

**Table 1. Descriptive Statistics<sup>1</sup>**

<b>Variable</b>	<b>Union Mines</b>	<b>Nonunion Mines</b>	<b>All Mines</b>
Number of Mines	269	1,954	2,100
Number of Mine-Quarters	4,460	26,428	30,888
Mean Hours Worked per Qtr.	102,336 (105,574)	30,488 (44,303)	40,863 (62,659)
Mean Employees <sup>2</sup> per Qtr.	184.23 (184.04)	53.67 (74.47)	75.52 (108.36)
Mean Coal Tonnage <sup>3</sup> per Qtr.	403,320 (483,518)	132,198 (280,797)	171,346 (332,106)

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<sup>1</sup> Standard deviations, where applicable, are reported in parentheses. Mines that were unionized for some but not all of the quarters in which they were active are included in both the union and non-union mine counts; therefore, the sum of union and non-union mines is greater than the value of all mines.

<sup>2</sup> See MINE SAFETY & HEALTH ADMIN., U.S. DEP'T OF LABOR, REPORT ON 30 C.F.R. PART 50, at 14 (1986), available at <http://www.msha.gov/stats/part50/rptonpart50.pdf> (defining employees as the average number of persons working during a given quarter, rounded to the nearest whole number).

<sup>3</sup> Tonnage is the total coal production of all sections (including surface operations) at an underground mine.

Table 2. Effect of Union Status on Regular Inspection Hours per Mine-Quarter

Specification	Baseline (Hours Worked)		Employees		Tonnage	
Model	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
Mine/Controller Size Units:	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	24.089*** (7.00)	28.335*** (8.64)	19.284** (7.68)	22.794** (9.37)	18.346*** (6.04)	18.893** (7.56)
<b>Union X Mine Size</b>	-20.991*** (7.39)	-27.578*** (7.02)	-24.827*** (9.26)	-32.700*** (8.93)	-39.289* (21.30)	-46.851** (23.40)
<b>Mine Size</b>	95.021*** (7.86)	104.234*** (7.82)	105.830*** (9.84)	120.333*** (10.32)	179.759*** (23.65)	173.459*** (24.81)
<b>Log of Controller Size</b>	3.341*** (1.08)	2.656** (1.08)	4.968*** (1.32)	3.998*** (1.42)	8.887*** (0.88)	8.461*** (1.12)
<b>Observations</b>	23,751	17,017	23,044	16,526	23,044	16,526
<b># of Union Mines / # of Total Mines</b>	228 / 1,531	152 / 1,124	228 / 1,524	152 / 1,118	228 / 1,524	152 / 1,118
<b>R<sup>2</sup></b>	0.73	0.75	0.73	0.74	0.71	0.72

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Number of regular inspection hours per mine-quarter.

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, and district dummies. Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the mine-quarter.

**Sample:** The sample consists of underground bituminous coal mines with positive coal production and positive hours worked. The public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

Table 3. Effect of Union Status on Total Inspection Hours per Regular Inspection

Specification Model	Baseline (Hours Worked)		Employees		Tonnage	
	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
<b>Mine/Controller Size Units:</b>	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	26.118*** (6.96)	30.248*** (8.88)	22.138*** (7.56)	25.686*** (9.73)	15.809*** (6.06)	16.070** (7.80)
<b>Union X Mine Size</b>	-22.007*** (6.39)	-28.176*** (6.19)	-26.452*** (7.95)	-33.743*** (8.12)	-30.000* (16.81)	-33.625* (19.59)
<b>Mine Size</b>	93.538*** (7.10)	102.464*** (7.27)	106.040*** (9.03)	119.382*** (10.03)	180.862*** (18.47)	171.963*** (19.74)
<b>Log of Controller Size</b>	3.267*** (1.10)	2.415** (1.22)	4.600*** (1.33)	3.686** (1.63)	8.894*** (0.92)	8.861*** (1.16)
<b>Observations</b>	21,789	14,926	21,153	14,489	21,153	14,489
<b># of Union Mines / # of Total Mines</b>	222 / 1,363	147 / 950	222 / 1,360	147 / 948	222 / 1,360	147 / 948
<b>R<sup>2</sup></b>	0.80	0.81	0.79	0.81	0.77	0.78

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Total number of inspection hours per regular inspection.

