,1.04]	1.13 [1.05,1.23]	1.39 [1.29,1.49]
7150 Other Products (not elsewhere specified)	0.71 [0.65,0.78]	0.71 [0.63,0.79]	1.09 [0.99,1.20]
7210 General Construction	0.86 [0.81,0.91]	0.92 [0.86,0.99]	1.31 [1.22,1.39]
7220 Heavy Construction	0.64 [0.54,0.75]	0.64 [0.54,0.77]	1.41 [1.23,1.63]
7230 Road Construction or Maintenance	0.60 [0.55,0.66]	0.78 [0.70,0.86]	0.80 [0.73,0.88]
7310 Warehousing	1.00	1.00	1.00
7320 Transportation and Related Services	0.86 [0.80,0.91]	0.80 [0.74,0.86]	0.69 [0.64,0.74]
7410 Retail	0.39 [0.37,0.42]	0.37 [0.34,0.40]	0.61 [0.57,0.65]
7420 Wholesale	0.38 [0.35,0.41]	0.37 [0.34,0.41]	0.43 [0.40,0.47]
7530 Public Administration	0.68 [0.62,0.73]	0.72 [0.66,0.79]	0.97 [0.89,1.06]
7610 Accommodation, Food, and Leisure Service	0.38 [0.36,0.41]	0.36 [0.33,0.39]	0.62 [0.59,0.67]
7620 Business Services	0.08 [0.06,0.09]	0.11 [0.09,0.13]	0.11 [0.09,0.12]
7630 Professional, Scientific, & Tech Service	0.12 [0.10,0.13]	0.12 [0.11,0.14]	0.22 [0.20,0.24]
7640 Other Services (not elsewhere specified)	0.77 [0.73,0.82]	0.69 [0.64,0.74]	1.13 [1.06,1.21]
7650 Education	0.25 [0.22,0.28]	0.36 [0.31,0.40]	0.43 [0.38,0.48]
7660 Health Care and Social Services	0.82 [0.76,0.88]	0.48 [0.44,0.52]	0.74 [0.69,0.80]
7670 Utilities	0.26 [0.18,0.39]	0.32 [0.23,0.45]	0.44 [0.35,0.55]
Firm-CU Years	2,234,656	2,234,656	2,234,656
Firm-CUs	258,752	258,752	258,752

Exponentiated coefficients

Table B 4: GEE NB regression unmatched results, construction only, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.93 [0.87,0.99]	0.86 [0.79,0.93]	1.14 [1.08,1.20]
COR Firm Certification Indicator	0.88 [0.83,0.95]	0.95 [0.86,1.04]	1.04 [0.98,1.09]
Base Rate	1.12 [1.11,1.12]	1.17 [1.16,1.18]	1.07 [1.07,1.08]
2000	1.00	1.00	1.00
2001	1.17 [1.12,1.23]	1.07 [0.98,1.16]	1.22 [1.16,1.27]
2002	1.09 [1.05,1.14]	1.07 [0.99,1.16]	1.20 [1.15,1.25]
2003	0.96 [0.92,1.00]	0.95 [0.88,1.03]	1.22 [1.17,1.27]
2004	0.92 [0.88,0.96]	0.88 [0.82,0.95]	1.12 [1.07,1.17]
2005	0.95 [0.91,0.98]	0.94 [0.88,1.02]	1.16 [1.12,1.21]
2006	0.98 [0.94,1.02]	0.97 [0.90,1.04]	1.18 [1.13,1.23]
2007	1.03 [0.99,1.07]	1.10 [1.02,1.18]	1.23 [1.18,1.27]
2008	1.10 [1.06,1.14]	1.21 [1.13,1.30]	1.17 [1.12,1.21]
2010	0.94 [0.90,0.97]	1.13 [1.04,1.22]	0.98 [0.94,1.01]
2011	1.00 [0.96,1.04]	1.13 [1.05,1.22]	1.12 [1.07,1.16]
2012	0.95 [0.91,0.98]	1.06 [0.98,1.15]	1.05 [1.01,1.09]
2013	0.89 [0.86,0.93]	0.98 [0.91,1.06]	1.01 [0.97,1.05]
2014	0.87 [0.84,0.91]	0.93 [0.86,1.00]	1.00 [0.96,1.04]
2015	0.85 [0.81,0.88]	0.98 [0.91,1.05]	1.00 [0.96,1.04]
2016	0.81 [0.78,0.85]	0.86 [0.79,0.93]	0.97 [0.93,1.01]
Less than one full time equivalent	1.04 [0.96,1.12]	2.19 [1.99,2.41]	0.95 [0.90,1.02]
1 to 4 full time equivalents	0.72 [0.67,0.78]	1.21 [1.11,1.33]	0.74 [0.70,0.79]
5 to 9 full time equivalents	0.77 [0.71,0.82]	1.07 [0.98,1.18]	0.81 [0.76,0.86]
10 to 14 full time equivalents	0.84 [0.78,0.90]	1.04 [0.94,1.14]	0.87 [0.82,0.93]
15 to 19 full time equivalents	0.92 [0.86,0.99]	1.09 [0.98,1.20]	0.90 [0.85,0.96]
20 to 39 full time equivalents	0.98 [0.91,1.05]	1.08 [0.98,1.18]	0.96 [0.91,1.01]
40 to 59 full time equivalents	1.01 [0.96,1.07]	0.98 [0.90,1.07]	0.99 [0.94,1.04]
More than 100 full time equivalents	0.96 [0.88,1.05]	0.99 [0.86,1.13]	0.99 [0.92,1.06]
3 to 6 years	1.25 [1.19,1.32]	1.17 [1.10,1.25]	1.18 [1.12,1.23]
7 to 10 years	1.11 [1.06,1.18]	1.07 [1.00,1.14]	1.06 [1.01,1.12]
11 to 13 years	1.03 [0.97,1.09]	0.99 [0.92,1.06]	1.02 [0.97,1.07]
14 to 16 years	1.00	1.00	1.00
17 years	1.00 [0.95,1.06]	0.93 [0.87,0.98]	0.99 [0.95,1.04]
7210 General Construction	1.22 [1.05,1.41]	1.29 [1.08,1.53]	0.77 [0.68,0.87]
7220 Heavy Construction	1.00	1.00	1.00
7230 Road Construction or Maintenance	0.90 [0.76,1.06]	1.09 [0.90,1.32]	0.48 [0.42,0.55]
Firm-CU Years	484,036	484,036	484,036
Firm-CUs	59,128	59,128	59,128

