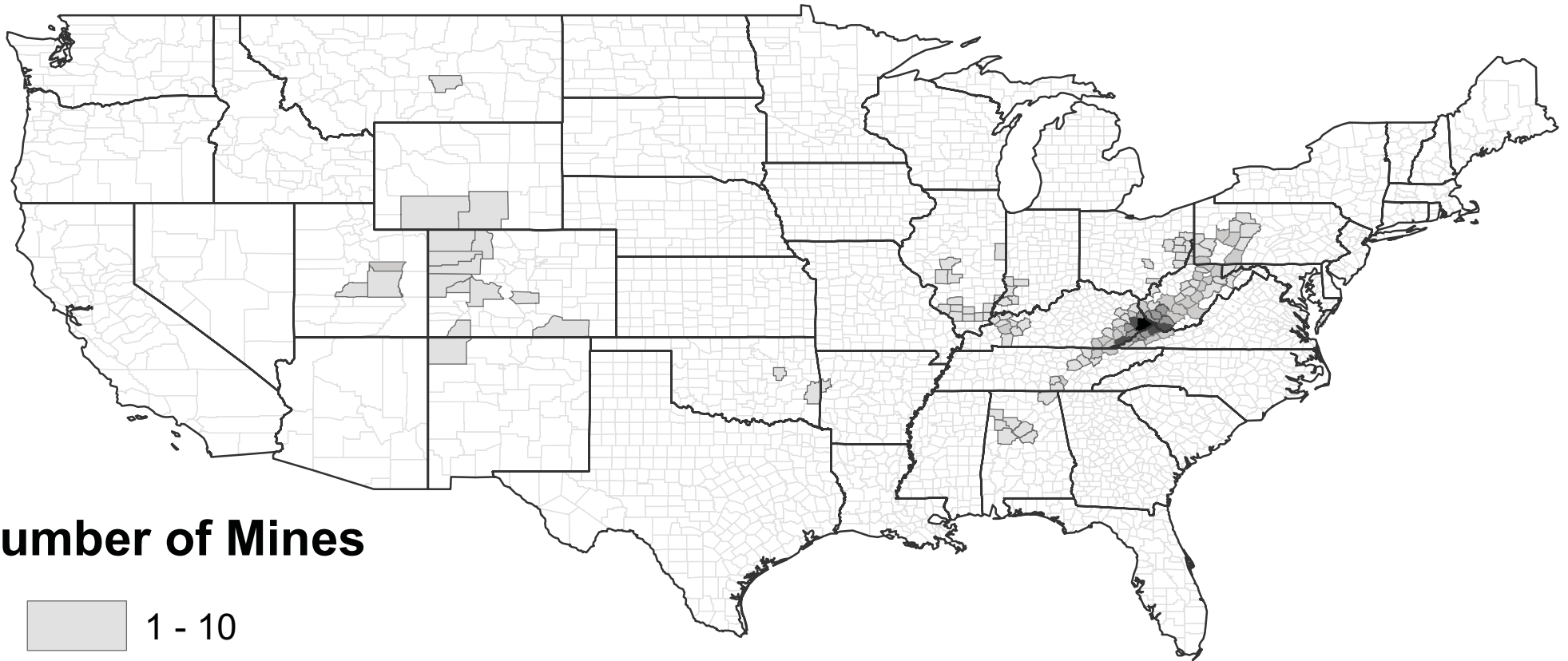
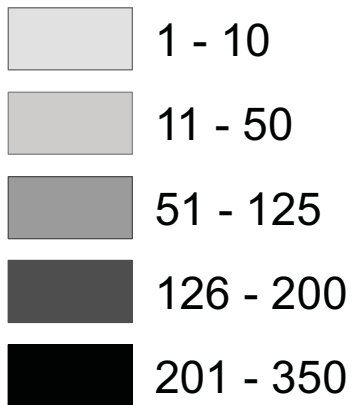


Figure 1. Underground Bituminous Coal Mines by County



Number of Mines



County information was provided by MSHA. The county-level mine counts incorporate all 2,662 underground bituminous coal mines that were active for at least one quarter between 1993 and 2010. Note that, due to high rates of entry and exit in the industry, no more than half of the sample was active in any given quarter.