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, and district dummies. Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the regular inspection.

**Sample:** The sample consists of regular inspections that occurred at underground bituminous coal mines with positive coal production and positive hours worked. The public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

Table 4. Effect of Union Status on Proportion of All Inspection Hours Spent Onsite per Regular Inspection

Specification Model	Baseline (Hours Worked)		Employees		Tonnage	
	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
<b>Mine/Controller Size Units:</b>	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	0.020*** (0.01)	0.024*** (0.01)	0.018*** (0.01)	0.021*** (0.01)	0.013** (0.01)	0.017** (0.01)
<b>Union X Mine Size</b>	-0.005 (0.00)	-0.005* (0.00)	-0.005 (0.00)	-0.005 (0.00)	-0.001 (0.01)	-0.004 (0.01)
<b>Mine Size</b>	0.012*** (0.00)	0.013*** (0.00)	0.012*** (0.00)	0.013*** (0.00)	0.006 (0.01)	0.011 (0.01)
<b>Log of Controller Size</b>	0.003*** (0.00)	0.004*** (0.00)	0.004*** (0.00)	0.005*** (0.00)	0.005*** (0.00)	0.006*** (0.00)
<b>Observations</b>	21,789	14,926	21,153	14,489	21,153	14,489
<b># of Union Mines / # of Total Mines</b>	222 / 1,363	147 / 950	222 / 1,360	147 / 948	222 / 1,360	147 / 948
<b>R<sup>2</sup></b>	0.13	0.12	0.13	0.13	0.13	0.13

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Proportion of all inspection hours that are spent onsite per regular inspection.

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, and district dummies. Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the regular inspection.

**Sample:** The sample consists of regular inspections that occurred at underground bituminous coal mines with positive coal production and positive hours worked. The public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

Table 5. Effect of Union Status on Total Violations per Mine-Quarter

Specification Model	Baseline (Hours Worked)		Employees		Tonnage	
	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
<b>Mine/Controller Size Units:</b>	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	1.310 (1.50)	1.996 (2.08)	0.805 (1.57)	1.400 (2.18)	-0.373 (1.45)	-0.663 (1.91)
<b>Union X Mine Size</b>	-1.094 (1.35)	-1.638 (1.65)	-1.366 (1.55)	-2.066 (1.92)	3.120 (5.57)	3.655 (6.40)
<b>Mine Size</b>	8.261*** (1.20)	9.664*** (1.46)	9.597*** (1.34)	11.303*** (1.80)	11.029*** (2.90)	12.190*** (3.25)
<b>Log of Controller Size</b>	0.497*** (0.19)	0.670** (0.29)	0.572** (0.23)	0.771** (0.36)	0.882*** (0.19)	0.978*** (0.29)
<b>Observations</b>	23,380	16,790	22,704	16,324	22,704	16,324
<b># of Union Mines / # of Total Mines</b>	227 / 1,519	151 / 1,114	227 / 1,514	151 / 1,109	227 / 1,514	151 / 1,109
<b>R<sup>2</sup></b>	0.62	0.64	0.62	0.64	0.61	0.63

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Total violations per mine-quarter.

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, and district dummies. Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the mine-quarter.

**Sample:** The sample consists of underground bituminous coal mines with positive coal production and positive hours worked. The public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

Table 6. Effect of Union Status on Total Violations per 1000 Onsite Inspection Hours per Mine-Quarter