Exponentiated coefficients

Table B 5: GEE NB regression unmatched results, construction only, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.93 [0.86,0.99]	0.86 [0.79,0.93]	1.14 [1.08,1.20]
COR Firm Certification Period 2003-2008	1.06 [0.98,1.15]	1.11 [0.98,1.25]	1.10 [1.03,1.18]
COR Firm Certification Period 2009-2012	0.82 [0.75,0.88]	0.89 [0.79,1.01]	1.02 [0.95,1.09]
COR Firm Certification Period 2013-2016	0.84 [0.76,0.93]	0.89 [0.79,1.01]	1.01 [0.94,1.09]
Base Rate	1.12 [1.11,1.12]	1.17 [1.16,1.18]	1.07 [1.07,1.08]
2000	1.00	1.00	1.00
2001	1.17 [1.12,1.22]	1.06 [0.98,1.16]	1.21 [1.16,1.27]
2002	1.09 [1.04,1.14]	1.07 [0.98,1.15]	1.20 [1.15,1.25]
2003	0.95 [0.91,1.00]	0.95 [0.88,1.03]	1.22 [1.17,1.27]
2004	0.92 [0.88,0.95]	0.88 [0.81,0.95]	1.12 [1.07,1.17]
2005	0.93 [0.90,0.97]	0.93 [0.86,1.00]	1.16 [1.11,1.20]
2006	0.96 [0.93,1.00]	0.95 [0.89,1.03]	1.17 [1.13,1.22]
2007	1.02 [0.98,1.06]	1.09 [1.01,1.17]	1.22 [1.18,1.27]
2008	1.09 [1.05,1.13]	1.20 [1.11,1.28]	1.16 [1.12,1.21]
2010	0.94 [0.90,0.98]	1.13 [1.05,1.22]	0.98 [0.94,1.02]
2011	1.00 [0.97,1.05]	1.13 [1.05,1.22]	1.12 [1.08,1.16]
2012	0.95 [0.91,0.99]	1.07 [0.99,1.15]	1.05 [1.01,1.09]
2013	0.89 [0.86,0.93]	0.98 [0.91,1.06]	1.01 [0.97,1.05]
2014	0.88 [0.84,0.91]	0.93 [0.86,1.01]	1.00 [0.96,1.05]
2015	0.85 [0.82,0.89]	0.98 [0.91,1.06]	1.00 [0.96,1.05]
2016	0.81 [0.78,0.85]	0.86 [0.80,0.93]	0.97 [0.93,1.01]
Less than one full time equivalent	1.04 [0.96,1.12]	2.19 [1.99,2.41]	0.95 [0.90,1.02]
1 to 4 full time equivalents	0.73 [0.68,0.78]	1.22 [1.11,1.33]	0.74 [0.70,0.79]
5 to 9 full time equivalents	0.77 [0.71,0.83]	1.07 [0.98,1.18]	0.81 [0.76,0.86]
10 to 14 full time equivalents	0.84 [0.78,0.90]	1.04 [0.94,1.14]	0.87 [0.83,0.93]
15 to 19 full time equivalents	0.93 [0.86,1.00]	1.09 [0.99,1.21]	0.90 [0.85,0.96]
20 to 39 full time equivalents	0.98 [0.91,1.05]	1.08 [0.98,1.18]	0.96 [0.91,1.01]
40 to 59 full time equivalents	1.01 [0.96,1.07]	0.98 [0.90,1.07]	0.99 [0.94,1.04]
More than 100 full time equivalents	0.96 [0.87,1.05]	0.98 [0.86,1.12]	0.99 [0.92,1.06]
3 to 6 years	1.25 [1.19,1.32]	1.17 [1.10,1.25]	1.17 [1.12,1.23]
7 to 10 years	1.11 [1.05,1.17]	1.07 [1.00,1.14]	1.06 [1.01,1.11]
11 to 13 years	1.03 [0.97,1.09]	0.99 [0.92,1.06]	1.02 [0.97,1.07]
14 to 16 years	1.00	1.00	1.00
17 years	1.00 [0.95,1.06]	0.93 [0.87,0.99]	0.99 [0.95,1.04]
7210 General Construction	1.21 [1.04,1.41]	1.28 [1.08,1.53]	0.77 [0.68,0.87]
7220 Heavy Construction	1.00	1.00	1.00
7230 Road Construction or Maintenance	0.89 [0.75,1.05]	1.09 [0.90,1.32]	0.48 [0.41,0.55]
Firm-CU Years	484,036	484,036	484,036
Firm-CUs	59,128	59,128	59,128

