DOES UNIONIZATION STRENGTHEN REGULATORY ENFORCEMENT? AN EMPIRICAL STUDY OF THE MINE SAFETY AND HEALTH ADMINISTRATION

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Introduction

Often described as "the day the New Deal began,"[1] the catastrophic blaze at the Triangle Shirtwaist Factory helped usher in a new era of state and federal regulation. The next century witnessed the pas-

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1. *See, e.g.*, *The Birth of the New Deal*, Economist, Mar. 17, 2011, at 39 (attributing quote to Secretary of Labor Frances Perkins, who designed many of the social welfare programs that became hallmarks of the New Deal); Jodie T. Allen, *A Century After Triangle, Unions Face Uncertain Future,* Pew Res. Center (Mar. 23, 2011), http://pewresearch.org/databank/dailynumber/?NumberID=1217 (attributing quote to Frances Perkins); Bjorn Claeson, *Century After Historic Fire, Focus is On Worker Safety*, Hous. Chron., (Mar. 25, 2011) http://www.chron.com/opinion/outlook/article/Century-after-historic-fire-focus-is-on-worker-1684355.php (attributing quote to Frances Perkins).

sage of the Coal Mine Health and Safety Act of 1969,[2] the Occupational Safety and Health Act of 1970 (OSH Act),[3] the Federal Mine Safety and Health Act of 1977 (Mine Act),[4] the proliferation of state workers' compensation laws,[5] and a panoply of other legal reforms designed to mitigate the occupational hazards that an unfettered labor market posed to American workers.[6] Somewhat surprisingly, given their prominence in the federal regulatory firmament, the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA) have received relatively little empirical scrutiny. Numerous scholars have catalogued the shortcomings of administrative standards setting and rulemaking[7] or proposed legal reforms that might enhance the agencies' effectiveness.[8] However, only a handful of studies have scrutinized granular enforcement data in an effort to understand how inspectors "on the ground" carry out day-to-day tasks such as monitoring workplaces, citing violations, and assessing penalties.[9] This article contributes to the scant empirical

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2. Pub. L. No. 91-173, 83 Stat. 792 (1969) (codified as amended at 30 U.S.C. §§ 901–45 (2006)).

3. Pub. L. No. 91-596, 84 Stat. 1590 (1970) (codified as amended at 29 U.S.C. §§ 651–78 (2006)).

4. Pub. L. No. 95-164, 91 Stat. 1290 (1977) (amended by Mine Improvement and New Emergency Response Act of 2006, Pub. L. No. 109-236).

5. *See* Price V. Fishback & Shawn Everett Kantor, *The Adoption of Workers' Compensation in the United States, 1900–1930*, 41 J.L. & ECON. 305, 320 (1998) (detailing the adoption of workers compensation laws in the United States).

6. For a description of the legislation passed in New York in the wake of the fire, see RICHARD A. GREENWALD, THE TRIANGLE FIRE, THE PROTOCOLS OF PEACE, AND INDUSTRIAL DEMOCRACY IN PROGRESSIVE ERA NEW YORK 161 (2005).

7. *See, e.g.*, John Howard, *OSHA Standards-Setting: Past Glory, Present Reality and Future Hope*, 14 EMPLOYEE RTS. & EMPL. POL'Y J. 237, 240–51 (2010); Thomas O. McGarity, *Some Thoughts on 'Deossifying' the Rulemaking Process*, 41 DUKE L.J. 1385, 1387–96 (1992); Stuart Shapiro, *The Role of Procedural Controls in OSHA's Ergonomic Rulemaking*, 67 PUB. ADMIN. REV. 688, 690 (2007).

8. *See, e.g.*, Jarod S. Gonzalez, *A Pot of Gold at the End of the Rainbow: An Economic Incentives-Based Approach to OSHA Whistleblowing*, 14 EMPLOYEE RTS. & EMPL. POL'Y J. 325, 326 (2010); César Cuauhtémoc García Hernández, *Feeble, Circular and Unpredictable: OSHA's Failure to Protect Temporary Workers*, 27 B.C. THIRD WORLD L.J. 193, 214–17 (2007); Adam J. Hiller & Leah E. Saxtein, *Falling Through the Cracks: The Plight of Domestic Workers and Their Continued Search for Legislative Protection*, 27 HOFSTRA LAB. & EMP. L.J. 233, 260–64 (2009); Jay Lapat & James P. Notter, *Inspecting the Mine Inspector: Why the Discretionary Function Exception Does Not Bar Government Liability for Negligent Mine Inspections*, 23 HOFSTRA LAB. & EMP. L.J. 413, 434–39 (2006); Brooke Lierman, *To Assure Safe and Healthful Working Conditions: Taking Lessons from Labor Unions to Fulfill OSHA's Promises*, 12 LOY. J. PUB. INT. L. 1, 32–36 (2010).

9. *See* Mary E. Deily & Wayne B. Gray, *Agency Structure and Firm Culture: OSHA, EPA, and the Steel Industry*, 23 J.L. ECON. & ORG. 685, 686–88 (2007); Wayne B. Gray & John Mendeloff, *The Declining Effects of OSHA Inspections on Manufacturing Injuries, 1979 to 1998*, 58 IND. LAB. REL. REV. 571, 575 (2005); Ali-

literature on the enforcement of occupational safety and health laws by examining whether the intensity, scope and stringency of MSHA's enforcement activities vary significantly across unionized and non-unionized underground coal mines.

Coal mine safety is an especially timely and fertile area of empirical inquiry. For much of the twentieth century, coal mining was one of the most dangerous occupations in the United States, and several recent, well-publicized mine explosions have highlighted the roles that federal regulatory enforcement and unionization can play in preventing catastrophic loss of life.[10] Yet the only prior study to examine whether a union's presence at a mine enhances the stringency of MSHA's regulatory enforcement relies upon data that is decades out of date.[11] Moreover, recent empirical scholarship on the "union safety effect"—linking mine unionization to lower rates of fatal and traumatic injuries[12]—raises the question of whether organized labor could affect the intensity of MSHA's enforcement scrutiny.

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son Morantz, *Has Regulatory Devolution Injured American Workers? State and Federal Enforcement of Construction Safety*, 25 J.L. Econ. & Org. 183, 190–94 (2009); David Weil, *Are Mandated Health and Safety Committees Substitutes For or Supplements To Labor Unions?*, 52 Indus. Lab. Rel. Rev. 339, 346 (1999) [hereinafter Weil, *Mandated Health and Safety Committees*]; David Weil, *Assessing OSHA Performance: New Evidence From the Construction Industry,* 20 Pol'y Analysis & Mgmt. 651, 654 (2001) [hereinafter Weil, *Assessing OSHA Performance*]; David Weil, *Building Safety: The Role of Construction Unions in the Enforcement of OSHA,* 12 J. Lab. Res. 121, 123–24 (1992) [hereinafter Weil, *Building Safety*]; David Weil, *Enforcing OSHA, The Role of Labor Unions*, 30 Indus. Rel. 20, 25–28 (1991) [hereinafter Weil, *Enforcing OSHA*].