Specification Model	Baseline (Hours Worked)		Employees		Tonnage	
	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
<b>Mine/Controller Size Units:</b>	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	-31.363*** (10.40)	-26.716** (11.28)	-21.789** (8.49)	-23.297** (10.93)	-17.609** (8.76)	-17.683 (11.33)
<b>Union X Mine Size</b>	9.307** (4.63)	7.315 (5.24)	7.081 (5.67)	6.324 (7.42)	19.759 (26.08)	16.175 (31.75)
<b>Mine Size</b>	-12.422** (5.62)	-5.180 (6.15)	-4.407 (6.46)	1.526 (8.60)	13.967 (22.66)	27.636 (27.66)
<b>Log of Controller Size</b>	-1.915 (2.21)	-2.581 (2.44)	-6.278*** (1.81)	-6.789** (2.70)	-6.843*** (1.61)	-6.885*** (2.33)
<b>Observations</b>	23,273	16,694	22,601	16,230	22,601	16,230
<b># of Union Mines / # of Total Mines</b>	227 / 1,519	151 / 1,114	227 / 1,514	151 / 1,109	227 / 1,514	151 / 1,109
<b>R<sup>2</sup></b>	0.023	0.028	0.029	0.030	0.030	0.031

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Total Violations per 1000 Onsite Inspection Hours per mine-quarter.

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, and district dummies. Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the level. The unit of analysis for all models is the mine-quarter.

**Sample:** The sample consists of underground bituminous coal mines with positive coal production and positive hours worked. The public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

Table 7. Effect of Union Status on Log of Total Proposed Penalties per Mine-Quarter

Specification	Baseline (Hours Worked)		Employees		Tonnage	
Model	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
Mine/Controller Size Units:	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	0.228*** (0.08)	0.240** (0.10)	0.184** (0.09)	0.207** (0.10)	0.135* (0.07)	0.090 (0.09)
<b>Union X Mine Size</b>	-0.113* (0.07)	-0.170*** (0.05)	-0.119 (0.08)	-0.196*** (0.06)	-0.180 (0.15)	-0.242* (0.13)
<b>Mine Size</b>	0.301*** (0.05)	0.378*** (0.06)	0.326*** (0.07)	0.435*** (0.07)	0.495*** (0.12)	0.624*** (0.16)
<b>Log of Controller Size</b>	0.111*** (0.01)	0.102*** (0.02)	0.134*** (0.02)	0.123*** (0.02)	0.123*** (0.01)	0.112*** (0.02)
<b>Observations</b>	23,349	16,767	22,679	16,305	22,679	16,305
<b># of Union Mines / # of Total Mines</b>	227 / 1,517	151 / 1,113	227 / 1,512	151 / 1,108	227 / 1,512	151 / 1,108
<b>R<sup>2</sup></b>	0.53	0.56	0.54	0.56	0.53	0.55

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Log of total proposed penalties per mine-quarter.

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, and district dummies. Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the mine-quarter.

**Sample:** The sample consists of underground bituminous coal mines with positive coal production and positive hours worked. The Public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

Table 8. Effect of Union Status on Total Penalty Points per S&S Violation —  
Ten Most Common Violation Types

Specification	Baseline (Hours Worked)		Employees		Tonnage	
Model	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
Mine/Controller Size Units:	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	2.112*** (0.73)	2.014*** (0.75)	1.991*** (0.75)	2.012** (0.79)	1.121 (0.70)	1.112 (0.74)
<b>Union X Mine Size</b>	-0.385 (0.25)	-0.396* (0.22)	-0.427 (0.28)	-0.433 (0.28)	-0.315 (0.66)	-0.339 (0.61)
<b>Mine Size</b>	0.173 (0.29)	0.297 (0.35)	-0.144 (0.33)	0.076 (0.43)	0.495 (0.63)	0.462 (0.73)
<b>Log of Controller Size</b>	1.140*** (0.13)	0.881*** (0.13)	1.341*** (0.14)	1.061*** (0.15)	1.120*** (0.11)	0.939*** (0.11)
<b>Observations</b>	106,483	83,968	104,030	82,081	104,030	82,081
<b># of Union Mines / # of Total Mines</b>	226 / 1,547	150 / 1,134	225 / 1,540	150 / 1,129	225 / 1,540	150 / 1,129
<b>R<sup>2</sup></b>	0.81	0.84	0.81	0.84	0.81	0.84

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Total number of penalty points per S&S violation (limited to the ten most common violation types).