Exponentiated coefficients

Table B 6: GEE NB regression unmatched results, forestry only, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.96 [0.85,1.07]	0.95 [0.82,1.09]	0.88 [0.80,0.98]
COR Firm Certification Indicator	0.75 [0.68,0.82]	0.76 [0.66,0.88]	0.98 [0.90,1.08]
Base Rate	1.01 [0.99,1.03]	1.06 [1.04,1.08]	1.04 [1.02,1.06]
2000	1.00	1.00	1.00
2001	1.06 [0.97,1.16]	1.14 [0.97,1.34]	1.11 [1.01,1.23]
2002	1.02 [0.93,1.12]	1.21 [1.02,1.44]	1.12 [1.01,1.24]
2003	0.98 [0.89,1.07]	1.11 [0.94,1.32]	1.11 [1.00,1.23]
2004	0.87 [0.79,0.96]	1.06 [0.89,1.26]	1.05 [0.95,1.16]
2005	0.97 [0.88,1.07]	1.21 [1.03,1.43]	0.97 [0.87,1.08]
2006	0.89 [0.80,0.98]	0.93 [0.78,1.12]	0.94 [0.84,1.05]
2007	0.96 [0.87,1.06]	1.08 [0.90,1.29]	0.97 [0.88,1.07]
2008	0.99 [0.90,1.10]	1.21 [1.00,1.45]	0.87 [0.78,0.97]
2010	0.91 [0.81,1.02]	0.99 [0.80,1.22]	0.88 [0.78,1.00]
2011	0.97 [0.87,1.09]	1.13 [0.91,1.39]	0.92 [0.82,1.04]
2012	0.89 [0.79,1.00]	1.06 [0.86,1.29]	0.94 [0.84,1.06]
2013	1.03 [0.92,1.16]	1.19 [0.97,1.45]	0.91 [0.81,1.03]
2014	1.00 [0.89,1.13]	1.15 [0.93,1.42]	1.07 [0.95,1.21]
2015	0.95 [0.84,1.07]	1.00 [0.80,1.24]	0.93 [0.82,1.05]
2016	0.91 [0.80,1.03]	1.00 [0.79,1.26]	0.94 [0.82,1.08]
Less than one full time equivalent	2.85 [2.10,3.87]	5.28 [3.59,7.75]	1.71 [1.36,2.14]
1 to 4 full time equivalents	1.31 [0.97,1.77]	1.76 [1.20,2.58]	0.84 [0.67,1.06]
5 to 9 full time equivalents	1.28 [0.94,1.73]	1.72 [1.17,2.53]	0.81 [0.65,1.02]
10 to 14 full time equivalents	1.28 [0.94,1.74]	1.46 [0.98,2.17]	0.85 [0.67,1.07]
15 to 19 full time equivalents	1.29 [0.95,1.76]	1.49 [1.00,2.23]	0.84 [0.66,1.05]
20 to 39 full time equivalents	1.44 [1.07,1.94]	1.51 [1.02,2.23]	0.98 [0.79,1.23]
40 to 59 full time equivalents	1.44 [1.06,1.97]	1.48 [0.99,2.21]	1.09 [0.86,1.39]
60 to 99 full time equivalents	1.42 [1.08,1.87]	1.47 [0.99,2.18]	1.12 [0.89,1.42]
More than 100 full time equivalents	1.00	1.00	1.00
3 to 6 years	1.50 [1.30,1.74]	1.43 [1.18,1.73]	1.20 [1.04,1.38]
7 to 10 years	1.22 [1.04,1.42]	1.23 [1.02,1.49]	1.11 [0.97,1.28]
11 to 13 years	1.09 [0.93,1.28]	1.16 [0.95,1.41]	1.09 [0.95,1.26]
14 to 16 years	1.00	1.00	1.00
17 years	0.92 [0.79,1.08]	0.93 [0.77,1.12]	0.99 [0.87,1.14]
Firm-CU Years	54,650	54,650	54,650
Firm-CUs	6,761	6,761	6,761