Figure 2. Union Penetration



Figure 3. Rates of Total and Traumatic Injuries

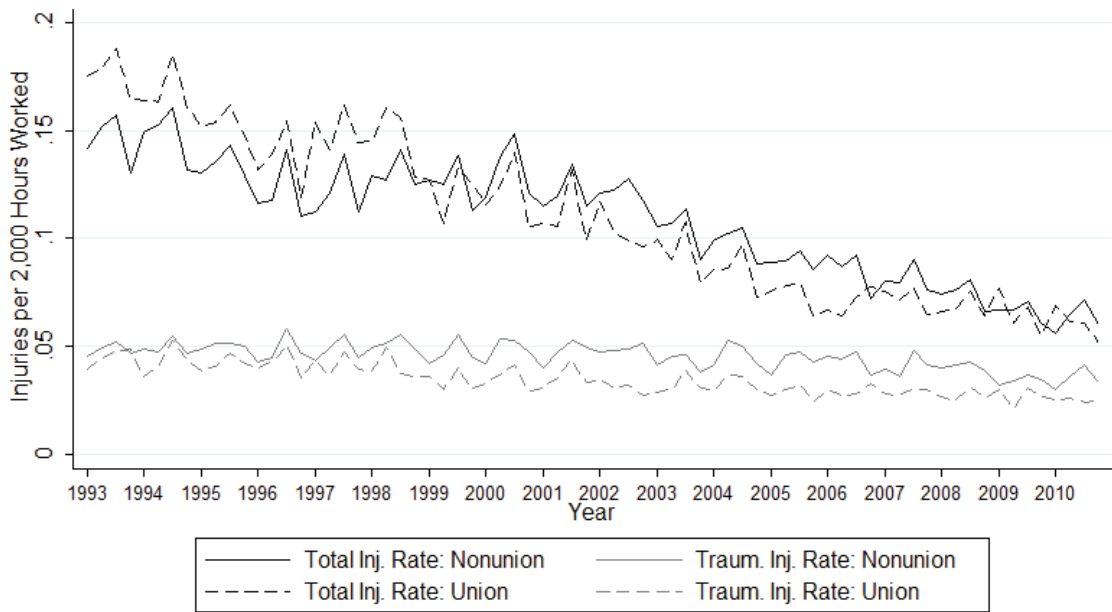


Figure 4. Susceptibility of Injury Type to Reporting Bias

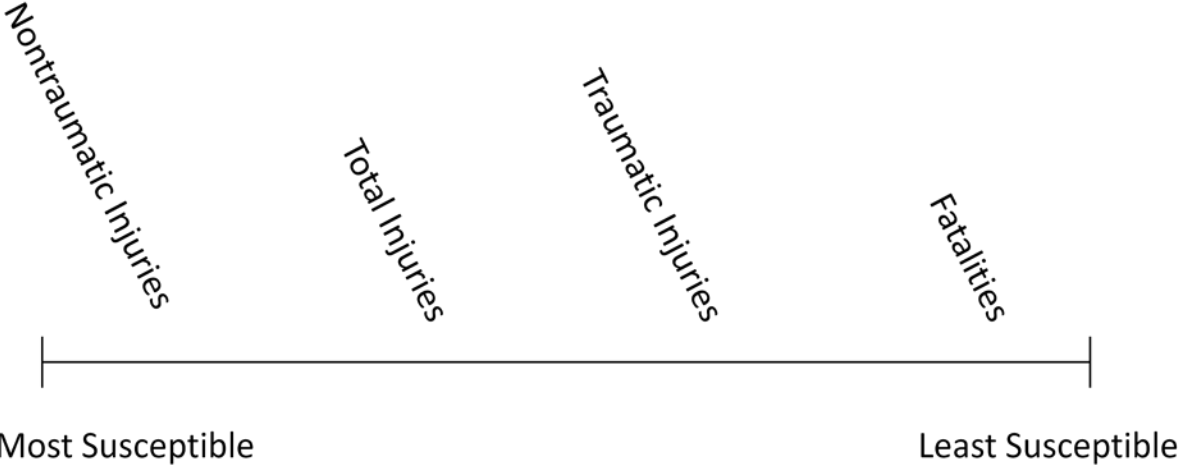


Table 1: Injury Type Breakdown

Injury Type	All Mines:		Union Mines:		Nonunion Mines:	
	Frequency	% of Total	Frequency	% of Total	Frequency	% of Total
Nontraumatic ^a	47,793	62.5%	20,153	69.9%	27,640	58.1%
Total	76,440	100%	28,847	100%	47,593	100%
Traumatic ^b	28,647	37.5%	8,694	30.1%	19,953	41.9%
Fatality	341	0.4%	75	0.3%	266	0.6%

Notes:

This table reports the frequency of each injury type, as well as the share of total injuries that each category represents. Note that these categories are not mutually exclusive.

^a The nontraumatic injury category is comprised of all injuries not classified as traumatic (see below). Note that the nontraumatic and traumatic injury counts sum to the total injury count.

^b The traumatic injury category is comprised of the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. See footnote 13 for more details on this injury category.

Table 2: Effect of Union Status on Injury Frequency: Baseline Models

<i>Specification:</i>	Baseline (Hours Worked)		Employees		Tonnage	
<i>Mine/Controller Size Units:</i>	100 Quarterly FTEs		100 Employees		Millions of Tons	
<i>Version:</i>	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
Nontraumatic Injury Model	1.359*** (0.07)	1.269*** (0.10)	1.381*** (0.07)	1.299*** (0.10)	1.367*** (0.07)	1.290*** (0.09)
Total Injury Model	1.157*** (0.05)	1.056 (0.07)	1.170*** (0.05)	1.072 (0.07)	1.144*** (0.05)	1.045 (0.06)
Traumatic Injury Model	0.774*** (0.04)	0.696*** (0.05)	0.774*** (0.04)	0.695*** (0.05)	0.764*** (0.04)	0.683*** (0.04)