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, district dummies, and dummies for each violation type (i.e., section of CFR deemed to have been violated). Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the S&S violation—ten most common violation types.

**Sample:** The sample consists of S&S violations received by underground bituminous coal mines with positive coal production and positive hours worked, but is restricted to the ten most common violation types. The public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

Table 9. Effect of Union Status on Persons Potentially Affected Penalty Points per S&S Violation — Ten Most Common Violation Types

Specification Model	Baseline (Hours Worked)		Employees		Tonnage	
	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
<b>Mine/Controller Size Units:</b>	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	0.182** (0.09)	0.274** (0.11)	0.240** (0.10)	0.360*** (0.12)	0.114 (0.09)	0.219** (0.11)
<b>Union X Mine Size</b>	-0.028 (0.02)	-0.030 (0.02)	-0.056* (0.03)	-0.065** (0.03)	-0.007 (0.07)	-0.044 (0.08)
<b>Mine Size</b>	0.010 (0.03)	-0.016 (0.03)	0.018 (0.03)	-0.003 (0.04)	-0.036 (0.07)	-0.126 (0.08)
<b>Log of Controller Size</b>	-0.038*** (0.01)	-0.045*** (0.02)	-0.040*** (0.01)	-0.051*** (0.02)	-0.028** (0.01)	-0.035** (0.01)
<b>Observations</b>	106,483	83,968	104,030	82,081	104,030	82,081
<b># of Union Mines / # of Total Mines</b>	226 / 1,547	150 / 1,134	225 / 1,540	150 / 1,129	225 / 1,540	150 / 1,129
<b>R<sup>2</sup></b>	0.12	0.12	0.12	0.12	0.12	0.12

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Number of penalty points assigned due to the number of persons that could be affected per S&S violation (limited to the ten most common violation types).

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, district dummies, and dummies for each violation type (i.e., section of CFR deemed to have been violated). Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the S&S violation—ten most common violation types.

**Sample:** The sample consists of S&S violations received by underground bituminous coal mines with positive coal production and positive hours worked, but is restricted to the ten most common violation types. The public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

Table 10. Effect of Union Status on Mine Size Penalty Points per S&S Violation — Ten Most Common Violation Types

Specification Model	Baseline (Hours Worked)		Employees		Tonnage	
	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
<b>Mine/Controller Size Units:</b>	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	1.263*** (0.26)	1.287*** (0.29)	1.155*** (0.27)	1.202*** (0.28)	0.844*** (0.22)	0.753*** (0.25)
<b>Union X Mine Size</b>	-0.327** (0.14)	-0.380*** (0.11)	-0.361** (0.16)	-0.432*** (0.12)	-0.901*** (0.35)	-0.878*** (0.30)
<b>Mine Size</b>	0.516*** (0.13)	0.602*** (0.13)	0.505*** (0.16)	0.658*** (0.15)	0.863*** (0.33)	0.771** (0.34)
<b>Log of Controller Size</b>	0.503*** (0.04)	0.381*** (0.04)	0.563*** (0.05)	0.424*** (0.05)	0.516*** (0.04)	0.416*** (0.04)
<b>Observations</b>	106,483	83,968	104,030	82,081	104,030	82,081
<b># of Union Mines / # of Total Mines</b>	226 / 1,547	150 / 1,134	225 / 1,540	150 / 1,129	225 / 1,540	150 / 1,129
<b>R<sup>2</sup></b>	0.70	0.73	0.70	0.72	0.70	0.72