Exponentiated coefficients

Table B 7: GEE NB regression unmatched results, forestry only, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.96 [0.85,1.08]	0.96 [0.83,1.10]	0.89 [0.80,0.98]
COR Firm Certification Period 2003-2008	0.83 [0.73,0.94]	0.88 [0.70,1.10]	1.10 [0.96,1.25]
COR Firm Certification Period 2009-2012	0.70 [0.62,0.79]	0.76 [0.63,0.92]	0.90 [0.80,1.01]
COR Firm Certification Period 2013-2016	0.75 [0.65,0.87]	0.67 [0.54,0.84]	1.02 [0.87,1.20]
Base Rate	1.01 [0.99,1.03]	1.06 [1.04,1.08]	1.04 [1.02,1.06]
2000	1.00	1.00	1.00
2001	1.05 [0.95,1.15]	1.14 [0.97,1.34]	1.09 [0.99,1.21]
2002	1.01 [0.92,1.11]	1.21 [1.02,1.44]	1.10 [0.99,1.22]
2003	0.96 [0.87,1.06]	1.11 [0.94,1.32]	1.09 [0.98,1.21]
2004	0.86 [0.78,0.95]	1.06 [0.89,1.26]	1.03 [0.93,1.14]
2005	0.96 [0.87,1.06]	1.21 [1.02,1.43]	0.95 [0.86,1.06]
2006	0.88 [0.79,0.97]	0.93 [0.77,1.12]	0.92 [0.83,1.03]
2007	0.92 [0.83,1.03]	1.04 [0.86,1.26]	0.92 [0.82,1.04]
2008	0.93 [0.82,1.07]	1.13 [0.91,1.40]	0.80 [0.70,0.92]
2010	0.93 [0.83,1.05]	0.99 [0.79,1.23]	0.92 [0.81,1.04]
2011	1.00 [0.89,1.13]	1.13 [0.91,1.40]	0.96 [0.85,1.08]
2012	0.92 [0.81,1.04]	1.06 [0.86,1.30]	0.98 [0.87,1.11]
2013	1.02 [0.88,1.17]	1.28 [1.02,1.61]	0.87 [0.75,1.02]
2014	0.99 [0.86,1.13]	1.24 [0.98,1.56]	1.03 [0.88,1.20]
2015	0.93 [0.80,1.08]	1.08 [0.85,1.38]	0.88 [0.76,1.03]
2016	0.89 [0.76,1.04]	1.08 [0.83,1.40]	0.90 [0.76,1.06]
Less than one full time equivalent	2.02 [1.67,2.45]	3.58 [2.84,4.53]	1.54 [1.25,1.89]
1 to 4 full time equivalents	0.93 [0.77,1.12]	1.20 [0.95,1.51]	0.76 [0.62,0.93]
5 to 9 full time equivalents	0.91 [0.75,1.09]	1.17 [0.93,1.48]	0.73 [0.60,0.90]
10 to 14 full time equivalents	0.91 [0.75,1.11]	1.00 [0.77,1.28]	0.76 [0.62,0.94]
15 to 19 full time equivalents	0.91 [0.76,1.10]	1.02 [0.79,1.31]	0.75 [0.61,0.92]
20 to 39 full time equivalents	1.02 [0.86,1.21]	1.03 [0.81,1.31]	0.88 [0.72,1.08]
40 to 59 full time equivalents	1.02 [0.87,1.20]	1.01 [0.78,1.30]	0.98 [0.79,1.22]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	0.70 [0.54,0.92]	0.68 [0.46,1.01]	0.89 [0.71,1.13]
3 to 6 years	1.50 [1.29,1.74]	1.43 [1.18,1.73]	1.20 [1.04,1.38]
7 to 10 years	1.22 [1.04,1.42]	1.24 [1.02,1.49]	1.11 [0.97,1.28]
11 to 13 years	1.09 [0.93,1.28]	1.16 [0.95,1.42]	1.09 [0.95,1.26]
14 to 16 years	1.00	1.00	1.00
17 years	0.92 [0.79,1.08]	0.93 [0.77,1.12]	0.99 [0.87,1.14]
Firm-CU Years	54,650	54,650	54,650
Firm-CUs	6,761	6,761	6,761

Exponentiated coefficients

Table B 8: GEE NB regression unmatched results, oil and gas only, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.84 [0.65,1.09]	1.09 [0.84,1.42]	1.50 [1.23,1.83]
COR Firm Certification Indicator	0.78 [0.62,0.98]	0.77 [0.56,1.06]	0.97 [0.80,1.17]
Base Rate	1.20 [1.14,1.26]	1.30 [1.24,1.36]	1.16 [1.12,1.21]
2000	1.00	1.00	1.00
2001	1.09 [0.87,1.37]	1.15 [0.80,1.65]	1.32 [1.11,1.57]
2002	1.22 [0.99,1.52]	1.06 [0.78,1.45]	1.16 [0.96,1.41]
2003	0.97 [0.78,1.19]	1.05 [0.75,1.47]	1.19 [0.99,1.43]
2004	1.00 [0.83,1.21]	1.05 [0.76,1.44]	1.08 [0.90,1.29]
2005	1.02 [0.85,1.24]	1.14 [0.84,1.56]	1.18 [0.97,1.43]
2006	1.19 [0.96,1.47]	1.38 [1.02,1.87]	1.15 [0.97,1.35]
2007	1.12 [0.94,1.32]	1.29 [0.96,1.72]	1.10 [0.94,1.28]
2008	1.25 [1.07,1.46]	1.32 [1.00,1.76]	1.11 [0.92,1.35]
2010	0.75 [0.64,0.89]	0.95 [0.69,1.30]	0.66 [0.56,0.77]
2011	0.89 [0.75,1.05]	1.06 [0.80,1.41]	0.71 [0.61,0.84]
2012	0.84 [0.69,1.01]	0.83 [0.61,1.13]	0.79 [0.67,0.94]
2013	0.63 [0.49,0.81]	0.74 [0.52,1.07]	0.71 [0.60,0.85]
2014	0.70 [0.55,0.88]	0.87 [0.58,1.31]	0.64 [0.53,0.77]
2015	0.76 [0.59,0.98]	0.92 [0.62,1.37]	0.65 [0.53,0.80]
2016	0.68 [0.50,0.92]	1.01 [0.67,1.53]	0.77 [0.61,0.97]
Less than one full time equivalent	1.42 [1.03,1.95]	3.14 [1.99,4.93]	0.95 [0.72,1.25]
1 to 4 full time equivalents	1.01 [0.79,1.28]	1.49 [1.06,2.10]	0.67 [0.54,0.83]
5 to 9 full time equivalents	1.07 [0.84,1.36]	1.56 [1.09,2.24]	0.81 [0.64,1.02]
10 to 14 full time equivalents	1.03 [0.81,1.30]	1.26 [0.87,1.82]	0.90 [0.73,1.09]
15 to 19 full time equivalents	1.09 [0.86,1.36]	1.27 [0.88,1.83]	1.12 [0.91,1.37]
20 to 39 full time equivalents	1.25 [0.96,1.64]	1.60 [1.18,2.18]	1.15 [0.94,1.42]
40 to 59 full time equivalents	0.92 [0.77,1.10]	1.15 [0.84,1.59]	1.13 [0.95,1.34]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	0.63 [0.51,0.77]	0.85 [0.65,1.10]	1.05 [0.89,1.24]
3 to 6 years	0.56 [0.40,0.78]	0.76 [0.58,1.00]	0.84 [0.62,1.13]
7 to 10 years	0.55 [0.39,0.77]	0.69 [0.53,0.90]	0.71 [0.54,0.93]
11 to 13 years	0.77 [0.53,1.14]	0.78 [0.59,1.02]	0.75 [0.55,1.03]
13 to 16 years	1.00	1.00	1.00
14 to 16 years	0.92 [0.57,1.50]	0.97 [0.66,1.43]	0.83 [0.59,1.15]
Firm-CU Years	18,314	18,314	18,314
Firm-CUs	2,414	2,414	2,414