10. *See, e.g.*, Carrie Coolidge, *The Most Dangerous Jobs in America: Recent West Virginia Mining Tragedy a Reminder of Unsafe Occupations*, Forbes, Jan. 5, 2006, http://www.msnbc.msn.com/id/10725454/ns/business-forbes_com/t/most-dangerous-jobs-america/ (noting that according to data from the Bureau of Labor Statistics, the mining industry has the second-highest fatality rate per 100,000 employees); John Holusha, *Sago Mine Hearing Opens with Questions*, N.Y. Times, May 2, 2006, http://www.nytimes.com/2006/05/02/us/02cnd-mine.html (describing emotional testimony by relatives of twelve miners killed by the explosion of Sago Mine on January 2, 2006); Ian Urbina, *Call for Criminal Inquiry Into Deadly Mine Collapse*, N.Y. Times, May 9, 2008, at A25 (describing the results of an independent investigation into the death of nine miners as a result of the collapse of Crandall Canyon mine in August 2007); Ian Urbina, *No Survivors Found After West Virginia Mine Disaster*, N.Y. Times, Apr. 9, 2010, at A1 (describing an explosion at Upper Big Branch mine in West Virginia, which killed twenty-nine miners) [hereinafter Urbina, *No Survivors Found*].

11. David Weil, Government and Labor at the Workplace: The Role of Labor Unions in the Implementation of Federal Health and Safety Policy 23–43, 120–34 (May 13, 1987) (unpublished Ph.D dissertation, Harvard University) (on file with author) [hereinafter Weil, Government and Labor at the Workplace].

12. Alison Morantz, *Coal Mine Safety: Do Unions Make a Difference?* (Stanford Law Sch. Law & Econ. Olin Paper Series, Paper No. 413, 2011), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1846700 (finding that unionized mines

This article probes three closely intertwined questions. First, do the frequency, distribution, intensity, and/or scope of MSHA inspections differ significantly across union and non-union mines? Second, do conventional metrics of regulatory enforcement stringency and compliance—such as the frequency of violations and the magnitude of penalties—vary by union status? Finally, do such disparities (if any) seem likely to explain the "union safety effect" reported in recent empirical scholarship?

The analysis reveals, first, that unionization predicts significantly greater frequency, duration, and intensity of MSHA inspections. Second, unionization correlates with a significant rise in the average fine assessed for non-trivial violations. However, both of these disparities diminish sharply with mine size, whereas the union, non-union differential in traumatic and fatal injuries is most robust and pronounced among large mines. Therefore, the disparities in enforcement behavior reported here do not seem to fully explain the "union safety effect" identified in prior scholarship.

The remainder of the article is organized as follows. Part I summarizes existing literature on the relationship between regulatory enforcement, mine safety, and unionization. Part II provides a brief overview of how MSHA inspectors implement their statutory duties. Part III describes the data and empirical methodology upon which the analysis relies, and Part IV presents the results. The concluding section, Part V, highlights the study's key findings, discusses its implications, and identifies several promising areas for future research.

I.
Summary of Prior Scholarship on the Impact of Unionization on Regulatory Enforcement

Scholars have identified a variety of mechanisms whereby unions can increase the quantity and intensity of regulatory enforcement.[13]

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report fewer fatalities and traumatic injuries per hour than non-unionized mines) [hereinafter Morantz, *Coal Mine Safety*].

13. *See, e.g.*, Thomas Kochan et al., The Effectiveness of Union-Management Safety and Health Committees 85 (1977); Richard Brown, *Unions, Markets and Other Regulatory Mechanisms: Theory and Evidence,* 44 U. Toronto L.J. 1, 38–39 (1995) (suggesting means through which unionization may increase regulatory implementation); Neil Gunningham, *Occupational Health and Safety, Worker Participation, and the Mining Industry in a Changing World of Work*, 29 Econ. & Indus. Democracy 336, 338–39 (2008) (suggesting that unionized workers are more likely to voice concerns and call for inspections); Robert Stewart Smith, *Greasing the Squeaky Wheel: The Relative Productivity of OSHA Complaint Inspections*, 40 Indus. & Lab. Rel. Rev. 35, 44 (1986) (arguing that regulatory complaints are more likely to come from unionized entities); Weil, *Assessing OSHA Performance*, *supra* note 9,

For example, unions may increase the likelihood that inspections will take place by filing complaints with pertinent regulatory agencies.[14] Unions can also ensure that workers exercise their statutory rights by accompanying an inspector on his or her tour of the workplace and pointing out subtle hazards that might otherwise evade detection.[15] A number of empirical studies focusing on the manufacturing and construction industries support the hypothesis that unionization increases the quantity and intensity of regulatory enforcement.[16] Several other studies of U.S., Australian, and Canadian workplaces also indirectly lend credence to this claim.[17]

Only one prior empirical study has probed whether MSHA enforcement and compliance patterns differ across union and non-union coal mines.[18] The study reported that, in the early 1980s, union mines were more likely to designate employee representatives, received more frequent MSHA inspections of longer average duration, received more citations per inspection, were granted shorter periods in which to abate violations, were granted fewer abatement extensions, paid higher penalties per violation, and were less successful, as compared to non-union mines, in reducing penalty amounts through MSHA's

at 656–57; Weil, *Mandated Health and Safety Committees*, *supra* note 9 (arguing that mandated health and safety committees increase OSHA enforcement to a greater extent in unionized workplaces than in non-unionized workplaces); Weil, *Building Safety*, *supra* note 9 (arguing that OSHA regulations are more stringently and effectively enforced on unionized construction sites than on non-unionized construction sites); Weil, *Enforcing OSHA*, *supra* note 9 (arguing that the rate of OSHA enforcement is much higher in large unionized workplaces than in comparable non-unionized workplaces in the manufacturing sector); Weil, Government and Labor at the Workplace, *supra* note 11 (arguing that unionization increases the quality of regulatory scrutiny under both OSHA and MSHA); Heather L. Grob, Self Regulation and Safety Programs in Construction 114, 131, 193 (July 1998) (unpublished Ph.D. dissertation, University of Notre Dame) (on file with Hesburgh Library, University of Notre Dame) (finding that OSHA enforcement is less important for workplaces with union safety programs because those programs are more successful than non-union safety programs).

14. *See* Alison Morantz, *The Elusive Union Safety Effect: Toward a New Empirical Research Agenda*, 61 Lab. & Emp. Rel. Ass'n Proc. 130, 133–34 (2009) [hereinafter Morantz, *Elusive Union Safety Effect*].

15. *Id.* at 134.

16. *See, e.g.*, Weil, *Assessing OSHA Performance*, *supra* note 9, at 656–57; Weil, *Mandated Health and Safety Committees*, *supra* note 9, at 352–54; Weil, *Building Safety*, *supra* note 9, at 127–28; Weil, *Enforcing OSHA*, *supra* note 9, at 28–31.

17. Morantz, *Elusive Union Safety Effect*, *supra* note 14, at 135 (noting that several prior studies suggested that unionization increases the strictness and quality of regulatory scrutiny); Brown, *supra* note 13, at 38–39 (discussing Canada); Gunningham, *supra* note 13, at 338–39 (discussing Australia).