# of Observations	38,890	24,593	38,890	24,593	38,890	24,593
# of Union Mines / # of Total Mines	355 / 2,635	186 / 1,684	355 / 2,635	186 / 1,684	355 / 2,635	186 / 1,684
Fatality Model	0.346*** (0.13)	0.421* (0.19)	0.358*** (0.13)	0.437* (0.20)	0.369*** (0.13)	0.424** (0.18)
# of Observations	11,045	6,948	11,045	6,948	11,045	6,948
# of Union Mines / # of Total Mines	352 / 2,568	182 / 1,644	352 / 2,568	182 / 1,644	352 / 2,568	182 / 1,644

Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.

Results Presented: The table reports IRR (incidence rate ratio)^a coefficients on the union indicator variables in negative binomial regression models. Hours worked is the exposure term.

Definitions: A quarterly FTE is defined as 500 hours worked.

Unit of Observation: The unit of observation is the mine-quarter for the nontraumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.

Dependent Variables: The dependent variables are counts of injuries of each type (specified in the far-left column) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and nontraumatic injuries comprises *total injuries*.

Independent Variables: All models include the following regressors: union dummy, mine size (a continuous variable whose units are specified in column header), union X mine size, logged controller size (a continuous variable whose units are specified in column header), mine age, mine productivity, total lost-work injuries (in hundreds) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, and a constant term. Public-fields versions also include a longwall indicator. Confidential-fields versions also include the number of coal beds, mean coal bed thickness (in yards), subsidiary indicator, captive production

as a percentage of total production, recoverable coal reserves, and mining method percentages. See Appendix C for complete variable definitions. An expanded version of this table, including a full covariate report, is available at <http://amorantz.stanford.edu/companions/union-coal-mine-safety/>.

Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked. The public-fields versions contain mine-quarters from 1993–2010, whereas the confidential-fields versions are restricted to 1998–2010. Because the historical variables (lost-work injuries and penalty points) are summed up over the previous four *quarters* in the non-traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open. The number of union mines is computed by counting the mines that were unionized for any of the mine-quarters in the sample period. The number of total mines is computed by counting each mine in the sample, regardless of union status.

^a A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

Table 3: Effect of Union Status on Injury Frequency: Discrete Size Groups

	Nontraumatic Injuries	Total Injuries	Traumatic Injuries	Fatalities
Union X Size Quartile 1	1.222 (0.16)	1.227* (0.14)	1.223 (0.19)	0.000*** (0.00)
Union X Size Quartile 2	1.237*** (0.10)	1.171** (0.08)	0.988 (0.09)	0.321 (0.32)
Union X Size Quartile 3	1.424*** (0.12)	1.196*** (0.08)	0.815*** (0.05)	0.824 (0.51)
Union X Size Quartile 4	1.250*** (0.07)	0.999 (0.05)	0.695*** (0.04)	0.307*** (0.09)
Observations	38,890	38,890	38,890	11,045
# of Union Mines / # of Total Mines	355 / 2,635	355 / 2,635	355 / 2,635	352 / 2,568

Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.

Results Presented: The table reports IRR (incidence rate ratio)^a coefficients on the union indicator variables in negative binomial regression models. Hours worked is the exposure term.

Definitions: A quarterly FTE is defined as 500 hours worked.

Unit of Observation: The unit of observation is the mine-quarter for the non-traumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.

Dependent Variables: The dependent variables are counts of injuries of each type (specified in the top row) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and non-traumatic injuries comprises *total injuries*.

Independent Variables: All specifications presented above rely exclusively on regressors that are publicly available. In addition to discrete union-size interaction terms, all models include the following regressors: size quartiles (as determined by total FTEs), logged controller size (a continuous variable reflecting the controller's total number of FTEs), mine age, mine productivity, total lost-work injuries (in hundreds) during previous calendar year (for the fatality model) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for the fatality model) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, longwall indicator, and a constant term. See Appendix C for complete variable definitions. An expanded version of this table, including a full covariate report, is available at <http://amorantz.stanford.edu/companions/union-coal-mine-safety/>.

Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked from 1993–2010. Because the historical variables (lost-work injuries and penalty points) are summed up over the previous four *quarters* in the non-traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open. The number of union mines is computed by counting the mines that were unionized for any of the mine-quarters in the sample period. The total number of mines is computed by counting each mine in the sample, regardless of union status.

^a A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

Table 4: Effect of Union Status on Injury Frequency: Time Trend

Model	FTE Public (Baseline)	1993-1998	1999-2004	2005-2010
Nontraumatic Injury Model	1.359*** (0.07)	1.504*** (0.09)	1.243** (0.12)	1.283** (0.16)
Total Injury Model	1.157*** (0.05)	1.320*** (0.07)	1.052 (0.09)	1.003 (0.10)
Traumatic Injury Model	0.774*** (0.04)	0.919 (0.06)	0.673*** (0.06)	0.698*** (0.08)
Observations	38,890	16,629	11,460	10,801
# of Union Mines / # of Total Mines	355 / 2,635	294 / 1,765	129 / 1,141	65 / 928
Fatality Model	0.346*** (0.13)	0.378* (0.19)	0.331* (0.20)	0.555 (0.38)
Observations	11,045	4,763	3,308	2,974
# of Union Mines / # of Total Mines	352 / 2,568	290 / 1,690	128 / 1,093	65 / 903

Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.