Exponentiated coefficients

Table B 9: GEE NB regression unmatched results, oil and gas only, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.82 [0.64,1.06]	1.07 [0.83,1.38]	1.52 [1.25,1.84]
COR Firm Certification Period 2003-2008	0.81 [0.61,1.08]	0.75 [0.51,1.09]	1.30 [1.00,1.71]
COR Firm Certification Period 2009-2012	0.84 [0.65,1.09]	0.79 [0.52,1.18]	0.81 [0.66,0.99]
COR Firm Certification Period 2013-2016	0.73 [0.52,1.01]	0.89 [0.53,1.48]	0.70 [0.55,0.88]
Base Rate	1.20 [1.14,1.26]	1.30 [1.24,1.36]	1.16 [1.12,1.20]
2000	1.00	1.00	1.00
2001	1.10 [0.88,1.39]	1.15 [0.80,1.66]	1.30 [1.09,1.54]
2002	1.23 [0.99,1.53]	1.07 [0.79,1.45]	1.14 [0.95,1.38]
2003	0.97 [0.79,1.21]	1.06 [0.75,1.48]	1.17 [0.98,1.40]
2004	0.98 [0.81,1.20]	1.02 [0.74,1.41]	1.05 [0.88,1.26]
2005	1.03 [0.84,1.25]	1.15 [0.85,1.57]	1.09 [0.89,1.35]
2006	1.19 [0.96,1.49]	1.40 [1.03,1.89]	1.05 [0.88,1.27]
2007	1.12 [0.94,1.34]	1.30 [0.96,1.75]	1.01 [0.85,1.20]
2008	1.25 [1.07,1.46]	1.33 [1.01,1.77]	1.01 [0.84,1.22]
2010	0.75 [0.63,0.89]	0.95 [0.69,1.30]	0.67 [0.58,0.79]
2011	0.89 [0.75,1.05]	1.06 [0.80,1.41]	0.73 [0.62,0.85]
2012	0.83 [0.69,1.01]	0.83 [0.61,1.12]	0.81 [0.68,0.96]
2013	0.65 [0.49,0.86]	0.72 [0.50,1.05]	0.76 [0.63,0.92]
2014	0.71 [0.55,0.93]	0.84 [0.55,1.30]	0.69 [0.56,0.84]
2015	0.78 [0.59,1.03]	0.88 [0.58,1.34]	0.69 [0.55,0.86]
2016	0.70 [0.51,0.96]	0.98 [0.64,1.52]	0.81 [0.64,1.04]
Less than one full time equivalent	1.42 [1.03,1.95]	3.14 [2.00,4.93]	0.96 [0.73,1.26]
1 to 4 full time equivalents	1.01 [0.79,1.28]	1.49 [1.06,2.10]	0.68 [0.55,0.84]
5 to 9 full time equivalents	1.07 [0.84,1.36]	1.56 [1.08,2.23]	0.82 [0.65,1.03]
10 to 14 full time equivalents	1.03 [0.81,1.30]	1.25 [0.86,1.82]	0.91 [0.74,1.11]
15 to 19 full time equivalents	1.08 [0.86,1.36]	1.27 [0.88,1.83]	1.12 [0.92,1.37]
20 to 39 full time equivalents	1.25 [0.96,1.64]	1.60 [1.18,2.18]	1.17 [0.95,1.44]
40 to 59 full time equivalents	0.92 [0.77,1.10]	1.15 [0.83,1.58]	1.14 [0.96,1.36]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	0.63 [0.51,0.77]	0.85 [0.65,1.11]	1.04 [0.89,1.23]
3 to 6 years	0.55 [0.40,0.78]	0.76 [0.58,1.00]	0.82 [0.61,1.10]
7 to 10 years	0.55 [0.39,0.76]	0.69 [0.53,0.90]	0.70 [0.53,0.91]
11 to 13 years	0.77 [0.53,1.14]	0.78 [0.59,1.02]	0.75 [0.55,1.02]
14 to 16 years	0.92 [0.57,1.49]	0.97 [0.66,1.43]	0.83 [0.60,1.16]
17 years	1.00	1.00	1.00
Firm-CU Years	18,314	18,314	18,314
Firm-CUs	2,414	2,414	2,414