18. Weil, Government and Labor at the Workplace, *supra* note 11, at 107–85.

internal administrative appeals process.[19] These disparities were typically most pronounced among smaller mines.[20] On the basis of these findings, the study concludes that MSHA regulations were more stringently and effectively enforced at unionized mines.[21]

Although not focusing on MSHA's enforcement behavior, two recent studies find that unionization predicts a robust, sizable decline in the frequency of serious mining accidents. The first study, focusing on the early twentieth century, concludes that unionism significantly lowered the frequency of mining fatalities by at least twenty percent during this period.[22] Analyzing data from 1993–2009, the second study similarly finds that unionization predicts a sizable and statistically significant drop in traumatic injuries and fatalities, and that the magnitude of this "union safety effect" has—at least by some measures—grown since the turn of the millennium.[23] Neither study pinpoints the causal mechanisms driving these disparities, but the latter speculates that differences in MSHA's enforcement scrutiny could play a role.[24]

This article builds upon earlier scholarship by probing whether the disparities in enforcement behavior documented in the 1980s also characterize the more recent period (1995–2009). After comparing various indicia of regulatory oversight and compliance across the two settings, the article considers whether the findings could provide at least a partial explanation for the "union safety effect" reported in prior scholarship.

II.
Federal Enforcement of Safety Regulations in the Mining Industry

Although the first federal statute governing coal mine safety passed in 1891, Congress did not grant mine inspectors enforcement authority until 1952.[25] A series of statutory reforms in the latter half of the twentieth century gradually enlarged the scope of federal author-

19. *Id.* Although most of Weil's analysis relies on data from a single year (1982), several comparisons also include data from 1978, 1981, 1983, and 1985. *Id.*

20. *Id.* at 183.

21. *Id.* at 179.

22. William M. Boal, *The Effect of Unionism on Accidents in U.S. Coal Mining, 1897-1929*, 48 Ind. Rel. 97, 117 (2009).

23. Morantz, *Coal Mine Safety*, *supra* note 12, at 12.

24. *Id.* at 15.

25. *See* The Federal Coal Mine Safety Act of 1952, Pub. L. No. 82-552, 66 Stat. 692 (1952); *History of Mine Safety and Health Legislation*, Mine Safety & Health Admin., http://www.msha.gov/mshainfo/mshainf2.htm (last visited Sept. 7, 2011).

ity.[26] Most importantly, the Mine Act created MSHA to regulate and inspect coal, metal, and non-metal mines.[27]

MSHA is subdivided into two sections: one that oversees coal mines and another that oversees metal and non-metal mines.[28] The Coal Mine Safety and Health section is, in turn, divided into twelve districts encompassing approximately forty-five field offices located throughout the nation's coal-producing regions.[29] Inspectors at MSHA's field offices conduct several different types of inspections. The most frequent are "regular" inspections that must, under the Mine Act, be conducted four times per year at every underground coal mine.[30] Other inspection types include spot inspections (that focus on location(s) warranting special scrutiny), technical inspections of particular operational systems (such as ventilation or roof control), respirable dust monitoring inspections, post-accident investigations, and inspections triggered by employee complaints.[31]

Although the Mine Act's regulations specify that every violation of a mandatory health or safety standard "shall" trigger the assessment of a civil penalty,[32] the process whereby such penalties are calculated depends upon the type of assessment. Regular assessments—which are capped at $70,000[33] and averaged about $623 during the period analyzed[34]—are calculated using tables that assign penalty points

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26. *See, e.g.*, *History of Mine Safety and Health Legislation*, *supra* note 25.

27. MSHA describes its core statutory functions as follows:

> The Mine Act provides that MSHA inspectors shall inspect each surface mine at least 2 times a year and each underground mine at least 4 times a year (seasonal or intermittent operations are inspected less frequently) to determine whether there is compliance with health and safety standards or with any citation, order, or decision issued under the Mine Act, and whether an imminent danger exists. If violations of safety or health standards are found, inspectors will issue citations to the mine operators . . . [O]ther important mandatory activities [include] assessing and collecting civil monetary penalties for violations of mine safety and health standards . . . .

MSHA's Statutory Functions, MINE SAFETY & HEALTH ADMIN., http://www.msha.gov/mshainfo/mshainf1.htm (last visited Sept. 7, 2011).

28. *See Organizational Chart*, MINE SAFETY & HEALTH ADMIN., http://www.msha.gov/aboutmsha.htm (last visited Oct. 25, 2011).

29. *See Coal Mine Safety and Health*, MINE SAFETY & HEALTH ADMIN., http://www.msha.gov/programs/coal.htm (last visited Sept. 7, 2011).

30. Federal Mine Safety and Health Act of 1977, Pub. L. No. 91-173, § 103, 83 Stat. 742, 749–50 (1969).

31. *Id.*

32. 30 C.F.R. § 100.3(a)(1) (2010).

33. § 100.3(a)(1).

34. Mine Safety & Health Admin., (Oct. 25, 2011) (unpublished electronic database, Stanford University) (on file with author) [hereinafter MSHA Data].

based on several statutorily mandated criteria.[35] Among these criteria are the size of the mine, the operator's history of prior violations and corresponding degree of negligence, the gravity of the violation and severity of any resulting injury, and whether the operator has made a good-faith effort to abate the hazard.[36] After calculating the total penalty points for a given violation, MSHA officials use a conversion table to determine the corresponding fine.[37]

The other two assessment types, "single" assessments and "special" assessments, are less common and permit MSHA officials considerably greater discretion when setting penalties. Single assessments, which ceased to exist in 2007,[38] are relatively nominal fines (averaging $60) levied for minor violations.[39] Special assessments are used in extraordinary circumstances that warrant a deviation from the usual formulaic approach—for example, to penalize egregiously deceptive conduct by a mine operator.[40] Unlike regular assessments, special assessments can, and frequently do, exceed $70,000.[41] Their mean value during the sample period was $7,024.[42]

Three other aspects of the penalty-assessment process merit detailed explanation. First, the negligence component of the penalty-point formula consists of a scale ranging from zero (no negligence) to fifty ("reckless disregard").[43] Only 1.8% of regular violations in the dataset receive a negligence rating of thirty-five or higher.[44] These are described henceforth as "high-negligence" violations, while those receiving a rating of ten or lower are described as "low-negligence" violations. A second important facet of the penalty-point calculation is whether a given violation caused, or was adjudged highly likely to cause, an injury. Slightly over 1% of regular violations in the dataset meet this criterion, a subset referred to as "likely-injury-causing" violations.[45] Finally, MSHA categorizes some violations as "significant

35. *See* § 100.3(a)(2).
36. § 100.3.
37. *Id.*
38. Criteria and Procedures for Proposed Assessment of Civil Penalties, 72 Fed. Reg. 13,592, 13,621 (Mar. 22, 2007) (deleting the single penalty assessment provision).
39. MSHA Data, *supra* note 34.
40. § 100.5 (2011).
41. *Id. See also* MSHA Data, *supra* note 34.
42. MSHA Data, *supra* note 34.
43. § 100.3.
44. MSHA Data, *supra* note 34.
45. MSHA Data, *supra* note 34.