Results Presented: The table reports IRR (incidence rate ratio)^a coefficients on the union indicator variables in negative binomial regression models. Hours worked is the exposure term. The “FTE Public (Baseline)” column contains coefficient estimates from the principal baseline models (using 100 quarterly FTEs as the size measure and relying exclusively on public data) presented in Table 2. The results presented in the other three columns correspond, respectively, to coefficient estimates from identical models run on six-year subsamples.

Definitions: A quarterly FTE is defined as 500 hours worked.

Unit of Observation: The unit of observation is the mine-quarter for the nontraumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.

Dependent Variables: The dependent variables are counts of injuries of each type (specified in the far-left column) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and nontraumatic injuries comprises *total injuries*.

Independent Variables: All specifications presented above rely exclusively on regressors that are publicly available. All models include the following regressors: union dummy, mine size (a continuous variable reflecting the mine’s total number of FTEs), union X mine size, logged controller size (a continuous variable reflecting the controller’s total number of FTEs), mine age, mine productivity, total lost-work injuries (in hundreds) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, a longwall indicator, and a constant term. See Appendix C for complete variable definitions. An expanded version of this table, including a full covariate report, is available at <http://amorantz.stanford.edu/companions/union-coal-mine-safety/>.

Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked from 1993–2010. Because the historical variables (lost-work injuries and penalty points) are summed over the previous four *quarters* in the nontraumatic, total, and traumatic injuries regressions but are summed

up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open. The number of union mines is computed by counting the mines that were unionized for any of the mine-quarters in the sample period. The total number of mines is computed by counting each mine in the sample, regardless of union status.

^a A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

Appendix Table A1: Characteristics of Underground, Bituminous Coal Mines: Sample Means

Variable	Union Mean	Nonunion Mean	Variable	Union Mean	Nonunion Mean
Total sample size^a			Mine characteristics		
Mine-quarters	5,689	33,201	Mine age (in years)	17.15 (16.44)	6.89 (7.72)
Mines ^b	355	2,444			
Injury Rates (per annual FTE)			Productivity	7.41 (4.05)	6.93 (4.59)
Total injuries	0.1295 (0.1714)	0.1076 (0.2676)	Percent Captive Production	0.0798 (0.2582)	0.0738 (0.2563)
Traumatic injuries	0.0357 (0.0357)	0.0397 (0.0397)	Subsidiary indicator	0.3529 (0.4779)	0.2062 (0.4046)
Nontraumatic injuries	0.0937 (0.1413)	0.0679 (0.1743)	Longwall indicator	0.3146 (0.4644)	0.0408 (0.1978)
Fatalities	0.0003 (0.0062)	0.0010 (0.0537)			
Mine and Controller Size Measures			Subunits contained ^c		
Mine FTEs	194.68 (207.44)	58.76 (87.40)	Surface	0.8613 (0.3457)	0.8272 (0.3781)
Size Quartile 1	9.77 (4.12)	9.87 (4.44)	Mill or prep plant	0.2781 (0.4481)	0.0439 (0.2048)
Size Quartile 2	26.36 (5.28)	25.39 (5.32)	Mining method percentages		
Size Quartile 3	51.53 (10.57)	49.33 (10.12)	Conventional	0.0755 (0.2641)	0.1625 (0.3675)
Size Quartile 4	320.67 (200.23)	179.18 (135.64)	Continuous	0.6552 (0.4262)	0.7763 (0.4088)
Mine Employees	176.65 (181.42)	51.91 (73.47)	Longwall	0.664 (0.3895)	0.0341 (0.1644)
Mine Tonnage	368,828 (459,803)	123,184 (267,355)	Shortwall	0.0019 (0.0379)	0.0001 (0.0110)
Controller FTEs	1,451.81 (1,910.59)	632.69 (1,146.56)	Geological features		
Controller employees	1,292.98 (1,673.56)	542.75 (980.04)	Number of Coal beds	1.0197 (0.1537)	0.9999 (0.1811)
Controller tonnage	3,125,170 (4,624,872)	1,296,810 (2,556,860)	Mean coal bed thickness (in yards)	0.9227 (0.8580)	0.8483 (0.713)
			Recoverable reserves (in millions of tons)	19,593 (31,958)	6,857 (27,711)

Results Presented: Table contains mean values for all mine quarters in each group; standard deviations are in parentheses. See Appendix C for complete variable definitions.