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

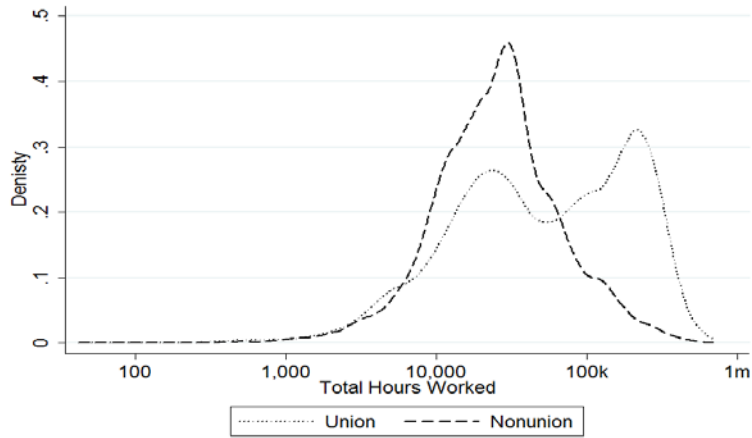
**Dependent Variable:** Number of penalty points assigned due to mine size per S&S violation (limited to the ten most common violation types).

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, district dummies, and dummies for each violation type (i.e., section of CFR deemed to have been violated). Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the S&S violation—ten most common violation types.

**Sample:** The sample consists of S&S violations received by underground bituminous coal mines with positive coal production and positive hours worked, but is restricted to the ten most common violation types. The public-fields version models contain mine quarters from 1995–2009, whereas the confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

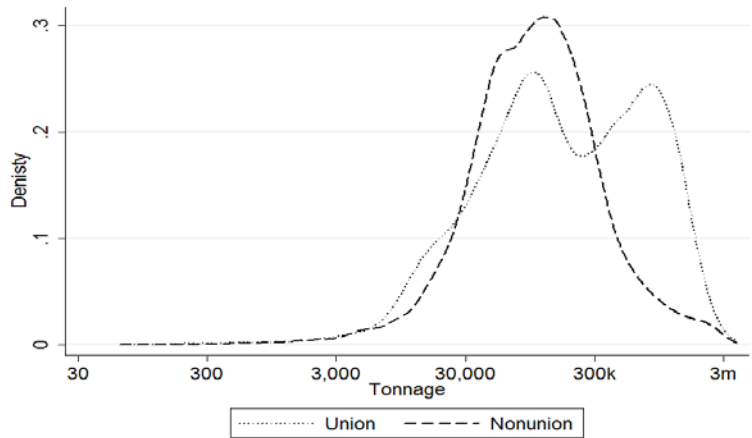
**Figure 1a: Total Hours Worked<sup>a</sup>**



**Figure 1b: Employees<sup>a</sup>**



**Figure 1c: Tonnage<sup>a</sup>**



<sup>a</sup> The horizontal axis represents the log of the size measure. Therefore the density plots are in fact density plots of the log of the size measure.

Table 11. Effect of Union Status on Total Abatement Period per S&S Violation — Ten Most Common Violation Types

Specification Model	Baseline (Hours Worked)		Employees		Tonnage	
	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
<b>Mine/Controller Size Units:</b>	100 Quarterly FTEs	100 Quarterly FTEs	100 Employees	100 Employees	Millions of Tons	Millions of Tons
<b>Union</b>	0.333 (0.67)	-0.044 (0.47)	0.407 (0.69)	-0.030 (0.48)	-0.024 (0.58)	-0.407 (0.41)
<b>Union X Mine Size</b>	-0.201 (0.14)	-0.084 (0.12)	-0.251 (0.17)	-0.109 (0.15)	-0.326 (0.43)	0.053 (0.29)
<b>Mine Size</b>	-0.132 (0.13)	-0.173 (0.13)	-0.078 (0.16)	-0.109 (0.17)	-0.405 (0.44)	-0.945** (0.42)
<b>Log of Controller Size</b>	-0.101 (0.08)	-0.131 (0.10)	-0.140* (0.08)	-0.239*** (0.08)	-0.118* (0.07)	-0.183*** (0.07)
<b>Observations</b>	110,128	86,745	107,424	84,706	107,424	84,706
<b># of Union Mines / # of Total Mines</b>	226 / 1,548	150 / 1,134	225 / 1,540	150 / 1,129	225 / 1,540	150 / 1,129
<b>R<sup>2</sup></b>	0.020	0.027	0.021	0.030	0.021	0.030

Source: MSHA, EIA and NIOSH, 1995–2009.