and substantial" (S&S).[46] S&S violations are those for which, "based upon the particular facts surrounding the violation[,] there exists a reasonable likelihood that the hazard contributed to, or will result in, an injury or illness of a reasonably serious nature."[47] Approximately 38% of all violations and 66% of regular violations in the dataset are classified as S&S.[48] Although a violation's categorization as S&S does not affect its penalty points or its monetary assessment,[49] the designation can, under certain conditions, enable MSHA to take the extraordinary step of ordering all miners to vacate the mine section affected by the violation.[50]

III.
Explanation of Empirical Methodology and Description of Data Used

The dataset used here, which matches MSHA's inspection records to mine-level data obtained from the Department of Energy's Energy Information Administration (EIA) and the National Institute for Occupational Safety and Health (NIOSH), is nearly identical to that used in a previous study.[51] The MSHA portion of the dataset contains detailed inspection records—including cited violations and assessed penalties—for the years 1995–2009.[52] The EIA dataset, encompassing every coal mine in the U.S., includes information on union status, geological characteristics (such as mine age, number of coal beds, and coal bed thickness), the share of production attributable to various extraction techniques (such as conventional, continuous, longwall, shortwall, and other mining methods), and economic vari-

46. *See* Mine Safety and Health Admin., U.S. Dep't of Labor, Handbook No. PH08-I-1, Citation and Order Writing Handbook for Coal Mines and Metal and Nonmetal Mines 18 (2008), *available at* http://www.msha.gov/readroom/handbook/ph08-i-1.pdf.

47. *Id.*

48. MSHA Data, *supra* note 34.

49. *See* Mine Safety and Health Admin., U.S. Dep't of Labor, *Sago Mine Information Citation and Order Explanations*, http://www.msha.gov/sagomine/citationsandorders.asp (last visited Sept. 7, 2011) (describing the procedure for finding and recording S&S violations, which does not include an alteration of penalty points or monetary assessments).

50. *See* 30 U.S.C. §§ 814(d)(1), e(1) (2006).

51. *See* Morantz, *Coal Mine Safety*, *supra* note 12, at 5–8.

52. Although some records were available for years prior to 1995, MSHA officials indicated that the assessments file is incomplete for years prior to 1995. Therefore, in contrast to Morantz, *Coal Mine Safety*, *supra* note 12, all of the empirical analysis in this article commences in 2005. E-mail from Chad Hancher, Management and Program Analyst, Mine Safety and Health Admin., to Alison Morantz, Professor of Law, Stanford Law School (June 10, 2011) (on file with author).

ables (such as productive capacity and recoverable reserves) for the years 1995–2009.[53] The NIOSH dataset, available for the same time period, specifies whether each mine uses the longwall mining method and the MSHA district to which the mine belongs.[54] To ensure relative comparability across the mines examined, the analysis is restricted to underground, bituminous coal mines.

Importantly, the analysis presented here does not account for the potentially consequential role of independent contractors, whom mine operators may employ to perform specific functions within the mine. A report released by the West Virginia Governor's Independent Investigation Panel in May 2011, in the wake of the Upper Big Branch mining disaster,[55] suggests that the increase in contract mining significantly complicates regulators' task of identifying and correcting mine hazards.[56] Unfortunately, available data are insufficiently detailed to permit any empirical analysis of how many contractors a given mine utilizes, how intensively those contractors are inspected, or how much work they perform. Therefore, violations committed by independent contractors are excluded from the empirical analysis.[57]

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53. For more information on EIA and its reports, see U.S. ENERGY INFO. ADMIN., *Coal: All Reports*, http://www.eia.gov/coal/reports.cfm?t=9999&f=d (last visited Oct. 9, 2011).

54. For more information on NIOSH and its reports, see NAT'L INST. FOR OCCUPATIONAL SAFETY AND HEALTH, *NIOSH Office of Safety and Mine Research: Publications*, http://www.cdc.gov/niosh/mining/pubs/ (last visited Oct. 9, 2011).

55. *See* Urbina, *No Survivors Found*, *supra* note 10.

56. J. DAVITT MCATEER ET AL., UPPER BIG BRANCH, THE APRIL 5, 2010 EXPLOSION: A FAILURE OF BASIC COAL MINE SAFETY PRACTICES 18 (2011), *available at* http://www.nttc.edu/programs&projects/minesafety/disasterinvestigations/upperbig branch/UpperBigBranchReport.pdf (observing that the increased use of contract workers "has made it more difficult for federal and state governments to accurate[ly] assess and characterize a company's safety performance.").

57. The omission of contractor violations could, in theory, bias the results. For example, if contract mining is more prevalent among unionized mines, MSHA officials might spend more time inspecting union mines for this reason alone (i.e., because there are more persons working onsite). As a robustness check, alternative specifications were estimated in which violations committed by mine operators *and* onsite contractors (if any) were included. These results, presented on this article's companion website, do not vary materially from the findings presented here. *See* Alison Morantz, COMPANION WEBSITE FOR DOES UNIONIZATION STRENGTHEN REGULATORY ENFORCEMENT?, http://amorantz.stanford.edu/mining_unionization_and_regulation.html (last visited Nov. 6, 2011).

TABLE 1. DESCRIPTIVE STATISTICS[58]

Variable	Union Mines	Nonunion Mines	All Mines
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[59] per Qtr.	184.23 (184.04)	53.67 (74.47)	75.52 (108.36)
Mean Coal Tonnage[60] per Qtr.	403,320 (483,518)	132,198 (280,797)	171,346 (332,106)

As is shown in Table 1, union mines constitute a relatively small fraction—approximately 13%—of the sample, and only a slightly higher fraction—approximately 14%—of mine-quarters. Table 1 also reveals that union mines are, on average, much larger than non-union mines. The mean hours worked, the mean number of employees, and the mean coal tonnage per mine-quarter[61] are all more than three times as large at union mines as at non-union mines.

The empirical analysis unfolds in two stages. The first stage uses ordinary least squares (OLS) regression models,[62] with standard errors clustered on mine, to isolate differences in the frequency, intensity, and scope of MSHA inspections across union and non-union mines. In particular, the analysis compares regular inspection hours per mine-quarter, total inspection hours per regular inspection, and the proportion of all inspection hours spent onsite per regular inspection.

The second stage of the empirical analysis uses OLS regression models, with standard errors clustered on mine, to explore the frequency and distribution of violations, the magnitude of penalties and the speed of abatement across the two environments. Initially, the inquiry focuses on disparities in total violations per mine-quarter and per 1000 onsite inspection hours, respectively. Scrutiny then shifts to disparities in fines and penalty points, including the log of total proposed penalties per mine-quarter and several alternative measures of

58. 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.

59. *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).

60. Tonnage is the total coal production of all sections (including surface operations) at an underground mine.

61. The mine-quarter is the unit of observation that represents the activity of a given mine in a given quarter.

62. For an explanation of OLS regression models, see *Ordinary Least Squares for Simple Regression*, XYCOON, http://www.xycoon.com/ols.htm (last visited Oct. 17, 2011).

penalty points. The analysis concludes by comparing total abatement periods for the most frequent subset of S&S violations.