^a Total sample sizes represent counts (of mine-quarters and of mines, respectively) as opposed to mean values.

^b Because a mine that was unionized for part of the sample period and nonunionized for part of the sample period is counted here as both a union mine and a nonunion mine, some mines are double counted for a total of 2,799

mines. The total number of mines used in the baseline regressions is 2,635. The difference between these two numbers, 164 mines, is the number of mines that switched union status at some point during the sample period. These are the mines that are included in the fixed effects models in Appendix Table A1.

c Only descriptive statistics for the surface and the mill or prep plant subunits are shown here. Other subunits include auger subunit; culm-refuse subunit; dredge subunit; independent shops or yard subunit; strip, quarry, or pit subunit; underground subunit; and other subunits. Descriptive statistics for all ten subunits are available on the *Companion Website* (<http://amorantz.stanford.edu/companions/union-coal-mine-safety/>).

Appendix Table A2: Effect of Union Status on Injury Frequency:
Expanded Covariate Report for Baseline, Public-Fields Specifications

	Nontraumatic Injury Model	Total Injury Model	Traumatic Injury Model	Fatality Model
Union	1.335*** (0.07)	1.143*** (0.05)	0.780*** (0.04)	0.346*** (0.13)
Union X Size	0.975 (0.02)	0.962** (0.02)	0.982 (0.02)	1.019 (0.03)
Mine Size	0.869*** (0.02)	0.890*** (0.02)	0.925*** (0.02)	0.899*** (0.03)
Log of Controller Size	0.943*** (0.01)	0.985** (0.01)	1.047*** (0.01)	1.021 (0.06)
Mine Age	0.999 (0.00)	0.999 (0.00)	0.999 (0.00)	1.007 (0.01)
Productivity	0.994 (0.00)	0.997 (0.00)	0.997 (0.00)	0.942*** (0.02)
Lost-Day Injuries in Prev. Year	1.000*** (0.00)	1.000*** (0.00)	1.000*** (0.00)	1.000 (0.00)
Penalty Points in Prev. Year	1.000*** (0.00)	1.000*** (0.00)	1.000*** (0.00)	1.000*** (0.00)
Longwall Indicator	0.914 (0.05)	0.898* (0.05)	0.919 (0.07)	1.569 (0.54)
Mining Subunit Dummies^a	Y	Y	Y	Y
District Fixed Effects^a	Y	Y	Y	Y
Quarter/Year Fixed Effects^a	Y	Y	Y	Y
Observations	38,905	38,905	38,905	11,045
# of Union Mines / # of Total Mines	355 / 2,639	355 / 2,639	355 / 2,639	352 / 2,568

Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.

Results Presented: The information presented in this table is identical to that presented in the Baseline/Public-Fields column of Table 2, but includes additional coefficient estimates. Each value represents the IRR (incidence rate ratio)^a coefficient on an independent variable in a negative binomial regression model. Hours worked is the exposure term.

Definitions: A quarterly FTE is defined as 500 hours worked.

Unit of Observation: The unit of observation is the mine-quarter for the nontraumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.

Dependent Variables: The dependent variables are counts of injuries of each type (specified in the top row) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and non-traumatic injuries comprises *total injuries*.

Independent Variables: All models include the following regressors: union dummy, mine size (a continuous variable reflecting the mine's total number of FTEs), union X mine size, logged controller size (a continuous variable reflecting the controller's total number of FTEs), mine age, mine productivity, total lost-work injuries (in hundreds)

during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, longwall indicator, and a constant term. See Appendix C for complete variable definitions. An expanded version of this table, including a complete covariate report, is available at <http://amorantz.stanford.edu/companions/union-coal-mine-safety/>.

Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked, including all mine-quarters from 1993–2010. Because the historical variables (lost - work injuries and penalty points) are summed up over the previous four *quarters* in the non - traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open. The number of union mines is computed by counting the mines that were unionized for any of the mine-quarters in the sample period. The total number of mines is computed by counting each mine in the sample, regardless of union status.

^a A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

APPENDIX TABLE A3: FIXED EFFECTS MODELS

<i>Specification:</i>	Baseline (Hours Worked)		Employees		Tonnage	
<i>Mine/Controller Size Units:</i>	100 Quarterly FTEs		100 Employees		Millions of Tons	
<i>Version:</i>	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
Nontraumatic Injury Model	1.374*** (0.14)	1.091 (0.15)	1.385*** (0.14)	1.101 (0.15)	1.440*** (0.13)	1.103 (0.12)
Total Injury Model	1.208** (0.09)	1.056 (0.11)	1.205** (0.09)	1.066 (0.12)	1.258*** (0.09)	1.063 (0.09)
Traumatic Injury Model	0.896 (0.09)	1.037 (0.12)	0.882 (0.09)	1.058 (0.14)	0.971 (0.08)	1.032 (0.10)
# of Observations	4,075	1,558	4,075	1,558	4,075	1,558
# of Union Mines / # of Total Mines	164 / 164	79 / 79	164 / 164	79 / 79	164 / 164	79 / 79
Fatality Model	0.381** (0.17)	5.067 (9.08)	0.386** (0.17)	2.607 (3.88)	0.423** (0.18)	. ^a .
# of Observations	1,082	412	1,082	412	1,082	412
# of Union Mines / # of Total Mines	151 / 151	71 / 71	151 / 151	71 / 71	151 / 151	71 / 71

*Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.*

Limitations of Fixed Effects Model: Only a small proportion of underground coal mines (6.2%) changed union status during the period examined (1993-2010). Those that did change union status seem to be highly unrepresentative of the population as a whole: at least 19% of coal mines that de-unionized and 78% of mines that became unionized during the sample period experienced major disruptions (defined as production, employment, or hours worked dropping by over 50%; a year or more of inactivity; or change of the mine operator or mine controller) during the year when the transition took place. Any analysis predicated upon this idiosyncratic subgroup is likely to yield biased estimates of unionization’s true effect, which is why I place this table in an appendix.

Results Presented: The table reports IRR (incidence rate ratio)^b coefficients on the union indicator variables in negative binomial regression models. Hours worked is the exposure term.

Definitions: A quarterly FTE is defined as 500 hours worked.

Unit of Observation: The unit of observation is the mine-quarter for the non-traumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.

Dependent Variables: The dependent variables are counts of injuries of each type (specified in the top row) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and nontraumatic injuries comprises *total injuries*.

Independent Variables: All models include the following regressors: union dummy, mine size (a continuous variable whose units are specified in column header), union X mine size, logged controller size (a continuous

variable whose units are specified in column header), mine age, mine productivity, total lost-work injuries (in hundreds) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, and a constant term. Public-fields versions also include a longwall indicator. Confidential-fields versions also include the number of coal beds, mean coal bed thickness (in yards), subsidiary indicator, captive production as a percentage of total production, recoverable coal reserves, and mining method percentages. See Appendix C for complete variable definitions. An expanded version of this table, including a full covariate report, is available at <http://amorantz.stanford.edu/companions/union-coal-mine-safety/>.

Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked that switched union status at some point during the sample period. The public-fields versions contain mine-quarters from 1993–2010, whereas the confidential-fields versions are restricted to 1998–2010. Because the historical variables (lost-work injuries and penalty points) are summed up over the previous four *quarters* in the non-traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open.

^a Of the 412 mine-years in our sample for the confidential-fields version of the tonnage specification (rightmost column above), there were only 10 fatalities, which occurred in 5 unionized mine-years and 5 nonunionized mine-years. Because of the small sample size and lack of significant variation, the negative binomial regression did not converge for this model.