Exponentiated coefficients

Table B 10: GEE NB regression unmatched results, manufacturing only, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	1.00 [0.88,1.14]	1.01 [0.90,1.14]	1.36 [1.24,1.49]
COR Firm Certification Indicator	0.72 [0.65,0.79]	0.74 [0.66,0.84]	0.90 [0.83,0.97]
Base Rate	1.19 [1.18,1.20]	1.22 [1.21,1.24]	1.18 [1.17,1.19]
2000	1.00	1.00	1.00
2001	1.11 [1.06,1.15]	1.04 [0.96,1.13]	1.14 [1.10,1.19]
2002	0.97 [0.93,1.02]	1.04 [0.96,1.13]	1.05 [1.01,1.10]
2003	0.93 [0.89,0.97]	0.97 [0.89,1.06]	1.02 [0.97,1.06]
2004	0.90 [0.86,0.94]	1.02 [0.94,1.11]	0.99 [0.95,1.04]
2005	0.97 [0.93,1.02]	1.04 [0.96,1.13]	1.02 [0.98,1.07]
2006	1.04 [1.00,1.09]	1.12 [1.04,1.22]	1.06 [1.01,1.10]
2007	1.07 [1.03,1.12]	1.21 [1.12,1.32]	1.10 [1.06,1.15]
2008	1.04 [0.99,1.08]	1.17 [1.07,1.28]	1.04 [0.99,1.08]
2010	0.78 [0.74,0.82]	1.07 [0.98,1.18]	0.90 [0.86,0.94]
2011	0.84 [0.80,0.88]	1.11 [1.01,1.22]	0.94 [0.89,0.98]
2012	0.84 [0.80,0.89]	1.08 [0.96,1.21]	0.94 [0.90,0.99]
2013	0.82 [0.78,0.87]	1.07 [0.97,1.17]	0.91 [0.87,0.96]
2014	0.80 [0.76,0.84]	1.02 [0.93,1.12]	0.92 [0.87,0.97]
2015	0.79 [0.75,0.84]	1.07 [0.97,1.17]	0.88 [0.84,0.93]
2016	0.71 [0.67,0.75]	0.98 [0.89,1.08]	0.83 [0.79,0.87]
Less than one full time equivalent	0.93 [0.83,1.04]	2.24 [1.92,2.63]	0.94 [0.84,1.05]
1 to 4 full time equivalents	0.71 [0.65,0.76]	1.33 [1.20,1.48]	0.77 [0.71,0.82]
5 to 9 full time equivalents	0.78 [0.72,0.84]	1.23 [1.12,1.36]	0.84 [0.78,0.90]
10 to 14 full time equivalents	0.86 [0.80,0.93]	1.25 [1.13,1.39]	0.90 [0.85,0.97]
15 to 19 full time equivalents	0.97 [0.90,1.04]	1.15 [1.03,1.28]	0.97 [0.91,1.04]
20 to 39 full time equivalents	0.99 [0.93,1.06]	1.16 [1.06,1.27]	0.97 [0.92,1.03]
40 to 59 full time equivalents	1.01 [0.95,1.06]	1.07 [0.98,1.16]	0.98 [0.93,1.03]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	0.88 [0.82,0.95]	0.74 [0.68,0.82]	0.97 [0.91,1.03]
3 to 6 years	1.17 [1.07,1.28]	1.10 [0.99,1.23]	1.19 [1.09,1.29]
7 to 10 years	1.03 [0.93,1.13]	0.95 [0.86,1.06]	1.06 [0.97,1.16]
11 to 13 years	0.98 [0.89,1.08]	1.01 [0.90,1.12]	1.03 [0.93,1.13]
14 to 16 years	1.00	1.00	1.00
17 years	1.01 [0.93,1.10]	0.93 [0.85,1.02]	1.00 [0.92,1.09]
7110 Food and Beverage Products	1.32 [1.20,1.47]	1.41 [1.25,1.60]	0.84 [0.76,0.93]
7120 Metal and Non-Metallic Mineral Products	1.44 [1.32,1.57]	1.36 [1.22,1.51]	1.60 [1.48,1.73]
7130 Petroleum, Coal, Rubber, Plastic & Chemicals	0.83 [0.73,0.94]	0.89 [0.75,1.04]	0.77 [0.68,0.87]
7140 Wood and Paper Products	1.26 [1.15,1.38]	1.52 [1.36,1.70]	1.20 [1.10,1.30]
7150 Other Products (not elsewhere specified)	1.00	1.00	1.00
Firm-CU Years	134,266	134,266	134,266
Firm-CUs	14,484	14,484	14,484

Exponentiated coefficients

Table B 11: GEE NB regression unmatched *results, manufacturing only, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims*