This article presents and discusses results from several leading specifications.[63] Each table contains two alternative versions of three models, for a total of six specifications. The two versions of each model differ in that the "public-fields" version relies exclusively on public data, whereas the "confidential-fields" version incorporates confidential data fields obtained from the EIA. The first model uses full-time equivalents (FTEs)[64] as the defining measure of mine size. Because it is conventional in epidemiology,[65] industrial medicine,[66] and economics[67] to use FTEs as a size metric when comparing the

63. Results from the full analysis cannot be presented due to space constraints.

64. Yearly FTEs are defined as 2,000 man-hours, and quarterly FTEs are defined as 500 man-hours.

65. *See, e.g.*, Hasanat Alamgir et al., *Epidemiology of Work-Related Injuries Requiring Hospitalization Among Sawmill Workers in British Columbia, 1989-1997*, 22 Eur. J. Epidemiology 273, 273 (2007) (using FTEs as the denominator for the injury rate at sawmills); Peng Bi et al., *Occupational Blood and Body Fluid Exposure in an Australian Teaching Hospital*, 134 Epidemiology & Infection 465, 466 (2006) (using FTEs as the denominator for the rate of hospital staff injuries); Sean P. Clarke et al., *Sharp-Device Injuries to Hospital Staff Nurses in 4 Countries*, 28 Infection Control & Hosp. Epidemiology 473, 473 (2007) (using FTEs as the denominator for the rate of hospital staff injuries); SeJean Sohn et al., *Effect of Implementing Safety-Engineered Devices on Percutaneous Injury Epidemiology*, 25 Infection Control & Hosp. Epidemiology 536, 538 (2004) (using FTEs as the denominator for annual instance of injuries).

66. *See, e.g.*, Michelle Kaminski, *Unintended Consequences: Organizational Practices and Their Impact on Workplace Safety and Productivity*, 6 J. Occupational Health Psychol. 127 (2001) (using FTEs as the denominator for the rate of lost-time injuries); Lina Lander et al., *Near-Miss Reporting System as an Occupational Injury Preventive Intervention in Manufacturing*, 54 Am. J. Indus. Med. 40, 45 (2011) (using FTEs as the denominator for the rate of nonfatal occupational injuries); Richard Letz et al., *A Cross Sectional Epidemiological Survey of Shipyard Workers Exposed to Hand-Arm Vibration*, 49 Brit. J. Indus. Med. 53, 58 (1992) (using FTEs to measure the time until the onset of symptoms resulting from the use of vibratory tools); Timothy K. Thomas et al., *Is It Safe On Deck? Fatal and Non-Fatal Workplace Injuries Among Alaskan Commercial Fishermen*, 40 Am. J. Indus. Med. 693, 693 (2001) (using FTEs as the denominator to calculate the fatality rate for Alaskan fishermen).

67. *See, e.g.*, Robert C. Bird & John D. Knopf, *Do Wrongful-Discharge Laws Impair Firm Performance?*, 52 J.L. & Econ. 197, 207 (2009) (using FTEs to measure bank firm employment); Carl-Ardy Dubois & Martin McKee, *Cross-National Comparisons of Human Resources for Health — What Can We Learn?*, 1 Health Econ. Pol'y. & L. 59, 70 (2006) (discussing the impact of using FTEs for cross-national labor comparisons); John W. Ruser, *The Changing Composition of Lost-Workday Injuries*, 122 Monthly Lab. Rev. 11 (1999) (using FTEs as the denominator in calculating the injury rate of workers); Nicolas R. Ziebarth & Martin Karlsson, *A Natural Experiment on Sick Pay Cuts, Sickness Absence, and Labor Costs* (HEDG Working Paper No. 09/34 2009), *available at* http://www.york.ac.uk/res/herc/documents/wp/09_34.pdf (using FTEs to measure the number of doctors working for the German Medical Service).

frequency—or prevalence—of workplace-related events, this is described as the "baseline" model. To test the robustness of these results, the second and third models utilize employees[68] and coal tonnage,[69] respectively, as alternative measures of mine size. Appendix A describes the covariates included in the public-fields and confidential-fields versions of each model, and Appendix B lists the definition and source of each independent variable.[70] Additional model specifications, robustness checks, and the (non-confidential) data used in the analysis are available on this article's companion website.[71]

IV.
Results of Empirical Analysis

Tables 2 through 4, encompassing the first stage of the empirical analysis, present results from OLS models comparing the inspection intensity of MSHA inspections across union and non-union mines.[72] Table 2, which focuses on regular inspection hours per mine-quarter, suggests that union mines are subjected to more intensive scrutiny.[73] Unionization predicts a statistically significant rise of at least eighteen regular inspection hours across all specifications.[74] However, Table 2 also indicates that the disparity diminishes sharply with mine size.[75] Table 3, probing total inspection hours per regular inspection, displays a very similar pattern.[76] Although union status predicts a steep and robust spike in total inspection hours per regular inspection, the effect again diminishes sharply with mine size.[77] Rounding out the first phase of the analysis, Table 4 analyzes the proportion of all inspection hours spent on-site per regular inspection and reveals that this proportion is significantly higher at unionized mines. This time, the disparity varies little by mine size.[78]

Tables 5 through 11, presenting results from the second stage of the empirical analysis, focus on violations, assessments, and abate-

68. *See supra* note 59.
69. *See supra* note 60.
70. *See infra* Appendices A, B.
71. *See* Alison Morantz, Companion Website for Does Unionization Strengthen Regulatory Enforcement?, *supra* note 57.
72. *See infra* Tables 2–4.
73. *See infra* Table 2.
74. *Id*.
75. *Id.* This inference follows from Table 2's negative and highly significant coefficient on the interaction term.
76. *See infra* Table 3.
77. *Id.*
78. *See infra* Table 4.

ment periods.[79] Table 5 reveals that total violations per mine-quarter do *not* vary significantly by union status.[80] Although not robust across all specifications, Table 6 indicates that MSHA inspectors tend to cite fewer violations per inspection hour at union mines.[81] As is shown in Table 7, union mines also receive higher penalties per mine quarter.[82] Table 8, which limits the analysis to the ten most prevalent violations that are classified as S&S, confirms that union mines receive more penalty points per violation.[83] Tables 9 and 10 seek to pinpoint the source of the latter disparity by comparing, respectively, the assignment of penalty points for mine size[84] and for the number of persons affected.[85] Table 9 suggests that unionization predicts a significant increase in number-of-persons-affected penalty points.[86] Similarly, Table 10 reveals that even when one controls for mine size in a continuous fashion, unionization predicts a significant increase in mine-size penalty points.[87] Yet as shown in Table 11, total abatement periods are statistically indistinguishable across union and non-union mines.[88]

At first glance, one might infer from Tables 8 through 10 that MSHA inspectors—whether consciously or not—treat union mines differently than their otherwise similar, yet non-unionized, counterparts when assigning penalty points. The remainder of this part considers alternative hypotheses that might explain the disparities in

79. *See infra* Tables 5–11.