**Definitions:** Significance levels: \*\*\* 1%, \*\* 5%, \* 10%. FTE is defined as 2,000 man-hours.

**Dependent Variable:** Total abatement period per S&S violation (limited to the ten most common violation types), defined as the termination date minus the issue date.

**Independent Variables:** All models include the following regressors: union dummy, union X size, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in previous four quarters, total penalty points (in thousands) in previous four quarters, constant term, dummies indicating presence of each type of mine subunit, quarter dummies, district dummies, and dummies for each violation type (i.e., section of CFR deemed to have been violated). Public-fields version models include a longwall indicator. Confidential-fields version models include 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 *infra* Appendix B for full definitions of all variables.

**Models:** All models are ordinary least squares regressions; standard errors (shown in parentheses) are clustered at the mine level. The unit of analysis for all models is the S&S violation—ten most common violation types.

**Sample:** The sample consists of S&S violations received by underground bituminous coal mines with positive coal production and positive hours worked, but is restricted to the ten most common violation types. The public-fields version models contain mine quarters from 1995–2009, whereas the Confidential-fields version models are restricted to 1998–2009. All specifications exclude mine-quarters in which a mine began production for the first time or resumed production after a year or more of inactivity.

## APPENDIX A: DESCRIPTION OF MODEL SPECIFICATIONS

The list below describes the three specifications and two models that are included in each set of regressions. In addition, in violation-level models that are restricted to the ten most common (top ten) violations—Tables 8, 9, 10, and 11—all specifications include dummies for these ten violation types.

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

**Employees Model:** Mine size is measured in 100 employees. Controller size is measured by the log of employees across all mines controlled by that controller, in 100 employees.

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

**Public-Fields Specification:** All models include the following regressors: union dummy, union-size interaction term, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in the previous four quarters, total penalty points (in thousands) in the previous four quarters, a constant term, dummies indicating presence of each type of mine subunit, quarter dummies, district dummies, and a longwall indicator. In addition, for regressions labeled S&S Violation—Ten Most Common Types, dummies for each violation type (i.e., section of CFR deemed to have been violated) are included.

**Confidential-Fields Specification:** All models include the following regressors: union dummy, union-size interaction term, mine size measure (defined as specified in column headers), logged controller size measure (defined as specified in column headers), mine age, productivity, total lost-work injuries (in hundreds) in the previous four quarters, total penalty points (in thousands) in the previous four quarters, a constant term, dummies indicating presence of each type of mine subunit, quarter 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. In addition, for violation-level regressions, dummies for each violation type (i.e., section of CFR deemed to have been violated) are included.

APPENDIX B: VARIABLE DICTIONARY

<b>Variable Name</b>	<b>Variable Definition</b>	<b>Source</b>
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	The subset of injuries that result in some loss of work	MSHA
Mine age	Age of mine in years since the first operator began work at the mine (top censored at 1950)	MSHA
Penalty Points	Thousands of penalty points in the previous year	MSHA
Productivity	Thousands of tons of coal produced per man-year	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 “surface” and “mill or prep plant”	MSHA
Mean coal bed thickness	The mean thickness of all coal beds at the mine, in yards	EIA <sup>a</sup>
Mining type	Proportion of underground operation that is of a given type, 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 <sup>a</sup>
Percent captive production	Percent of production for mine or parent company’s own use	EIA <sup>a,b</sup>
Recoverable reserves	Estimated tonnage of remaining coal reserves	EIA <sup>a,b</sup>
Subsidiary indicator	1 if mine is a subsidiary of a larger firm, 0 otherwise	EIA <sup>a</sup>
Union indicator	1 if mine is unionized, 0 otherwise	EIA
District dummies	1 if a mine is in a given district, 0 otherwise	NIOSH
Longwall Indicator	1 if mine is a longwall mine, 0 otherwise	NIOSH

Source: MSHA inspection records, 1995–2009; EIA coal mine data 1995–2009; NIOSH coal mine data 1995–2009.

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

<sup>b</sup> These data fields are unavailable prior to 1998.