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	1.00 [0.88,1.13]	1.01 [0.90,1.14]	1.36 [1.24,1.49]
COR Firm Certification Period 2003-2008	0.70 [0.55,0.90]	0.72 [0.52,1.00]	0.97 [0.82,1.16]
COR Firm Certification Period 2009-2012	0.78 [0.69,0.88]	0.78 [0.64,0.95]	0.93 [0.85,1.01]
COR Firm Certification Period 2013-2016	0.68 [0.61,0.77]	0.72 [0.62,0.82]	0.87 [0.79,0.95]
Base Rate	1.19 [1.18,1.20]	1.22 [1.21,1.24]	1.18 [1.17,1.19]
2001	1.11 [1.06,1.15]	1.04 [0.96,1.13]	1.14 [1.10,1.19]
2002	0.97 [0.93,1.02]	1.04 [0.96,1.13]	1.05 [1.01,1.10]
2003	0.93 [0.89,0.97]	0.97 [0.89,1.06]	1.02 [0.97,1.06]
2004	0.90 [0.86,0.94]	1.02 [0.94,1.11]	0.99 [0.95,1.04]
2005	0.97 [0.93,1.02]	1.04 [0.96,1.13]	1.02 [0.98,1.07]
2006	1.04 [1.00,1.09]	1.13 [1.04,1.22]	1.06 [1.01,1.10]
2007	1.07 [1.03,1.12]	1.22 [1.12,1.32]	1.10 [1.06,1.15]
2008	1.04 [0.99,1.08]	1.17 [1.08,1.28]	1.04 [0.99,1.08]
2010	0.78 [0.74,0.82]	1.07 [0.98,1.17]	0.90 [0.86,0.94]
2011	0.84 [0.80,0.88]	1.11 [1.01,1.21]	0.94 [0.89,0.98]
2012	0.84 [0.80,0.89]	1.08 [0.96,1.20]	0.94 [0.89,0.99]
2013	0.83 [0.79,0.87]	1.07 [0.97,1.18]	0.92 [0.87,0.96]
2014	0.81 [0.77,0.85]	1.03 [0.94,1.13]	0.92 [0.88,0.97]
2015	0.80 [0.76,0.84]	1.07 [0.98,1.18]	0.88 [0.84,0.93]
2016	0.71 [0.67,0.75]	0.98 [0.89,1.09]	0.83 [0.79,0.87]
Less than one full time equivalent	0.93 [0.83,1.04]	2.25 [1.92,2.63]	0.94 [0.84,1.05]
1 to 4 full time equivalents	0.71 [0.65,0.76]	1.33 [1.20,1.48]	0.77 [0.71,0.82]
5 to 9 full time equivalents	0.78 [0.72,0.84]	1.23 [1.12,1.36]	0.84 [0.78,0.90]
10 to 14 full time equivalents	0.86 [0.80,0.93]	1.25 [1.13,1.39]	0.90 [0.85,0.97]
15 to 19 full time equivalents	0.96 [0.90,1.04]	1.15 [1.03,1.28]	0.97 [0.91,1.04]
20 to 39 full time equivalents	0.99 [0.93,1.06]	1.16 [1.06,1.27]	0.97 [0.92,1.03]
40 to 59 full time equivalents	1.01 [0.95,1.06]	1.07 [0.98,1.16]	0.98 [0.93,1.03]
More than 100 full time equivalents	0.88 [0.82,0.95]	0.74 [0.68,0.82]	0.97 [0.91,1.03]
3 to 6 years	1.17 [1.07,1.29]	1.10 [0.99,1.23]	1.19 [1.09,1.29]
7 to 10 years	1.03 [0.94,1.13]	0.95 [0.86,1.06]	1.06 [0.97,1.16]
11 to 13 years	0.98 [0.89,1.08]	1.01 [0.90,1.12]	1.03 [0.93,1.13]
17 years	1.01 [0.93,1.10]	0.93 [0.85,1.02]	1.00 [0.92,1.09]
7110 Food and Beverage Products	1.32 [1.20,1.47]	1.41 [1.25,1.60]	0.84 [0.76,0.93]
7120 Metal and Non-Metallic Mineral Products	1.44 [1.32,1.57]	1.36 [1.22,1.51]	1.60 [1.48,1.73]
7130 Petroleum, Coal, Rubber, Plastic & Chemicals	0.83 [0.73,0.94]	0.89 [0.75,1.04]	0.77 [0.68,0.87]
7140 Wood and Paper Products	1.26 [1.15,1.37]	1.52 [1.36,1.69]	1.20 [1.10,1.30]
Firm-CU Years	134,266	134,266	134,266
Firm-CUs	14,484	14,484	14,484

Exponentiated coefficients

Table B 12 GEE NB unmatched regression results, transportation and warehousing, STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.88 [0.79,0.98]	1.07 [0.95,1.21]	1.18 [1.08,1.30]
COR Firm Certification Indicator	0.97 [0.88,1.06]	0.99 [0.86,1.15]	0.98 [0.90,1.07]
Base Rate	1.07 [1.06,1.09]	1.17 [1.15,1.20]	1.06 [1.05,1.08]
2000	1.00	1.00	1.00
2001	1.18 [1.11,1.25]	1.19 [1.06,1.34]	1.19 [1.10,1.28]
2002	1.09 [1.02,1.15]	0.99 [0.87,1.11]	1.14 [1.06,1.23]
2003	1.04 [0.98,1.10]	1.05 [0.93,1.19]	1.13 [1.04,1.22]
2004	1.02 [0.95,1.08]	1.12 [0.99,1.26]	1.13 [1.05,1.22]
2005	0.96 [0.91,1.02]	1.09 [0.97,1.22]	1.06 [0.99,1.14]
2006	0.95 [0.89,1.00]	0.98 [0.87,1.10]	0.99 [0.91,1.06]
2007	0.92 [0.87,0.98]	1.10 [0.98,1.23]	0.96 [0.89,1.03]
2008	0.99 [0.93,1.05]	1.20 [1.07,1.34]	1.02 [0.95,1.10]
2010	0.83 [0.78,0.88]	0.96 [0.85,1.09]	0.92 [0.85,0.99]
2011	0.88 [0.83,0.94]	1.02 [0.90,1.15]	1.08 [1.00,1.16]
2012	0.84 [0.79,0.89]	0.97 [0.85,1.09]	1.00 [0.93,1.08]
2013	0.81 [0.76,0.86]	0.85 [0.75,0.96]	0.98 [0.91,1.06]
2014	0.80 [0.75,0.85]	0.87 [0.77,0.98]	0.97 [0.90,1.05]
2015	0.79 [0.74,0.84]	0.87 [0.78,0.98]	0.98 [0.91,1.06]
2016	0.75 [0.71,0.80]	0.85 [0.75,0.97]	0.91 [0.84,0.98]
Less than one full time equivalent	1.02 [0.92,1.14]	1.72 [1.49,1.97]	0.87 [0.79,0.96]
1 to 4 full time equivalents	0.64 [0.57,0.72]	1.05 [0.91,1.21]	0.73 [0.67,0.81]
5 to 9 full time equivalents	0.69 [0.61,0.77]	1.09 [0.94,1.26]	0.84 [0.76,0.93]
10 to 14 full time equivalents	0.77 [0.69,0.87]	1.12 [0.96,1.31]	0.88 [0.79,0.98]
15 to 19 full time equivalents	0.79 [0.70,0.89]	1.06 [0.90,1.25]	0.95 [0.84,1.06]
20 to 39 full time equivalents	0.84 [0.76,0.94]	0.99 [0.86,1.14]	0.95 [0.87,1.05]
40 to 59 full time equivalents	0.96 [0.86,1.07]	1.03 [0.87,1.22]	1.03 [0.94,1.13]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	1.16 [1.02,1.32]	0.96 [0.82,1.12]	1.18 [1.06,1.32]
3 to 6 years	1.43 [1.32,1.54]	1.37 [1.21,1.55]	1.21 [1.10,1.33]
7 to 10 years	1.19 [1.09,1.29]	1.17 [1.03,1.34]	1.17 [1.07,1.28]
11 to 13 years	1.06 [0.97,1.17]	1.07 [0.92,1.24]	1.03 [0.94,1.14]
14 to 16 years	1.00	1.00	1.00
17 years	0.98 [0.89,1.07]	0.88 [0.77,1.01]	1.11 [1.01,1.21]
7310 Warehousing	1.35 [1.19,1.53]	1.17 [0.98,1.40]	1.73 [1.52,1.97]
7320 Transportation and Related Services	1.00	1.00	1.00
Firm-CU Years	276,992	276,992	276,992
Firm-CUs	33,145	33,145	33,145