80. *See infra* Table 5. Robustness checks respectively comparing the frequency of S&S violations, non-S&S violations, high-negligence violations, and low-negligence violations, also fail to find any significant disparities by union status. *See* Companion Website for Does Unionization Strengthen Regulatory Enforcement?, *supra* note 57.

81. *See infra* Table 6. Since union mines are inspected more intensely yet receive similar violations per mine-quarter, a negative correlation between union status and violations cited (per inspection hour) is to be expected.

82. *See infra* Table 7.

83. *See infra* Table 8.

84. MSHA calculates mine size based on the annual tonnage produced in a previous calendar year. *See* 30 C.F.R. § 100.3(b) (2010).

85. "Persons affected" is defined as the number of persons potentially affected if the event has occurred or were to occur. Federal Coal Mine Health and Safety Act of 1969, Pub. L. No. 91-173, § 103(e), 83 Stat. 742, 750 (1969) (amended by Mine Improvement and New Emergency Response Act of 2006, Pub. L. No. 109-236).

86. *See infra* Table 9.

87. *See infra* Table 10.

88. *See infra* Table 11. Robustness checks similarly show that there are no significant disparities in assigned or actual abatement periods for the top ten regular (or top ten S&S) violations. *See* Companion Website for Does Unionization Strengthen Regulatory Enforcement?, *supra* note 57.

persons-affected and "mine-size" penalty points revealed in Tables 9 and 10.[89]

With regard to the assignment of persons-affected penalty points, other characteristics of mining operations that correlate with union status—but are not caused by unionization—could be driving the disparity. For example, if miners in unionized mines work in closer geographic proximity to one another than their counterparts in non-unionized mines (for example, because of minimum-staffing provisions in collective bargaining agreements), then more unionized miners could be endangered by a given hazard even if inspectors apply the statutory criteria in an evenhanded manner. Unfortunately, available data are not granular enough to permit one to probe the validity of this conjecture.

With regard to the assignment of mine-size penalty points, further analysis suggests that the disparity is *not* driven by differences in the behavior of individual inspectors, but rather by the formula itself. Instead of using an algebraic formula in which penalty points bear a consistent, linear relationship to mine size, mines are grouped into several discrete, uneven size categories based on annual tonnage. All mines within a given category receive the identical number of penalty points.[90] As Figures 1a, 1b, and 1c (and Table 1) demonstrate, union mines tend to be larger than non-union mines regardless of how size is defined. Moreover, although the distribution of non-union mines is unimodal, the distribution of union mines is bimodal.[91] Therefore, the disparity arises from the fact that the penalty-point formula treats mine size in a highly discontinuous fashion, whereas the models used to generate the results presented here treat size as a continuous variable. In other words, the disparity in "mine-size" penalty points apparently stems not from any systematic bias in the way inspectors apply the formula, but from the highly discontinuous—and uneven—nature of MSHA's penalty-point formula, combined with the fact that union mines tend to be much larger (and have a differently-shaped size distribution) than their non-unionized counterparts.

The disparities identified here substantially mirror those reported in prior work using data from the early 1980s.[92] Unionization once again correlates with greater frequency, duration and intensity of MSHA's regulatory enforcement, and these disparities are usually most pronounced among smaller mines. Moreover, union mines gen-

89. *See infra* Tables 9 and 10.
90. *See* 30 C.F.R. § 100.3(b) (2010).
91. *See infra* Figures 1a, 1b, and 1c.
92. *See* Weil, Government and Labor in the Workplace, *supra* note 11, at 179.

erally receive higher penalty points and fines for non-trivial violations. Unlike prior scholarship, however, the analysis presented here reveals no statistically significant disparities in the duration of abatement periods, the ratio of proposed to current penalties, or total citations issued per inspection.[93]

V.
SUMMARY AND DISCUSSION OF MAIN FINDINGS

During the year preceding the Triangle Shirtwaist Factory fire, shirtwaist makers across New York City went on strike, demanding higher pay and safer working conditions under the leadership of the International Ladies Garment Workers Union.[94] The Triangle Waist Company was one of the companies that refused to settle.[95] Until it shut its doors in 1918, the company refused to recognize the Union or accede to its demands.[96] The catastrophe helped galvanize public support for two cornerstones of a progressive policy agenda: the protection of workers' right to bargain collectively with their employers through elected labor unions, and the direct government regulation of hazardous working conditions. The New Deal helped pave the way for both of these reforms. However, the complex interaction between labor unions and the federal regulatory apparatus designed to protect workers' safety and health has only recently become a topic of empirical scrutiny.

Focusing on the coal mining industry and relying upon data from 1995–2009, this article contributes to this scant scholarship by probing whether inspection intensity and regulatory compliance differ between union and non-union mines.

The findings suggest that MSHA's regulatory enforcement behavior varies significantly by union status. In particular, unionization predicts statistically significant and robust increases in regular inspection hours per mine-quarter, total inspection hours per regular inspection, and the proportion of total inspection hours spent onsite. These enforcement disparities are mostly confined to smaller mines. Although unionization has no apparent effect on total violations per

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93. Unfortunately, due to data constraints, not all of Weil's findings can be verified for the more recent time period. *See id.* at 122, 157 (discussing the greater use of employee representatives and less frequent abatement extensions at unionized mines).

94. Peter Dreier & Donald Cohen, *The Fire Last Time: Labor, Big Business, and the Forgotten Lessons of a Disaster That Happened 100 Years Ago This Month*, NEW REPUBLIC, Mar. 12, 2011, http://www.tnr.com/article/politics/85134/wisconsin-unions-walker-triangle-shirtwaist-fire.

95. *Id.*

96. *Id.*

mine-quarter or on total abatement periods, it does correlate with large increases in the proposed fine (and penalty points) assessed for significant and substantial violations. Although sizable and robust, these findings seem unlikely to fully explain the lower incidence of traumatic and fatal injuries at union mines reported in prior scholarship. While most of the differentials shown here decline sharply with mine size, the "union safety effect" reported in earlier work is most pronounced among large mines.[97]

Several important questions remain unanswered. First, are the observed differences in enforcement behavior confined to the mining industry, or do they apply to other regulatory agencies? Secondly, what are the causal mechanisms driving these disparities? For example, might specific characteristics of union workplaces—such as the higher prevalence of complaint inspections and/or greater likelihood that an experienced miner will accompany an MSHA inspector on his/her tour—induce greater enforcement intensity? Third, why are most of the disparities confined to smaller mines? Finally and most importantly, could federal regulators bring about further improvements in U.S. mine safety by channeling a larger share of inspection resources towards smaller, non-unionized mines? All of these questions represent promising topics for future inquiry.

97. *Morantz*, *supra* note 12.