^b A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

APPENDIX B: DESCRIPTION OF MODEL SPECIFICATIONS

The list below describes the three specifications and two versions that are included in Table 3.

Hours Worked (Baseline) Specification: Mine size is measured in units of 100 quarterly FTEs. Controller size is measured by the log of hours worked across all mines controlled by that controller, in units of 100 quarterly FTEs.

Employees Specification: Mine size is measured in hundreds of employees. Controller size is measured by the log of employees across all mines controlled by that controller, in hundreds of employees.

Tonnage Specification: Mine size is measured in millions of tons. Controller size is measured by the log of tonnage across all mines controlled by that controller, in millions of tons.

Public-Fields Version: All models include the following regressors: union dummy, union-size interaction term, mine size measure (defined as specified in column headers or the table note), logged controller size measure (defined as specified in column headers or the table note), mine age, mine productivity, number of lost-work injuries (in hundreds) in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), a constant term, dummies indicating presence of each type of mine subunit, quarter/year dummies, district dummies, and a longwall indicator.

Confidential-Fields Version: All models include the following regressors: union dummy, union-size interaction term, mine size measure (defined as specified in column headers or the table note), logged controller size measure (defined as specified in column headers or the table note), mine age, mine productivity, number of lost-work injuries (in hundreds) in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), a constant term, dummies indicating presence of each type of mine subunit, quarter/year dummies, district dummies, number of coal beds, mean coal bed thickness (in yards), subsidiary indicator, captive production as a percentage of total production, recoverable coal reserves, and the mining method percentages.

APPENDIX C: VARIABLE DICTIONARY

Variable Name	Variable Definition	Source
Nontraumatic injuries	Total number of injuries not classified as traumatic	MSHA
Total injuries	Total number of injuries and fatalities reported	MSHA
Traumatic injuries	A subset of injuries that are least prone to reporting bias. See footnote 13	MSHA
Fatalities	Total number of fatalities reported	MSHA
District dummies	1 if mine is located in a given MSHA district, 0 otherwise	MSHA
Ln (Controller Size)	Log of controller size measure. Controller size measure is either 100 FTEs, 100 employees, or one million tons	MSHA
Lost-workday injuries	Lost-workday injuries are those that result in time lost from work. When included as a regressor, it is the number of such injuries in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), in hundreds.	MSHA
Mine age	Age of mine in years since the first operator began work at the mine (top censored at 1970)	MSHA
Penalty Points	Thousands of penalty points in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models)	MSHA
Productivity	Thousands of tons of coal produced per annual FTE (2,000 hours)	MSHA
Quarter/year indicators	1 if observation is for a given year or quarter, 0 otherwise	MSHA
Size Measure	Size measure is either 100 FTEs, 100 employees, or one million tons	MSHA
Subunit indicator	1 if mine contains a given subunit, 0 otherwise Subunit types include e.g. "surface" and "mill or prep plant"	MSHA
Mean coal bed thickness	The mean thickness of all coal beds at the mine, in yards	EIA ^a

Mining method percentages	Proportion of underground operation that uses a given mining method, expressed as fraction between 0 and 1; types include conventional, continuous, longwall, shortwall, and other	EIA
Number of coal beds	Number of coal beds at the mine site	EIA ^a
Percent captive production	Percent of production for mine or parent company's own use	EIA ^{a,b}
Recoverable reserves	Estimated tonnage of remaining coal reserves	EIA ^{a,b}
Subsidiary indicator	1 if mine is a subsidiary of a larger firm, 0 otherwise	EIA ^a
Union indicator	1 if mine is unionized, 0 otherwise	EIA
Longwall Indicator	1 if mine is a longwall mine, 0 otherwise	NIOSH

Source: MSHA inspection records, 1993–2010; EIA coal mine data 1993–2010; NIOSH coal mine data 1993–2010.

^a These data fields were obtained on a confidential basis, and are considered trade secrets by the companies that provided them.

^b These data fields are unavailable prior to 1998.