Exponentiated coefficients

Table B 13 GEE NB regression unmatched results, transportation and warehousing, by year of certification (2003-2016), STD, LTD, and fatalities, serious injuries and health care only claims

	STD/LTD/FTL	Serious Injuries	Health Care Only
COR Firm Baseline Indicator	0.88 [0.79,0.98]	1.07 [0.95,1.21]	1.18 [1.08,1.30]
COR Firm Certification Period 2003-2008	0.77 [0.63,0.94]	0.88 [0.64,1.21]	0.93 [0.75,1.15]
COR Firm Certification Period 2009-2012	1.02 [0.90,1.16]	1.14 [0.94,1.38]	0.98 [0.88,1.10]
COR Firm Certification Period 2013-2016	0.96 [0.86,1.07]	0.90 [0.76,1.06]	0.99 [0.89,1.11]
Base Rate	1.07 [1.06,1.09]	1.17 [1.15,1.20]	1.06 [1.05,1.08]
2000	1.00	1.00	1.00
2001	1.18 [1.11,1.25]	1.20 [1.07,1.35]	1.19 [1.10,1.28]
2002	1.09 [1.03,1.15]	0.99 [0.88,1.12]	1.14 [1.06,1.23]
2003	1.04 [0.98,1.11]	1.06 [0.94,1.20]	1.13 [1.04,1.22]
2004	1.02 [0.96,1.08]	1.13 [1.00,1.27]	1.13 [1.05,1.22]
2005	0.97 [0.91,1.03]	1.10 [0.97,1.23]	1.06 [0.99,1.14]
2006	0.95 [0.90,1.01]	0.99 [0.88,1.11]	0.99 [0.92,1.06]
2007	0.93 [0.88,0.98]	1.11 [0.99,1.25]	0.96 [0.89,1.04]
2008	1.00 [0.94,1.06]	1.22 [1.08,1.37]	1.02 [0.95,1.10]
2010	0.83 [0.78,0.88]	0.95 [0.84,1.08]	0.92 [0.85,0.99]
2011	0.88 [0.83,0.94]	1.01 [0.89,1.14]	1.08 [1.00,1.17]
2012	0.84 [0.79,0.89]	0.95 [0.84,1.08]	1.00 [0.93,1.08]
2013	0.81 [0.76,0.86]	0.87 [0.77,0.99]	0.98 [0.91,1.06]
2014	0.80 [0.75,0.85]	0.89 [0.79,1.01]	0.97 [0.90,1.05]
2015	0.79 [0.74,0.84]	0.89 [0.79,1.01]	0.98 [0.91,1.06]
2016	0.75 [0.71,0.81]	0.87 [0.77,0.98]	0.91 [0.84,0.98]
Less than one full time equivalent	1.02 [0.91,1.14]	1.71 [1.49,1.97]	0.87 [0.79,0.96]
1 to 4 full time equivalents	0.64 [0.57,0.72]	1.05 [0.91,1.21]	0.73 [0.67,0.81]
5 to 9 full time equivalents	0.69 [0.61,0.77]	1.09 [0.94,1.26]	0.84 [0.76,0.93]
10 to 14 full time equivalents	0.77 [0.68,0.87]	1.12 [0.95,1.30]	0.88 [0.79,0.98]
15 to 19 full time equivalents	0.79 [0.70,0.89]	1.06 [0.90,1.25]	0.95 [0.84,1.06]
20 to 39 full time equivalents	0.84 [0.75,0.94]	0.98 [0.85,1.13]	0.95 [0.87,1.05]
40 to 59 full time equivalents	0.96 [0.86,1.07]	1.03 [0.87,1.22]	1.03 [0.94,1.13]
60 to 99 full time equivalents	1.00	1.00	1.00
More than 100 full time equivalents	1.16 [1.02,1.31]	0.96 [0.82,1.12]	1.18 [1.06,1.32]
3 to 6 years	1.43 [1.32,1.55]	1.37 [1.21,1.55]	1.21 [1.10,1.33]
7 to 10 years	1.19 [1.09,1.29]	1.18 [1.03,1.34]	1.17 [1.07,1.28]
11 to 13 years	1.06 [0.97,1.17]	1.07 [0.92,1.23]	1.03 [0.94,1.14]
14 to 16 years	1.00	1.00	1.00
17 years	0.98 [0.89,1.07]	0.88 [0.77,1.01]	1.11 [1.01,1.21]
7310 Warehousing	1.35 [1.19,1.53]	1.17 [0.98,1.40]	1.73 [1.52,1.97]
7320 Transportation and Related Services	1.00	1.00	1.00
Firm-CU Years	276,992	276,992	276,992
Firm-CUs	33,145	33,145	33,145

Exponentiated coefficients