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
Union	24.089*** (7.00)	28.335*** (8.64)	19.284** (7.68)	22.794** (9.37)	18.346*** (6.04)	18.893** (7.56)
Union X Mine Size	-20.991*** (7.39)	-27.578*** (7.02)	-24.827*** (9.26)	-32.700*** (8.93)	-39.289* (21.30)	-46.851** (23.40)
Mine Size	95.021*** (7.86)	104.234*** (7.82)	105.830*** (9.84)	120.333*** (10.32)	179.759*** (23.65)	173.459*** (24.81)
Log of Controller Size	3.341*** (1.08)	2.656** (1.08)	4.968*** (1.32)	3.998*** (1.42)	8.887*** (0.88)	8.461*** (1.12)
Observations	23,751	17,017	23,044	16,526	23,044	16,526
# of Union Mines / # of Total Mines	228 / 1,531	152 / 1,124	228 / 1,524	152 / 1,118	228 / 1,524	152 / 1,118
R^2	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	**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
Union	26.118*** (6.96)	30.248*** (8.88)	22.138*** (7.56)	25.686*** (9.73)	15.809*** (6.06)	16.070** (7.80)
Union X Mine Size	-22.007*** (6.39)	-28.176*** (6.19)	-26.452*** (7.95)	-33.743*** (8.12)	-30.000* (16.81)	-33.625* (19.59)
Mine Size	93.538*** (7.10)	102.464*** (7.27)	106.040*** (9.03)	119.382*** (10.03)	180.862*** (18.47)	171.963*** (19.74)
Log of Controller Size	3.267*** (1.10)	2.415** (1.22)	4.600*** (1.33)	3.686** (1.63)	8.894*** (0.92)	8.861*** (1.16)
Observations	21,789	14,926	21,153	14,489	21,153	14,489
# of Union Mines / # of Total Mines	222 / 1,363	147 / 950	222 / 1,360	147 / 948	222 / 1,360	147 / 948
R^2	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	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
Union	0.020*** (0.01)	0.024*** (0.01)	0.018*** (0.01)	0.021*** (0.01)	0.013** (0.01)	0.017** (0.01)
Union X Mine Size	-0.005 (0.00)	-0.005* (0.00)	-0.005 (0.00)	-0.005 (0.00)	-0.001 (0.01)	-0.004 (0.01)
Mine Size	0.012*** (0.00)	0.013*** (0.00)	0.012*** (0.00)	0.013*** (0.00)	0.006 (0.01)	0.011 (0.01)
Log of Controller Size	0.003*** (0.00)	0.004*** (0.00)	0.004*** (0.00)	0.005*** (0.00)	0.005*** (0.00)	0.006*** (0.00)
Observations	21,789	14,926	21,153	14,489	21,153	14,489
# of Union Mines / # of Total Mines	222 / 1,363	147 / 950	222 / 1,360	147 / 948	222 / 1,360	147 / 948
R^2	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	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
Union	1.310 (1.50)	1.996 (2.08)	0.805 (1.57)	1.400 (2.18)	-0.373 (1.45)	-0.663 (1.91)
Union X Mine Size	-1.094 (1.35)	-1.638 (1.65)	-1.366 (1.55)	-2.066 (1.92)	3.120 (5.57)	3.655 (6.40)
Mine Size	8.261*** (1.20)	9.664*** (1.46)	9.597*** (1.34)	11.303*** (1.80)	11.029*** (2.90)	12.190*** (3.25)
Log of Controller Size	0.497*** (0.19)	0.670** (0.29)	0.572** (0.23)	0.771** (0.36)	0.882*** (0.19)	0.978*** (0.29)
Observations	23,380	16,790	22,704	16,324	22,704	16,324
# of Union Mines / # of Total Mines	227 / 1,519	151 / 1,114	227 / 1,514	151 / 1,109	227 / 1,514	151 / 1,109
R^2	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	**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
Union	-31.363*** (10.40)	-26.716** (11.28)	-21.789** (8.49)	-23.297** (10.93)	-17.609** (8.76)	-17.683 (11.33)
Union X Mine Size	9.307** (4.63)	7.315 (5.24)	7.081 (5.67)	6.324 (7.42)	19.759 (26.08)	16.175 (31.75)
Mine Size	-12.422** (5.62)	-5.180 (6.15)	-4.407 (6.46)	1.526 (8.60)	13.967 (22.66)	27.636 (27.66)
Log of Controller Size	-1.915 (2.21)	-2.581 (2.44)	-6.278*** (1.81)	-6.789** (2.70)	-6.843*** (1.61)	-6.885*** (2.33)
Observations	23,273	16,694	22,601	16,230	22,601	16,230
# of Union Mines / # of Total Mines	227 / 1,519	151 / 1,114	227 / 1,514	151 / 1,109	227 / 1,514	151 / 1,109
R^2	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
Union	0.228*** (0.08)	0.240** (0.10)	0.184** (0.09)	0.207** (0.10)	0.135* (0.07)	0.090 (0.09)
Union X Mine Size	-0.113* (0.07)	-0.170*** (0.05)	-0.119 (0.08)	-0.196*** (0.06)	-0.180 (0.15)	-0.242* (0.13)
Mine Size	0.301*** (0.05)	0.378*** (0.06)	0.326*** (0.07)	0.435*** (0.07)	0.495*** (0.12)	0.624*** (0.16)
Log of Controller Size	0.111*** (0.01)	0.102*** (0.02)	0.134*** (0.02)	0.123*** (0.02)	0.123*** (0.01)	0.112*** (0.02)
Observations	23,349	16,767	22,679	16,305	22,679	16,305
# of Union Mines / # of Total Mines	227 / 1,517	151 / 1,113	227 / 1,512	151 / 1,108	227 / 1,512	151 / 1,108
R^2	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
Union	2.112*** (0.73)	2.014*** (0.75)	1.991*** (0.75)	2.012** (0.79)	1.121 (0.70)	1.112 (0.74)
Union X Mine Size	-0.385 (0.25)	-0.396* (0.22)	-0.427 (0.28)	-0.433 (0.28)	-0.315 (0.66)	-0.339 (0.61)
Mine Size	0.173 (0.29)	0.297 (0.35)	-0.144 (0.33)	0.076 (0.43)	0.495 (0.63)	0.462 (0.73)
Log of Controller Size	1.140*** (0.13)	0.881*** (0.13)	1.341*** (0.14)	1.061*** (0.15)	1.120*** (0.11)	0.939*** (0.11)
Observations	106,483	83,968	104,030	82,081	104,030	82,081
# of Union Mines / # of Total Mines	226 / 1,547	150 / 1,134	225 / 1,540	150 / 1,129	225 / 1,540	150 / 1,129
R^2	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	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
Union	0.182** (0.09)	0.274** (0.11)	0.240** (0.10)	0.360*** (0.12)	0.114 (0.09)	0.219** (0.11)
Union X Mine Size	-0.028 (0.02)	-0.030 (0.02)	-0.056* (0.03)	-0.065** (0.03)	-0.007 (0.07)	-0.044 (0.08)
Mine Size	0.010 (0.03)	-0.016 (0.03)	0.018 (0.03)	-0.003 (0.04)	-0.036 (0.07)	-0.126 (0.08)
Log of Controller Size	-0.038*** (0.01)	-0.045*** (0.02)	-0.040*** (0.01)	-0.051*** (0.02)	-0.028** (0.01)	-0.035** (0.01)
Observations	106,483	83,968	104,030	82,081	104,030	82,081
# of Union Mines / # of Total Mines	226 / 1,547	150 / 1,134	225 / 1,540	150 / 1,129	225 / 1,540	150 / 1,129
R^2	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	**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
Union	1.263*** (0.26)	1.287*** (0.29)	1.155*** (0.27)	1.202*** (0.28)	0.844*** (0.22)	0.753*** (0.25)
Union X Mine Size	-0.327** (0.14)	-0.380*** (0.11)	-0.361** (0.16)	-0.432*** (0.12)	-0.901*** (0.35)	-0.878*** (0.30)
Mine Size	0.516*** (0.13)	0.602*** (0.13)	0.505*** (0.16)	0.658*** (0.15)	0.863*** (0.33)	0.771** (0.34)
Log of Controller Size	0.503*** (0.04)	0.381*** (0.04)	0.563*** (0.05)	0.424*** (0.05)	0.516*** (0.04)	0.416*** (0.04)
Observations	106,483	83,968	104,030	82,081	104,030	82,081
# of Union Mines / # of Total Mines	226 / 1,547	150 / 1,134	225 / 1,540	150 / 1,129	225 / 1,540	150 / 1,129
R^2	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[a]

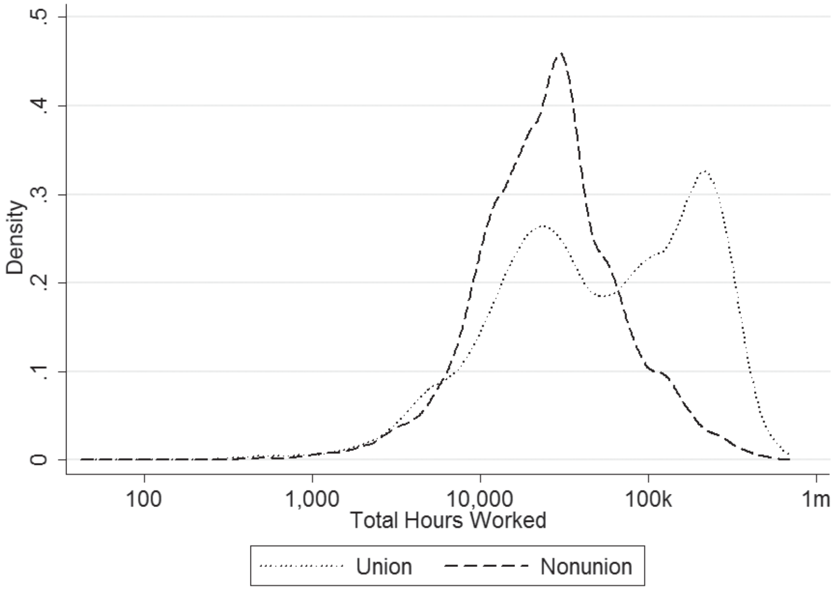
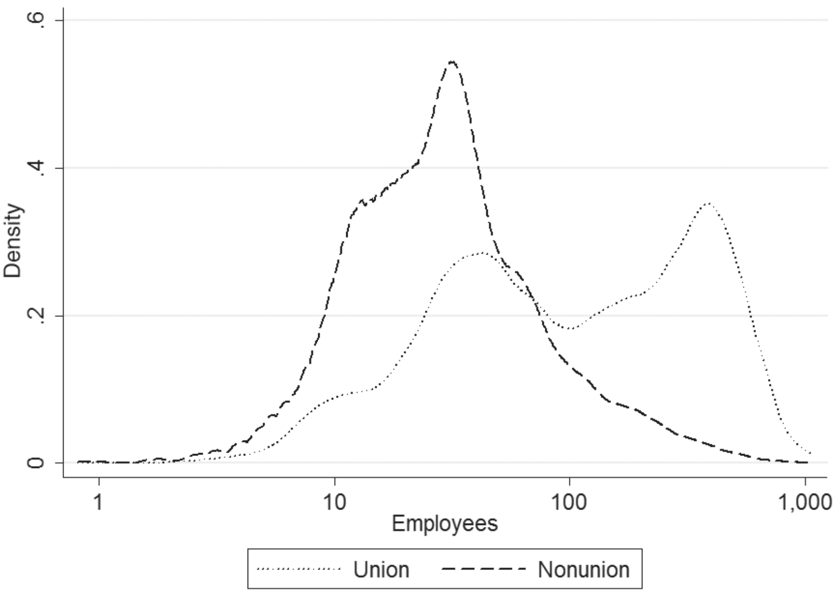
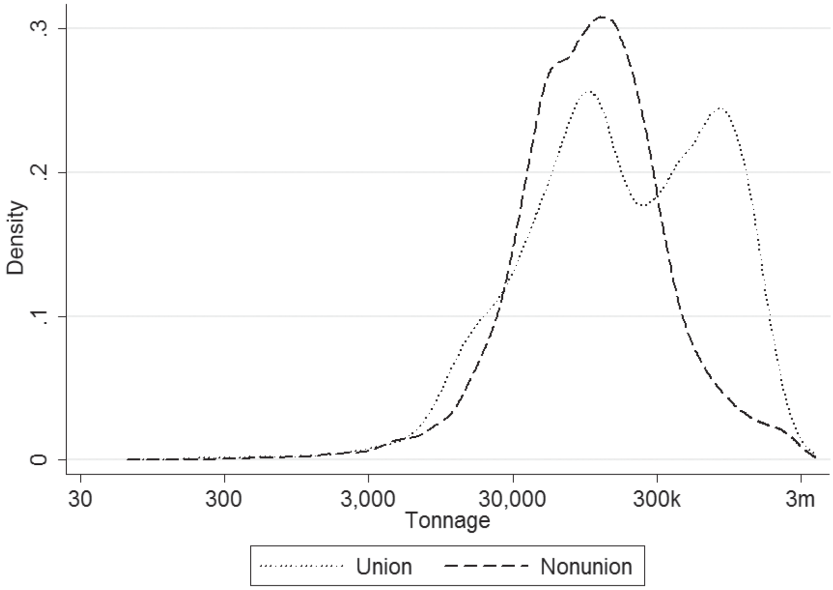


FIGURE 1B: EMPLOYEES[a]



[a] 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.

FIGURE 1C: TONNAGE[a]



[a] 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	**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
Union	0.333 (0.67)	-0.044 (0.47)	0.407 (0.69)	-0.030 (0.48)	-0.024 (0.58)	-0.407 (0.41)
Union X Mine Size	-0.201 (0.14)	-0.084 (0.12)	-0.251 (0.17)	-0.109 (0.15)	-0.326 (0.43)	0.053 (0.29)
Mine Size	-0.132 (0.13)	-0.173 (0.13)	-0.078 (0.16)	-0.109 (0.17)	-0.405 (0.44)	-0.945** (0.42)
Log of Controller Size	-0.101 (0.08)	-0.131 (0.10)	-0.140* (0.08)	-0.239*** (0.08)	-0.118* (0.07)	-0.183*** (0.07)
Observations	110,128	86,745	107,424	84,706	107,424	84,706
# of Union Mines / # of Total Mines	226 / 1,548	150 / 1,134	225 / 1,540	150 / 1,129	225 / 1,540	150 / 1,129
R^2	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, number of 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, number of 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

Variable Name	Variable Definition	Source
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[a]
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[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
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.

[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.